

## World Heritage Scanned Nomination

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UNESCO Region: ASIA AND THE PACIFIC

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**SITE NAME:** Phong Nha-Ke Bang National Park

**DATE OF INSCRIPTION:** 5<sup>th</sup> July 2003

**STATE PARTY:** VIET NAM

**CRITERIA:** N (i)

**DECISION OF THE WORLD HERITAGE COMMITTEE:**

*Excerpt from the Report of the 27<sup>th</sup> Session of the World Heritage Committee*

**Criterion (i):** Phong Nha is part of a larger dissected plateau, which also encompasses the Ke Bang and Hin Namno karsts. The limestone is not continuous and demonstrates complex interbedding with shales and sandstones. This, together with the capping of schists and apparent granites has led to a particularly distinctive topography.

The caves demonstrate discrete episodic sequences of events, leaving behind various levels of fossil passages, formerly buried and now uncovered palaeokarst (karst from previous, perhaps very ancient, periods of solution); evidence of major changes in the routes of underground rivers; changes in the solutional regime; deposition and later re-solution of giant speleothems and unusual features such as sub-aerial stromatolites. The location and form of the caves suggests that they might owe much of their size and morphology to some as yet undetermined implications of the schists and granites which overlay the limestone. On the surface, there is a striking series of landscapes, ranging from deeply dissected ranges and plateaux to an immense polje. There is evidence of at least one period of hydrothermal activity in the evolution of this ancient mature karst system. The plateau is probably one of the finest and most distinctive examples of a complex karst landform in SE Asia.

In summary, Phong Nha displays an impressive amount of evidence of earth's history. It is a site of very great importance for increasing our understanding of the geologic, geomorphic and geo-chronological history of the region.

### BRIEF DESCRIPTIONS

The karst formation of Phong Nha-Ke Bang National Park has evolved since the Palaeozoic (some 400 million years ago) and so is the oldest major karst area in Asia. Subject to massive tectonic changes, the park's karst landscape is extremely complex with many geomorphic features of considerable significance. The vast area, extending to the border of the Lao People's Democratic Republic, contains spectacular formations including 65 km of caves and underground rivers

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**1.b State, Province or Region:** Bo Trach and Minh Hoa Districts - Quang Binh Province

**1.d Exact location:** N17 32 14.0 E106 09 04.5

951 Rev  
5/7/2000  
# 1

UNITED NATIONS  
EDUCATION SCIENTIFIC CULTURAL ORGANIZATION

Date received:  
Identification No:

CONVENTION CONCERNING THE PROTECTION  
OF THE WORLD CULTURAL AND NATURAL HERITAGE

WORLD HERITAGE LIST  
NOMINATION FORM

**THE PHONG NHA-KE BANG  
NATIONAL PARK  
VIETNAM**

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# LOCATION MAP OF PHONG NHA - KÊ BÀNG NATIONAL PARK QUẢNG BÌNH PROVINCE - VIETNAM



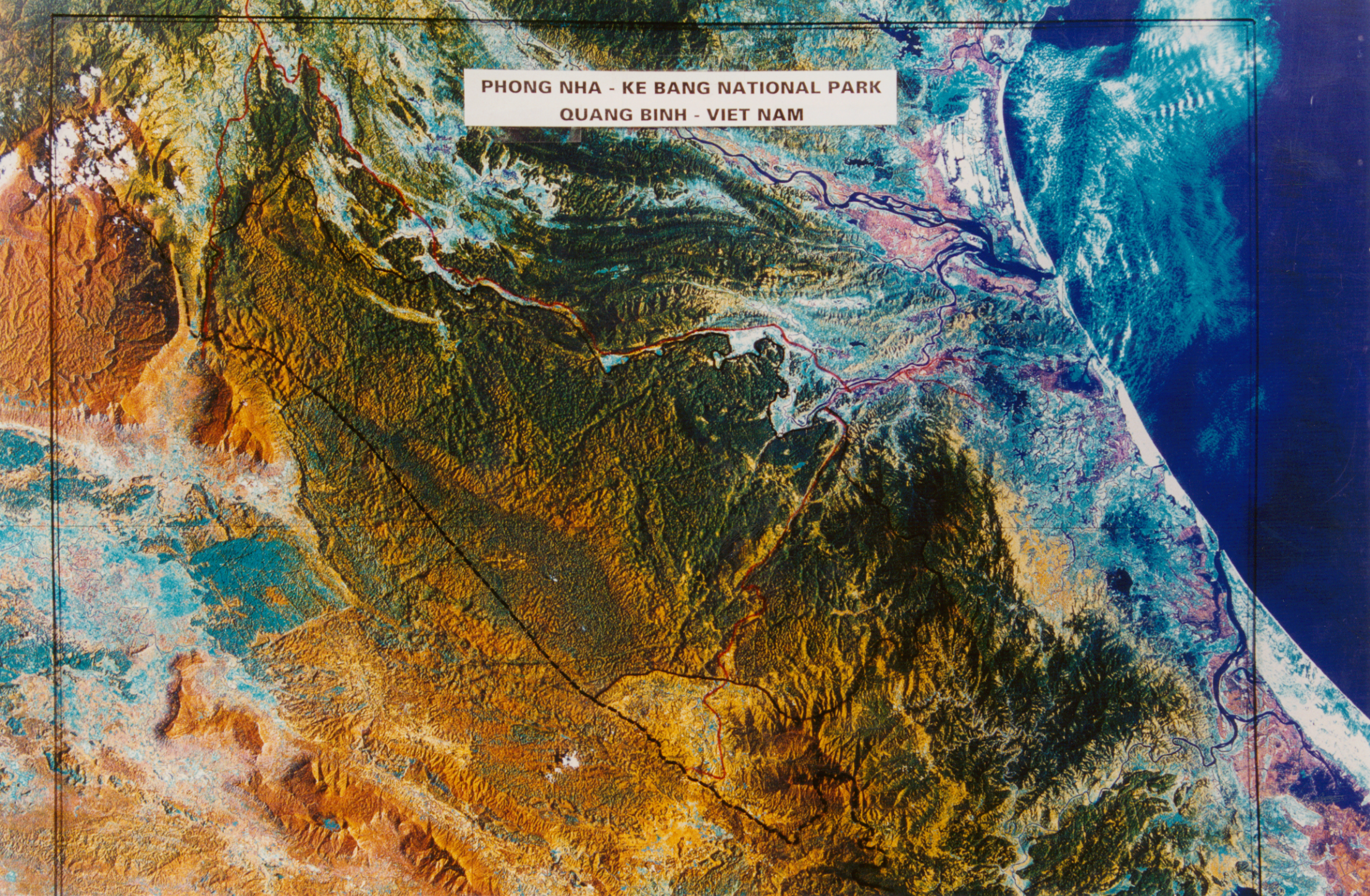
**PHONG NHA - KÊ BÀNG  
NATIONAL PARK**

**LEGEND**

- National boundary
- Provincial boundary
- River
- National road
- Provincial road
- Railway

SCALE 1 : 8,000,000

**PHONG NHA - KE BANG NATIONAL PARK  
QUANG BINH - VIET NAM**



**NOMINATION OF PROPERTY FOR INCLUSION ON THE  
WORLD NATURAL HERITAGE LIST**

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**1. Identification of the Property**

**a. Country**

Socialist Republic of Vietnam

**b. State, Province or Region**

Bo Trach and Minh Hoa Districts - Quang Binh Province.

**c. Name of Property**

Phong Nha - Ke Bang National Park

**d. Exact location on map and indication of geographical co-ordinates to the nearest second**

Latitude : 17<sup>o</sup>20' to 17<sup>o</sup>48' N

Longitude : 105<sup>o</sup>46' to 106<sup>o</sup>24' E

This site is located to the southwest of the Gianh River, 40km from Dong Hoi town, 500 km from Hanoi the capital, and close to the Laos-Vietnam border.

**e. Maps and/or plans showing boundary of area proposed for inscription and of any buffer zone**

**Appendix 1e**

- Map of Phong Nha -Ke Bang National Park in Vietnam, scale 1/2,500,000.
- Map of Phong Nha - Ke Bang National Park in Quang Binh Province, scale 1/250,000.

**f. Area of site proposed for inscription (ha.) and proposed buffer zone (ha.) if any.**

- The area of the core zone is 147,945 ha
- The area of the buffer zone is 195,400 ha.

**2. Justification for Inscription**

**a. Statement of significance**

- Phong Nha - Ke Bang is a karst area of the highest significance and value in both Southeast Asia and the world:
- ✓ The area has a complicated geological structure. Various rocks are present: sandstone, quartzitic sandstone, siltstone, shale, limestone, siliceous limestone, marl, granite, granodiorite, diorite, aplite, pegmatite, etc. This area has had a long earth crust development history from the Ordovician period (464 Ma) to the present, undergoing 5 major cycles:
  - 1) Late Ordovician - Early Silurian (O<sub>3</sub>-S<sub>1</sub>)
  - 2) Middle Devonian - Late Devonian (D<sub>2</sub> - D<sub>3</sub>)
  - 3) Carboniferous - Permian (C-P)
  - 4) Meozoic (T, J, K)
  - 5) Cenozoic (P, N, Q).
- ✓ The endogenous and exogenous geological processes which have occurred from the Triassic to the present have created the diverse topography and geomorphology of the area:
  - 1) Non - karst landforms: low, round-top mountains with planation surfaces, abrasion-accumulation terraces along the valleys of the Son and Chay Rivers and at the margins of the central limestone massif.



- 2) Transitional landforms, with complicated alternation between limestone massifs and terrigenous terrain.
  - 3) Karst landforms characterized old tropical karst formed mainly from the Mesozoic, but the most clear signals in the Cenozoic were constituting 2/3 of the area of the heritage site and forming the largest limestone wilderness in the world (Pierre, 1966). The karst formation process has left behind distinct and peculiar imprints such as "underground rivers", "dry caves", "terraced caves", "suspended caves", "dendritic caves", and "intersecting caves", related with the orogenic phases and tectonic faults in the Cenozoic from the Oligocene (36 Ma.) to the present.
- Phong Nha - Ke Bang National Park has contains a large area of primary forest on limestone. This area, which covers over 100,000ha, is the largest area of this habitat type in Southeast area.
  - More widely, Phong Nha - Ke Bang is also a high priority for biodiversity conservation with many threatened and endemic plant and animal species. The results of preliminary investigations by RAS 93/102/WWF/IUCN (1996-1997), Timmins et al. (1999), and the Vietnam - Russian Tropical Centre (1999), and the investigations by the Forest Inventory and Planning Institute and the Forestry College for preparation of the Phong Nha- Ke Bang National Park Management Plan showed that in this area there are 876 vascular plant species and 568 vertebrate species including 113 mammal species, 302 bird species, 59 reptile species, 22 amphibian species and 72 fish species.
  - In the plant list of the National Park, there are 51 threatened plant species, of which 38 species are listed in Vietnam Red Data Book and 25 species are listed in 1997 IUCN Red List of Threatened Plants. In the animal list of the National Park, there are 68 threatened animal species listed in Vietnam's Red Data Book and 44 species listed in the IUCN Red List of Threatened Animals, 1997

TỈNH HÀ TĨNH

# LANDUSE AND ZONING MAP OF THE PHONG NHA - KE BANG NATIONAL PARK QUANG BINH PROVINCE - VIET NAM

LÀO

H. MINH HOA

H. TUYẾN HOÀ

H. QUẢNG TRẠCH

H. BỐ TRẠCH

H. QUẢNG NINH

LÀO

## LEGEND

- |  |                                  |  |  |
|--|----------------------------------|--|--|
|  | Vietnam - Laos National Frontier |  | Tropical evergreen forest on limestone |
|  | Provincial Border                |  | Tropical evergreen forest on hill      |
|  | District Border                  |  | Tree and shrub savanna on limestone    |
|  | Commune Border                   |  | Tree and shrub savanna on hill         |
|  | National Park Boundary           |  | Cultivated land                        |
|  | Zoning Boundary                  |  | National Park Headquarter              |
|  | National Highway                 |  | Forest guard station                   |
|  | River, Stream, Lake              |  | Forest research post                   |
|  | Caves                            |  | Animal, Vegetation Observe post        |
|  | Mountain top                     |  | Border post                            |
|  |                                  |  | Core Zone                              |
|  |                                  |  | Regeneration Zone                      |
|  |                                  |  | Tourist Zone                           |
|  |                                  |  | Buffer Zone                            |

## Appendix 2a

- List of threatened plant and animal species of Phong Nha - Ke Bang National Park.
- Geological map of the Phong Nha - Ke Bang National Park, scale 1/100,000.

### **b. Possible comparative analysis (including state of conservation of similar properties)**

The Phong Nha - Ke Bang area is of high geological diversity:

1) Ancient limestone (Paleozoic) with various material compositions, colors and structures:

- Devonian limestone of light grey color, intercalated with argillaceous limestone and siliceous limestone of black color (in the area at the entrance of Phong Nha cave, Dark cave, etc.).
- Carboniferous - Permian limestone, accounting for most of the limestone massif, with  $\text{CaCO}_3$  content over 95 %, massive structure, and continuous distribution, which are formed in the stabilized tectonic stage.

2) Typical tropical karst developed in close association with tectonic cycles:

- Seven elevation levels of caves and planation surfaces related with 7 tectonic uplift cycles: Oligocene, Miocene, Pliocene, Early Pleistocene ( $Q_1$ ) Middle - Late Pleistocene ( $Q_{II-III}$ ), Late Pleistocene ( $Q_{III}^{2}$ ) and Early-Middle Holocene ( $Q_{iv}^{1-2}$ ).

3) The peculiarity of this area in comparison with karst in other countries worldwide

- In comparison with moderate karst zones in Europe such as the Pirin National Park (Bulgaria), Plitvice Lake National Park (Croatia), Skocjan caves (Slovenia), the Yorkshire Dales National Park (UK), and America as the Carlsbad cave and Mammoth cave national park (USA), the Phong

Nha - Ke Bang is a typical humid tropical karst area. The process of mechanical erosion and chemical dissolution of limestone ( $\text{CaCO}_3$ ) by the underground rivers in the area is extremely intensive, and the surface and underground river valleys here are very narrow. Water level marks cut deeply into the limestone on cave ceilings and walls; fields of terrigenous sand and gravel in the form of "terraces" and "flood plains" along the underground rivers; and "alluvial cones" of the branch caves are the characteristics of the Phong Nha - Ke Bang karst.

- In comparison with the karst and of other tropical areas in Southeast Asia such as the Gunung Mulu National Park (Malaysia), Lorents National Park (Indonesia) the difference is that their karst features are younger in age, these developed mainly in the Quaternary on the young Oligocene aged limestone (about 36 Ma), whereas the Phong Nha - Ke Bang limestone is of very old age from the Devonian (377 Ma) to the Permian (250 Ma).

Thirty six million years ago, when the reef limestones of most other Southeast Asia areas started their formation in the sea, a cave formation process in Oligocene was already going on inland by uplifting movement in the Phong Nha - Ke Bang limestone massive of Paleozoic age. This means that the karst features at Phong Nha - Ke Bang are at least 36 million years older.

- Comparison with karst features in Thailand and Laos:
  - ✓ In Thailand caves have developed in Permian limestone, with a total length of about 40 km, whereas in the Phong Nha - Ke Bang limestone massif, the caves have a total length of about 80 km (according to the British Cave Research Association's data, 1998).
  - ✓ In Laos the cave system has not been completely surveyed. It is mainly developed in Carboniferous - Permian limestones, which are connected with the Phong Nha - Ke Bang massif, while in other areas karst is weakly developed.

**The specific features of the Phong Nha - Ke Bang cave area are:**

- There are long underground rivers (river caves)

- The limestone is continuous, massive, and extensive, supporting primary tropical forest
- Caves are developed in massive pure limestones, thus forming many intersecting systems of different ages.
- The stalactites and stalagmites are beautiful, fantastic; there are many generations of stalactites and stalagmites superimposed on each other with ages corresponding to those of the cave levels.

### **c. Authenticity / Integrity**

- The entire Phong Nha - Ke Bang National Park is situated in an immense karst plateau named the Phong Nha - Ke Bang - Hin Namno limestone block. On the Vietnamese side, the limestone occupies an area of about 200,000 ha. In combination with the neighbouring limestone area belonging to the Laos People's Democratic Republic, the total area of this karst region is about of 400,000 ha. Phong Nha - Ke Bang, with a total area of 147,945 ha, is strictly protected. The population density inside the core zone is very low. This is also a frontier mountainous region, far from population centers, therefore its integrity is high and it is possible to carry out sustainable management of the Site. Vietnam's Government and local authorities support the establishment of Phong Nha - Ke Bang World Natural Heritage Site. The quick approval of Phong Nha - Ke Bang National Park and the establishment of a Management Board for this park has showed the willingness of Vietnam's Government and local authorities to establish a World Natural Heritage Site. The support of different authorities is a necessary condition for protection and management of this Site in the future.
- Phong Nha was declared by the Vietnamese Government's Decree N<sup>o</sup> 194/CT dated 9 August 1986 as a Nature Reserve in the Special Use Forest System of Vietnam.
- Phong Nha Cave and Xuan Son Ferry were declared by the Decision No 236-VH/QD dated 12 December 1986 from the Ministry of Culture and Information as a Relic and Landscape Site and a National Heritage.

- In 1994, Phong Nha Nature Reserve, with a total area of 41,132ha was established. It has a good management structure, and has been getting good support from district and provincial authorities.
- In 2000, the plan for expanding Phong Nha - Ke Bang National Park to 147,945 ha was approved. A Protection Section has been established with 96 rangers, 9 forest guard stations, and 2 mobile patrol units.
- Close to Phong Nha Nature Reserve, on the Laotian side, Hin Namno National Biodiversity Conservation Area (NBCA) with a total area of 75,500 ha, has been established. The two neighbouring provincial authorities have had many meetings to discuss cooperation in the protection of the 2 Nature Reserves. This will ensure that the integrity of the entire Site will be successfully protected.
- A project of Gianh River watershed was established by the Ministry of Agriculture and Rural Development for planning the catchment area of Gianh River.
- The Ho Chi Minh National Highway will be built in this area, but will not cross the Site. It will follow the root of road numbers 12A and 15A, outside the park.

**d. Criteria under which inscription is proposed (and justification for inscription under these criteria)**

Based on the UNESCO's classification of World Heritage, among the four criteria, Phong Nha - Ke Bang National Park has potential value as criteria (i) and (iv) to become a natural world heritage as follows:

**Criterion (i): Earth' history and geological features**

- The Phong Nha - Ke Bang area has a diverse and complicated geological structure, with 5 basic synclines and 5 basic anticlines:
- ✓ Dong Hoi dome - like anticline: 10 - 20km long, 5 - 8km wide, with the core aged Cambrian (ε), and the axis in an arched form, with its convex side facing South West

- ✓ Dai Du anticline: in arch form, 20 - 25km long, 6 - 7km wide, with the core aged Early Devonian ( $D_1$ ).
- ✓ Dong Phuong anticline: 20 - 25km long, 2 - 4km wide, with the core aged Middle Devonian ( $D_2$ ) and the axis extending in a NW - SE direction.
- ✓ Cao Mai anticline: 15 - 20km long, 2 - 3km wide, with the core aged Early Devonian ( $D_1$ ), and the axis extending in a NW - SE direction.
- ✓ Rao Nay graven - like syncline (beyond the proposed world natural heritage area).
- ✓ Quy Dat anticline: 20 - 25km wide, located between the Si Thuong and Cao Mai anticlines
- ✓ Phong Nha syncline: stretches from national highway No 20 to Thac Dai.
- ✓ Thac Dai - Ma Rai syncline; 15 - 20km long, 5 - 6km wide, with the core being limestone aged C - P.
- ✓ Trung Thuan syncline (beyond the proposed world natural heritage area).
- The fault system consists of faults along 2 main trends and 2 secondary trends:
  - ✓ The two main trends are NW - SE and NE - SW. The NW - SE trending faults are of Pre - Ordovician and Silurian age and were reactivated in the Cenozoic. The SE - NW trending faults appeared mainly in the Cenozoic and played the decisive role in the formation of the Phong Nha - Ke Bang cave system.
  - ✓ The secondary trends are longitudinal and latitudinal.
- The diverse petrological composition and geological structure are the result of the long geological development history which bears both global and local characteristics with 5 development stages:

- ✓ Late Ordovician - Silurian stage: The earth's crust was broken and then subsided, forming the terrigenous sediments of the Long Dai formation (O3 -S11d)
- ✓ Middle - Late Devonian stage: The earth's crust subsided for the second time and the sea was expanded. Sediments were formed composed of sandstone, siltstone and claystone intercalated with limestone.
- ✓ Carboniferous - Permian stage; The Carboniferous - Permian limestone massifs were formed. The earth's crust in the Phong Nha - Ke Bang area was broken down for the third time, creating shallow, isometric basins.
- ✓ Mezozoic orogenic stage (Triassic, Jurassic, Cretaceous): The Phong Nha - Ke Bang limestone massif was lifted up above sea level, and karst weathering and denudation processes occurred.
- ✓ Cenozoic stage: The mountains and old karstic cave systems of Phong Nha - Ke Bang were formed. The diverse topographic and geomorphologic features can be divided into 7 levels:

1,600 - 1,400m level: Terrace Oligocene

1,000 - 800m (in the west) 700 - 600m (in the east) Terrace Miocene

600 - 400m and 300 - 200m level: Terrace Pliocene

100 - 80m (Terrace Gun - Mindel interglacial)

80 -60m (Terrace Mindel - Riss interglacial)

40 - 25m, 25 - 15m (Terrace Riss - interglacial), and 15 - 6m: Flandrian transgression Terrace.

#### **Criterion (iv): Biodiversity and threatened species**

- Phong Nha - Ke Bang supports an extensive area of tropical forest on limestone and hills with a forest cover of 96.2%. The area of primary forest reaches 92.2%. Comparing to the average forest cover of Vietnam, which is only 28%, and of which the primary forest is only 10%, the forest cover of Phong Nha - Ke Bang is very high. Tropical forest on



limestone is a special type of vegetation. At this Site, there are many plant species endemic to limestone forest, such as: *Burretiodendron hsienmu*, *Annamocarya sinensis*, *Platanus kerrii*, and *Hopea sp.*.

- The primary forest at this Site supports extremely high levels of biodiversity:
- ✓ Flora: Based on the results of initial field surveys, a list of vascular plants was established, with 152 families, 511 genera and 876 vascular plant species. Among which, 38 threatened species are listed in Vietnam's Red Data Book, 25 species are listed in the 1997 IUCN Red List of Threatened Plants, and 13 species are endemic to Vietnam. In particular, *Hopea sp.*, a member of the Dipterocarpaceae, is a strictly endemic species, and Quang Binh province is the center of its distribution.
- ✓ Fauna: Preliminary faunal surveys have identified 113 mammal species with 35 species described in Vietnam's Red Data Book and 19 species listed in the 1997 IUCN Red List; 302 bird species, with 15 species noted in Vietnam's Red Data Book and 19 species listed in the 1997 IUCN Red List; 81 reptile and amphibian species, among which 18 species are noted in Vietnam's Red Data Book and 6 species are listed in the 1997 IUCN Red List; 259 butterfly species; 72 fish species, among which 4 are endemic to Quang Binh province. In 1996, one fish species new to Vietnam, and one species new to science were recorded at the Site. In particular, the forest on limestone is a suitable habitat for several primate species. In this area, the list of primates totals 10 species corresponding to about 50% of the total number primate species in Vietnam, 7 primate species are listed in Vietnam's Red Data Book and 3 species and subspecies are strictly endemic to Vietnam. In particular, the site supports the entire global population of Hatinh Langur.
- The Arem and Ruc ethnic tribes living in the Phong Nha - Ke Bang forest are the two smallest ethnic groups in Vietnam. Some groups still live in rocky caves, and gather forest products. These ethnic groups are an attractive subject for ethnological study.

### 3. Description

#### a. Description of Property

##### *Property natural characteristics*

##### **Topography**

- The endogenous and exogenous geological processes, which have occurred from Triassic up to now, have created the diverse topography and geomorphology of the area:
- ✓ Non-karst landforms: low, round-top mountains with planation surfaces, and abrasion-accumulation terraces along the valleys of Son, Chay Rivers and at the margins of the central limestone massif.
- ✓ Transitional landforms, with a complicated alternation between limestone massifs and terrigenous terrain.
- ✓ Karst landforms characterized old tropical karst formed mainly in the Cenozoic, constituting 2/3 the area of the site, and forming the largest limestone wilderness in the world (Pierre Gourou, 1966).

##### **Geological and cave system development process**

- The geological structure here expresses the diversity and long development history of the earth's crust. The earth's crust has undergone several main development stages (from the Ordovician period up to now) with 5 tectonic megacycles corresponding with the 5 geological evolution stages of the world.

##### *1- Late Ordovician - Early Silurian stage (463.9 - 430 Ma)*

The earth's crust was broken down and then subsided, forming the terrigenous sediments of the Long Dai formation ( $O_3-S_1ld$ ) which are distributed in a linear form extending in a NW-SE direction, yielding fossils of Graptolithina of  $O_3-S_1$  age (*Deirastrites convolutus*, *Monograptus halli*, etc.).

##### *2- Middle - Late Devonian stage ( $D_2 - D_3$ ) (386-362.5 Ma)*

The earth's crust subsided for the second time, and the sea expanded. The sediments that evolved were composed of sandstone, siltstone and claystone intercalated with limestone, yielding characteristic fossil assemblages corresponding with the transgressive direction as follows:

*Calceola sandalina*, *Desquamatia kurbesekiana* (near-shore) → *Stringocephalus burtini*, *Emanuella takwanesis*, *E.volhynica*, *Desquamatia ventrycosa*, *Scoliopora denticulata*, *Stachyodes costulata*, *S. lagowiensis* (shallow sea) and *Connodonta* (open sea).

### 3- Carboniferous - Permian stage (C-P) (362.5 - 245 Ma)

This was the stage when the Carboniferous - Permian limestones massifs were formed. The earth's crust in the Phong Nha - Ke Bang area was broken down for the third time, creating shallow, isometric basins (Marginal sea of continent), and yielding fossils aged from the Lower Carboniferous (*Crinoidea*, *Foraminifera*, and *Tetracoralla*) to the Middle Carboniferous (*Foraminifera*) and finally the Permian (*Foraminifera* and *Tetracoralla*).

### 4- Meozoic orogenic stage (Triassic, Jurassic, Cretaceous)

The Phong Nha - Ke Bang limestone massif was lifted up above the sea level, and karst, weathering and denudation processes occurred.

### 5- Cenozoic stage

This was the stage when the mountains and old karstic cave systems of Phong Nha - Ke Bang were formed, with ages respective to the following planation surface levels:

- ✓ 1,600- 1,400 m level: corresponding with the first generation of caves dating from the Oligocene (36 Ma).
- ✓ 1,000- 800 m (in the west) 700 - 600m (in the east) level: corresponding with the first generation of caves dating from the Miocene (23 Ma to 5 Ma).

- ✓ 600 - 400 m and 300- 200 m levels: corresponding with Pliocene (5 - 1.6 Ma).
- ✓ 100 - 0 m level (1.6 Ma to present), corresponding with various interglacial cycles in Quaternary: 100-80m: Gond - Mindel interglacial cycle (more than 800 Ka), 80 - 60m: Mindel - Riss interglacial cycle (over 300 Ka), 40 - 25 m and 25 - 15m: Riss - Wurm interglacial cycle (over 70 Ka) and 15 - 6m: Flandrian transgression (18 - 4 Ka).
- The Phong Nha - Ke Bang Caves consist of:
  - ✓ The Phong Nha Cave system, with 9 caves of various sizes
  - ✓ The Vom Cave system, with 8 caves of various sizes

The total length of the Phong Nha - Ke Bang Caves is 64,358m (from 4/1997). In these caves, there are many underground rivers. In some places they appear on the ground and all the inlets of underground rivers flow down to the Chay and Son Rivers. Finally, they combine with the Gianh River and run to the sea.

**Table 1: Cave systems at Phong Nha - Ke Bang**

No.	Name of cave	Commune	District	Length of cave (m)	Height of cave (m)
	<b>Phong Nha Cave system</b>			33,758	
1	Phong Nha Cave	Son Trach	Bo Trach	7,729	83
2	Toi Cave	Son Trach	Bo Trach	5,258	80
3	E Cave	Thuong Trach	Bo Trach	736	-
4	Cha An Cave	Thuong Trach	Bo Trach	667	15
5	Thung Cave	Thuong Trach	Bo Trach	3,351	133
6	En Cave	Thuong Trach	Bo Trach	1,645	49
7	Khe Tien Cave	Thuong Trach	Bo Trach	520	- 15

8	Khe Ry Cave	Thuong Trach	Bo Trach	13,817	120(+58-62)
9	Khe Thi Cave	Thuong Trach	Bo Trach	35	- 20
	<b>Vom Cave system</b>			<b>30,627</b>	
10	Vom Cave	Thuong Trach	Bo Trach	15,050	145
11	Dai Cao Cave	Thuong Trach	Bo Trach	1,645	28
12	Duat Cave	Thuong Trach	Bo Trach	3,927	45
13	Ca Cave	Thuong Trach	Bo Trach	1,500	60
14	Ho Cave	Thuong Trach	Bo Trach	1,616	+ 46
15	Over Cave	Thuong Trach	Bo Trach	3,244	103(+93-10)
16	Pygmy Cave	Thuong Trach	Bo Trach	845	- 94
17	Ruc Caroong Cave	Thuong Trach	Bo Trach	2,800	45

Some of above caves have been identified to particular geological ages as follows: (table 2)

**Table 2: Geological ages of some caves**

N	Name of cave	Elevation of cave bottom, m	Trend direction	Geologic ages
1	Khe Ry En	1500-1600	NW-SE	Oligocene (35 Ma)
		300		
2	Vom	360	SW-NE	Pliocene (5 Ma)
		0		
3	Over (belonging Vom cave system)	93	S-N	Q <sub>I</sub> (900 Ka)
		43		Q <sub>II</sub> (300 Ka)
		24		Q <sub>III</sub> (100 Ka)
		0		Q <sub>IV</sub> (present)

## **Phong Nha Cave system**

### *1- Phong Nha Cave*

Phong Nha Cave is the most famous one in the entire system. Phong Nha Cave was known in the ninth and tenth centuries and in that time it was used for worship.

The Phong Nha Cave entrance is the last part of an underground river that connects with the Son River. The length of the Cave is 7,729 m and small boats can penetrate inside the Cave to a distance of 1,500 m.

### *2- Toi Cave (Dark Cave)*

Following the Son River towards the upper area of the Chay River, on the left of this river is the Toi Cave. Its length is 5,258m and its height is 80m. The entrance of the Cave is wide and light and covered by dense forest. This is the habitat of Hatinh Langur (*Trachypetecus francoisi hatinhensis*).

### *3- E Cave*

E Cave is a small cave, 736 m in length, situated to the southeast of Phong Nha Cave in a deep valley. This Cave can be approached along the old Ho Chi Minh Trail.

### *4- Cha An Cave*

Cha An Cave is situated at the 16 km marker on road number 20. Its length is 667m and its width is 15m.

### *5- Thung Cave*

From Cha An Cave, it takes 3 hours on foot, to Thung Cave. This Cave also has an underground river, 3,351m long and 133 m wide. This underground river receives water from the Rao Thuong stream.

### *6- En Cave*

From road number 20, it take 2 days on foot to reach En Cave.. It is 1,645m in length and 78.6m in width. The entrance is wide with a large sandy beach. Thousands of swifts live and nest on the walls of the Cave.

### *7- Khe Tien Cave*

Khe Tien Cave is situated in the South of the Phong Nha area. Its entrance is located where the Toun Tien stream, where this stream flows down into the Cave. Its length is 520m.

### *8- Khe Ry Cave*

Khe Ry Cave is in the South of the site. Its entrance is located where the Khe Ry stream goes underground. Its length is 13,817m and its height is 120m. It originates in the mountain at about 1,300m. The Khe Ry stream forms part of the Son River watershed.

### *9- Khe Thi Cave*

Khe Thi Cave is a small cave and a total length of 35m. The Khe Thi stream originates from high elevation, and connects with Thung Cave and then flows down to the underground river system.

## **Vom Cave system**

### *10- Vom Cave*

Near the Ho Chi Minh Trail, along the Chay River is the Vom Cave. Its length is 15,050 m and it is 145m high. This Cave is the intersection of several caves with underground rivers, and a lake inside the mountain. The harmonious combination of stalactites, columns, rocky walls, lake and sunlight, forms an amazing landscape.

### *11- Dai Cao Cave*

Dai Cao Cave is connected to Vom Cave, but can't be accessed directly. To access this Cave, one must exit Vom Cave, and follow the Ho Chi Minh Trail. Dai Cao Cave is 1,645 m long and 28 m in height.

### *12- Maze Cave (Duat Cave)*

Maze Cave is connected with Dai Cao Cave, its length is 3,927m and it is 45m high. In spite of its small size, Duat Cave has many rocky and sandy beaches and connected dry caves.

### *13- Pitch Cave (Ca Cave)*

Pitch Cave is situated near an old Arem village. This Cave is wide but short, its length is 1,500m and it is 62m high. Within the Cave, there are many rocky beaches.

#### *14- Tiger Cave (Ho Cave)*

Ho Cave is connected with Ca Cave. The length of the Cave is 1,616m and its height is 46m. There is a short river with many rocky and sandy beaches.

#### *15- Over Cave*

The length of this Cave is 3,244 m, and it is 103 m high. Its width 30 - 50 m. Over Cave has many big rock and sand beaches.

#### *16- Pygmy Cave*

Pygmy Cave is situated near the origin of the stream system. It is short at 845m in length and the entrance of Cave has many rocky beaches.

#### *17- Ruc Caroong Cave*

Ruc Caroong Cave is situated in the South of Phong Nha - Ke Bang National Park. In this area, there is an Arem village. In the past these people lived in the limestone caves and subsisted on forest products.

### **Soil**

- In Phong Nha - Ke Bang National Park, there are many kinds of soil formed from different mother rocks:
  - ✓ Dark Macgalite - Feralite soil formed from limestone
  - ✓ Red and Red - Brown Feralite soil formed from limestone area.
  - ✓ Red - Yellow Feralite soil formed from schist
  - ✓ Yellow - Red Feralite soil formed from Magmatic acid
  - ✓ Yellow Feralite soil formed on sandstone
  - ✓ Alluvium soil situated in the valleys and at the foot of limestone karst
  - ✓ Alluvium soil situated along the streams and river



- ✓ Yellow Humic Feralite soil formed on low mountains

## Climate

### Temperature

- The annual mean temperature is 23 - 25°C
- The maximum temperature is 41,6°C (May/1992)
- The minimum temperature is 5,5°C (January/1993)
- Annual mean temperature in the Phong Nha area is lower than that in the coastal area by 1°C. The lowest temperature is in December, January, and February.
- The highest temperature is in June, July and August, with mean temperature greater than 28°C.
- Daily variation in temperature is high: about 10°C in summer and 8°C in winter.

**Table 3: Monthly and annual mean temperature (°C)**  
(1960 - 1996)

Met. station	Monthly mean												Annual mean
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tuyen Hoa	17.5	18.8	21.4	24.8	27.7	28.8	29.2	28.1	26.2	23.8	20.9	18,4	23.8
Ba Don	18.3	19.1	21.6	24.6	27.9	29.1	29.5	28.7	27.0	24.7	21.9	19.2	24.3
Dong Hoi	19.0	19.3	21.7	24.9	28.0	29.7	29.7	29.1	27.0	24.8	22.4	19.9	24.3

### Rainfall and humidity

- Phong Nha - Ke Bang is situated in region of the high rainfall with an average of 2,000mm to 2,500mm per year. In particular, in the limestone area near the Laos - Vietnam frontier, the rainfall is about 3,000mm per year.

- The highest rainfall is concentrated in September, October and November.
- The rainy season is from July to December (centered on the period from September to November). The rainfall in this period accounts for 88% of the total annual rainfall.
- The dry season is from January to June and the lowest rainfall is in February and March. In spite of low rainfall, the average number of rainy days still reaches more than 10 days per month.
- There are more than 160 rainy days per year.

**Table 4: Monthly and annual rainfall (mm)**

Met. station	Monthly total												Annual total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tuyen Hoa	50.7	34.9	49.2	65.0	140.7	170.0	136.1	209.5	530.1	582.0	231.4	67.9	2266.5
Ba Don	50.5	36.5	38.5	48.0	95.5	106.4	90.0	139.7	445.2	592.9	197.7	91.5	1932.4
Dong Hoi	62.4	43.4	43.2	56.1	106.0	84.2	86.9	140.4	444.6	396.5	366.2	128.9	2159.4

**Table 5: Monthly and annual rainy days**

Met. station	Month total												Annual total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tuyen Hoa	13.0	12.3	11.9	10.4	11.2	10.3	8.4	13.4	17.0	17.9	18.2	13.7	158.7
Ba Don	9.3	9.3	10.2	7.2	8.6	8.2	6.5	10.5	14.5	18.0	16.9	11.0	129.8
Dong Hoi	10.7	10.0	9.8	7.7	8.5	7.0	9.6	9.6	15.5	17.6	16.5	12.5	135.0

- Mean annual relative humidity is 83 - 84%. In the period September to April, humidity is highest (85-90%). The period May to August experiences hot and dry northwesterly winds, so that humidity is lower.

**Table 6: Monthly and annual evaporability (mm)**

Met. station	Monthly												Annual mean
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tuyen Hoa	42.8	38.8	58.2	81.9	129.3	147.0	184.3	134.4	67.9	52.6	44.4	48.9	1030.5
Ba Don	50.8	38.2	45.4	62.6	116.4	148.6	177.6	136.4	74.4	66.0	61.0	57.6	1035.0
Dong Hoi	62.6	46.4	52.7	71.0	136.1	170.4	201.1	160.6	89.1	79.8	77.3	75.1	1222.3

### Wind

- In the winter the Site experiences northeasterly winds and sometimes the easterly or southeasterly winds appeared.
- In the summer a southwesterly wind is common, which sometimes changes to a hot and dry northwesterly wind, in June, July, and August.
- The period from September to April, the easterly and southeasterly winds sometimes come from the sea.

### Hydrology

- Phong Nha - Ke Bang is the catchment area of many streams and rivers that feed the Gianh River. The Site also has a massive karst area, hence, underground rivers are common. Seemingly, there are no big rivers on the topographic map of the area. On the ground, many small streams flow down into the Rao Thuong stream. These streams flow into the Chay and Choc Rivers, which create the upper area of the Gianh River. In the rainy season, dry streams are full of water, but after the rains, the water withdraws rapidly to the underground rivers.
- The flooding season takes place from September to November, with the largest floods appearing in the middle of September and October. Besides the main rainy and flooding season, rains in May and June sometime cause large floods.
- In the dry season, from February to August, almost all the streams in Phong Nha - Ke Bang become “dead streams”. The water level in the Chay and Son Rivers is very low at this time.

## Vegetation

The results of the interpretation of remote sensing data (Spot 3 HRV2 272-315/0 dated 19 February 1995); field surveys of the RAS 93/102/WWF/UNDP project (1996-1997) and the Management Plan of Phong Nha - Ke Bang National Park (1998) show that the Park is 96.2% covered by forest, of which primary forest covers 92.2%. So that Phong Nha - Ke Bang National Park has one of the highest percentage forest coverage of the protected areas in Vietnam.

Based on the FAO (1986), classification of vegetation types, in Phong Nha - Ke Bang area, there are eleven vegetation types and subtypes as follows (table 6):

**Table 7: The area of Forest vegetation types of Phong Nha -Ke Bang**

No.	Vegetation types	Code	Area (ha)	%
1	Tropical dense moist evergreen forest on limestone under 800m asl.	2.1	110,476	74.7
2	Low tropical montane evergreen forest on limestone above 800m asl.	1.1	12,600	8.5
3	Tropical dense moist evergreen forest on hills under 800m asl.	2.1	12,220	8.3
4	Low tropical montane evergreen forest on hills above 800m asl.	1.2	1,070	0.7
5	Degraded evergreen forest on limestone	2.3	1,641	1.1
6	Degraded evergreen forest on hills	2.3	4,212	2.8
7	Tree and shrub savanna on limestone	2.8	1,925	1.3
8	Tree and shrub savanna on hills	2.7	2,950	2.0
9	Riverine forest	2.6	180	0.1
10	Bamboo forest	2.5	150	1.0
11	Cultivated land	2.9	521	0.3
<b>Total</b>			<b>147945</b>	<b>100.0</b>

Four major forest types and subtypes are described as follows:

***Tropical dense moist evergreen forest on limestone under 800m asl.***

This is the largest vegetation type (110,476 ha), distributed mainly in the north and centre of the area. This vegetation type covers almost all of the limestone area of Phong Nha - Ke Bang. It supports many tropical plant species, but the plant species composition of Phong Nha - Ke Bang National Park is rather different from that of the other protected areas situated on limestone such as: Cuc Phuong, Ba Be and Cat Ba National Parks. Families as the Lauraceae and Fagaceae and such tree species as *Terminalia myriocarpa*, *Cinnamomum balansae*, *Vatica tonkinensis*, *Castanopsis indica*, *Dysoxylon cochinchinensis*, *Tetrameles nudiflora*, *Parashorea sinensis*, *Schima sp.* and *Albizia lucida* are common at the three above National Parks, but have scattered distributions at Phong Nha - Ke Bang. The commonest tree species at Phong Nha - Ke Bang are *Hopea sp.*, *Hopea mollissima*, *Sumbaviopsis albicans*, *Garcinia fragraeoides*, *Burretiodendron hsienmu*, *Chukrasia tabularis*, *Photinia arboreum*, and *Diospyros salettii*, and the dominant families at this site are the Euphorbiaceae, Meliaceae, Sapindaceae, Elaeocarpaceae, Moraceae, Ebenaceae and Anacardiaceae.

*Cycas balansae*, *Dacrydium pierrei* and *Nageia fleuryii*, three gymnosperm species also have scattered distributions in the Phong Nha - Ke Bang area.

The typical phenomena of tropical evergreen forests such as buttress, cauliflory, giant trees and woody climbers are easily observed at Phong Nha - Ke Bang. On the rough, steep limestone slopes, bushes and small trees twisted trunks can be seen.

Seedlings can only grow in holes and cracks in the limestone that have accumulated soil. In general, natural regeneration in limestone forest is very poor, so it is very difficult for forest to recover after disturbance.

This forest type is stratified into 3 layers:

+ *Canopy layer*: composed of big trees. such as: *Dracontomelum dupperreanum*, *Canarium album*, *Mischocarpus oppositifolius*, *Syzygium cuminii*, *Elaeocarpus dubius*, *Aglaia gigantea*, *Hopea sp.*, *Burretiodendron hsienmu* and *Diospyros salettii*, with an average diameter of 40 - 50 cm. At the foot of the limestone karst, *Dipterocarpus kerrii*, a species in the

Dipterocarpaceae family (Diameter = 70 - 120 cm and height: 30 - 50m) is rather common. Specimens of this species often emerge from the canopy layer.

+ *Sub-canopy layer*: The dominant tree species are: *Sumbaviopsis albicans*, *Knema corticosa*, *Trigonostemon sp.*, *Glochidion sp.*, *Endospermum sinense* and *Engelhardtia chysolepis*. The size of these trees is smaller (15 - 18 cm in diameter), but the density is high and this sub-layer is continuous.

+ *Understorey*: This layer is well developed in moist areas. The dominant plant species are *Begonia spp.*, *Impatien balsamina*, *Homanolaema aromatica* and *Curculigo spp.*

### ***Low tropical montane evergreen forest on limestone above 800m asl.***

This forest type occupies 12,600 ha, or 8,5% of the total area of Phong Nha - Ke Bang National Park. It is distributed on the continuously narrow range of limestone mountain along the Vietnam - Laos frontier. In Vietnam, almost all limestone mountains are under 800m asl., except some limestone towers without vegetation, so the occurrence of this vegetation type at Phong Nha - Ke Bang is very unusual.

This forest type comprises rough karst towers, the surfaces of which are covered with crevices and holes, which accumulate soil. Plants grow inside these crevices and holes, and also grow on the limestone walls and cracks. The soil in this area is well-drained and thin, so most trees are slow growing and of small stature.

The flora is dominated by the following species *Cinnamomum litsaefolium*, *Litsea viridis*, *Machilus platicarpa*, *Phoebe lanceolata*, *Quercus glauca*, *Quercus quangtriensis*, *Quercus bambusaefolia*, *Pometia pinnata*, *Burretiodendron hsienmu*, *Syzigium spp.*, *Madhuca pasquieri*, *Croton yunanensis*, *Knema conferta* and *Ficus spp.*... Gymnosperm species are scattered distributions in this forest type such as *Podocarpus imbricatus*, *Podocarpus neriifolius*, and *Nageia fleuryi*. The dominant families are the Lauraceae, Fagaceae, Theaceae and Rosaceae.

The understorey includes representatives of the Rubiaceae, Araliaceae, Araceae and Selaginellaceae...

### ***Degraded evergreen forest on limestone.***

This vegetation subtype is distributed along road number 20 and in the area next to the villages in the north and northeast of the site. It derived directly from Tropical dense moist evergreen forest on limestone, and is influenced by human activities. The available data indicate most of the forest of this type is distributed on not-too-steep or rough topography. The main reasons for forest degradation are medicinal plant collection, wood cutting (mainly valuable timber species and large trees), rattan gathering and illegal hunting. In the lightly-impacted areas, the forest structure of this vegetation type is similar to that of primary forest, but softwood trees tend to be replaced by hardwood trees.

In the areas heavily impacted by exploitation or forest fire, almost all of the shade - demanding tree species of primary forest are replaced by light demanding fast-growing ones of the secondary forest, such as: *Mallotus apiculatus*, *Macaranga denticulata*, *Tetrameles nudiflora*, *Litsea cubeba*, *L. monosepala*, *Commersonia bartramia*, *Alchornea spp*, etc.

The main soil of this vegetation type is red - brown Feralite soil, which originates from limestone and is highly fertile. It provides excellent habitat for the development of shrubs and grasses. If the forest is well managed and protected, this vegetation type will return to its original condition.

### ***Tropical dense moist evergreen forest on hills under 800m asl.***

This vegetation type covers a large area (12,220 ha) and is concentrated in 3 areas:

One area is situated in the East of the Site from the stream of Va village, along road number 20, to the Rao Thuong river. The second area mainly covers all the mountain range of Co Khu. The third area is distributed in the southeast of the Ke Bang area.

These areas are characterized by different mother rocks (sandstone, schist and acidic granite) and most the streams in these areas are on the ground surface. The soil is red - yellow or yellow Feralite, and of varying thickness.

This vegetation type is dominated by evergreen tree species while deciduous trees, such as *Dipterocarpus kerrii*, *Anogeissus acuminata*, *Pometia pinnata*, *Lagerstroemia calyculata* have scattered distributions.

Broad leafed tree species are dominant in the canopy layer. Gymnosperm species have scattered distributions above 800 -900m asl.

This vegetation type is rather rich in timber resources because it develops on moist and thick soil. Large trees about 100cm in diameter are rather common.

This vegetation type is a good habitat for animals. Many animal species with high scientific and economic values can be found, such as Gaur, Barking Deer, Sun Bear, Pangolin, flying squirrel and many birds.

## Flora

Preliminary surveys of the botanical diversity of Phong Nha - Ke Bang have been less than comprehensive. However, the results indicate a rich and diversified flora at Phong Nha - Ke Bang. with the preliminary list of vascular plant standing at 152 families, 511 genera and 876 species (table 7).

**Table 8: Preliminary list of vascular plants at Phong Nha - Ke Bang**

Taxon	Number of families	Number of genera	Number of species
Pteridophyta	20	30	41
Pinophyta	5	6	10
Magnoliophyta	127	475	825
- Magnoliopsida	104	390	698
- Liliopsida	23	85	127
<b>Total</b>	<b>152</b>	<b>511</b>	<b>876</b>

- The flora of Phong Nha - Ke Bang is representative of the transition zone of two big floristic regions: the northern and southern regions. This area is the southernmost locality of some tree species of the northern floristic region, such as: *Burretiodendron hsienmu* and *Platanus kerrii*. The area is also northernmost of some tree species of the southern floristic region, such as *Dipterocarpus kerrii* and *D. grandiflorus*.
- In particular, Phong Nha - Ke Bang is center of endemism. The site supports 13 plant species that are endemic to Vietnam. In particular, a



narrowly endemic species Sao da (*Hopea sp.*) is confined to the site. This species is new to science and will be described in the near future.

**Table 9: List of endemic plant species to Vietnam at Phong Nha - Ke Bang**

No.	Scientific name	Vietnamese name
1	<i>Burretiodendron hsienmu</i>	Nghiến
2	<i>Cryptocarya lenticellata</i>	Nanh chuột
3	<i>Deutzianthus tonkinensis.</i>	Mọ
4	<i>Eberhardtia tonkinensis</i>	Mắc niễng
5	<i>Heritiera macrophylla</i>	Cui lá to
6	<i>Hopea sp.</i>	Sao đá
7	<i>Illicium parviflorum</i>	Hồi núi
8	<i>Litsea baviensis</i>	Bời lời ba vì
9	<i>Madhuca pasquieri</i>	Sến mật
10	<i>Michelia faveolata</i>	Giổi nhung
11	<i>Pelthophorum tonkinensis</i>	Lim xẹt
12	<i>Semecarpus annamensis</i>	Sung nam
13	<i>Sindora tonkinensis</i>	Gụ lau

Based on Vietnam Forest Trees (Vũ Văn Dũng et al. 1996 - Vietnam Agricultural Publishing House )

Among the recorded plant species, 38 are listed in the Plant Red Data Book of Vietnam (1996), and 25 species are listed in the 1997 IUCN Red List of Threatened Plants.

**Table 10: List of threatened plant species at Phong Nha - Ke Bang**

No.	Scientific name	Vietnamese name	Threatened		Morphology
			Vietnam	IUCN	
1.	<i>Acer oblongum</i>	Thích thuôn		E	Tree
2.	<i>Annamocarya sinensis</i>	Chò dãi	V	R	Tree
3.	<i>Anoectochilus setaceus</i>	Lan kim tuyến	E		Herb
4.	<i>Aquilaria crassna</i>	Trâm	E		Tree
5.	<i>Ardisia silvestris</i>	Lá khô	V		Climber

No.	Scientific name	Vietnamese name	Threatened		Morphology
			Vietnam	IUCN	
6.	<i>Breynia grandiflora</i>	Dé lớn		R	Shrub
7.	<i>Burretiodendron hsienmu</i>	Nghiến	V	V	Tree
8.	<i>Calamus dioicus</i>	Mây tăt		R	Climber
9.	<i>Calamus platyacanthus</i>	Song mật	V		Climber
10.	<i>Calamus poilanei</i>	Song bột	K	V	Climber
11.	<i>Callophyllum calaba</i>	Công tía		V	Tree
12.	<i>Callophyllum touranense</i>	Công chai	R	R	Tree
13.	<i>Cephalotaxus hainanensis</i>	Phỉ lược	R	V	Tree
14.	<i>Chenopodium ambrosioides</i>	Dâu giun		I	Climber
15.	<i>Chukrasia tabularis</i>	Lát	K		Tree
16.	<i>Cyanotis burmanniana</i>	Thài lài bích trai		R	Climber
17.	<i>Cinnamomum mairei</i>	Re mai		E	Tree
18.	<i>Coscinium fenestratum</i>	Vàng đắng	V	E	Climber
19.	<i>Cycas balansae</i>	Tuế núi đá	V		Shrub
20.	<i>Dacrydium pierrei</i>	Hoàng đàn giả	K		Tree
21.	<i>Dalbergia cochinchinensis</i>	Cắm lai nam	V		Tree
22.	<i>Dalbergia tonkinensis</i>	Stra	V	V	Tree
23.	<i>Dendrobium amabile</i>	Hoàng thảo	R		Herb
24.	<i>Drynaria fortunei</i>	Cốt toái bổ	T		Parasite
25.	<i>Dialium cochinchinensis</i>	Xoay	V		Tree
26.	<i>Euodia simplicifolia</i>	Ba gạc đơn		R	Tree
27.	<i>Fokienia hodginsii</i>	Pơ mu	K	R	Tree
28.	<i>Garcinia fagraeoides</i>	Trai	R		Tree
29.	<i>Helicia grandifolia</i>	Mạ sưa lá lớn	R		Tree
30.	<i>Hopea hainanensis</i>	Sao hải nam	K	E	Tree
31.	<i>Hopea pierrei</i>	Kiên kiên	K		Tree
32.	<i>Hypericum japonicum</i>	Ban		I	Tree
33.	<i>Illicium parviflorum</i>	Hội núi		E	Tree

No.	Scientific name	Vietnamese name	Threatened		Morphology
			Vietnam	IUCN	
34.	<i>Livistona chinensis</i>	Lá nón		R	Shrub
35.	<i>Madhuca hainanensis</i>	Sến hải nam		V	Tree
36.	<i>Madhuca pasquieri</i>	Sến mặt	T	E	Tree
37.	<i>Manglietia rufibarbata</i>	Giổi xanh		E	Tree
38.	<i>Markhamia stipulata</i>	Đinh	V		Tree
39.	<i>Melientha suavis</i>	Sắng	K		Tree
40.	<i>Morinda officinalis</i>	Ba kích	K		Climber
41.	<i>Nageia fleuryi</i>	Kim giao	V	V	Tree
42.	<i>Parashorea chinensis</i>	Chò chỉ	R	R	Tree
43.	<i>Platanus kerri</i>	Chò nước	T		Tree
44.	<i>Podocarpus neriifolius</i>	Thông tre	R		Tree
45.	<i>Pterocarpus macrocarpus</i>	Giáng hương	V		Tree
46.	<i>Rauwolfia verticillata</i>	Ba gạc	V		Shrub
47.	<i>Schoutenia hypoleuca</i>	Sơn tân	V		Tree
48.	<i>Sindora tonkinensis</i>	Gụ	V		Tree
49.	<i>Smilax glabra</i>	Thổ phục linh	T		Climber
50.	<i>Tarrietia javanica</i>	Huỳnh	V		Tree
51.	<i>Zenia insignis</i>	Muồng lá đỏ	R		Tree
	<b>Total</b>		<b>38</b>	<b>25</b>	

**Legend**

E: Endangered (Vietnam/IUCN)

T: Threatened (Vietnam/IUCN)

V: Vulnerable (Vietnam/IUCN)

R: Rare (Vietnam/IUCN)

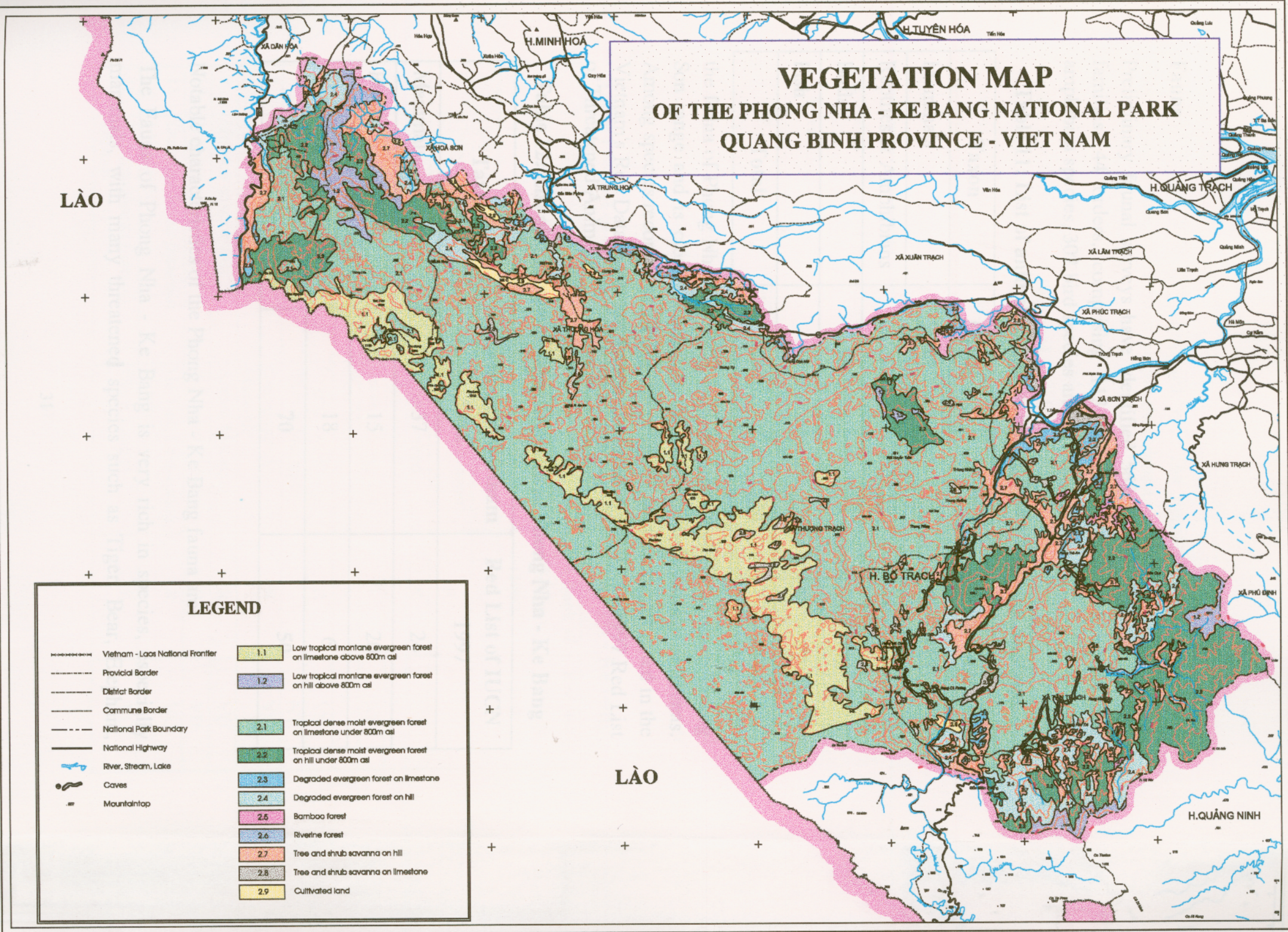
I: Indeterminate (IUCN)

K: Insufficiently known (Vietnam)

# VEGETATION MAP OF THE PHONG NHA - KE BANG NATIONAL PARK QUANG BINH PROVINCE - VIET NAM

**LEGEND**

	Vietnam - Laos National Frontier		1.1 Low tropical montane evergreen forest on limestone above 800m asl
	Provincial Border		1.2 Low tropical montane evergreen forest on hill above 800m asl
	District Border		2.1 Tropical dense moist evergreen forest on limestone under 800m asl
	Commune Border		2.2 Tropical dense moist evergreen forest on hill under 800m asl
	National Park Boundary		2.3 Degraded evergreen forest on limestone
	National Highway		2.4 Degraded evergreen forest on hill
	River, Stream, Lake		2.5 Bamboo forest
	Caves		2.6 Rivertine forest
	Mountaintop		2.7 Tree and shrub savanna on hill
			2.8 Tree and shrub savanna on limestone
			2.9 Cultivated land



## Fauna

Preliminary faunal surveys have identified 568 vertebrate species in 132 families, 44 orders, comprising 113 mammal species, 81 reptile and amphibian species, 302 bird species and 72 fish species.

**Table 11: List of animal species in Phong Nha - Ke Bang heritage.**

<b>Taxon</b>	<b>Order s</b>	<b>Families</b>	<b>Species</b>
Mammals	11	28	113
Reptiles & Amphibians	3	22	81
Birds	18	57	302
Fish	11	23	72
<b>Total</b>	<b>43</b>	<b>130</b>	<b>568</b>

the fauna of Phong Nha - Ke Bang is representative of the northern Truong Son range and is closely related to the Indian and Myanmarese faunas. Among species recorded at the site, there are 68 animal species listed in the Vietnam's Red Data Book and 44 species listed in the IUCN 1997 Red List of Threatened Animals.

**Table 12: List of threatened animal species at Phong Nha - Ke Bang**

<b>Taxon</b>	<b>Red Book of Vietnam 1992</b>	<b>Red List of IUCN 1997</b>
Mammals	37	24
Birds	15	20
Reptiles & Amphibians	18	6
<b>Total</b>	<b>70</b>	<b>50</b>

Notable characteristics of the Phong Nha - Ke Bang fauna are:

The Fauna of Phong Nha - Ke Bang is very rich in species, especially mammals, with many threatened species such as Tiger, Bear, Elephant,

Giant Muntjac, Wild Dog, Leopard, etc. The numerous caves, abundant food sources and low human population density provide good habitat for several primate species.

Ten species and subspecies of Primates have been recorded at the site equivalent to 45.5% of the total number of Vietnam's primate species. All these species are listed in Decree 18/HĐBT dated 17<sup>th</sup> January 1992 of the Council of Ministers, and seven of them listed in Vietnam's Red Data Book. The site supports four primate taxa endemic to Indochina: *Trachypithecus francoisi hatinhensis*, *Pygathrix nemaeus*, *Hylobates leucogonis* and *Nycticebus coucang*. In particular, the site supports the total world population of *Trachypithecus francoisi hatinhensis*

• **Mammal**

Of the 113 mammal species, 37 species are listed in the Red Data Book of Vietnam (1992), 24 species are listed in the IUCN, 1997 Red List of Threatened Animals (table 12). Two newly discovered large mammal species Mang Lon *Megamuntiacus vuquangensis* and Sao La *Pseudoryx nghetinhensis* are also found in the Phong Nha - Ke Bang area.

**Table 13: List of threatened mammal species at Phong Nha - Ke bang**

No.	Scientific name	English name	Red Book of Vietnam (1992)	Red list of IUCN (1997)
1	<i>Cynocephalus variegatus</i>		R	
2	<i>Cynopterus brachyotis</i>	Lesser Short-nosed Fruit Bat	R	
3	<i>Myotis siligorensis</i>	Small-toothed Whiskered Bat	R	
4	<i>Ia io</i>	Great Evening Bat	R	NT
5	<i>Nycticebus coucang</i>	Slow Loris	R	
6	<i>Nycticebus pygmaeus</i>	Pygmy Loris	R	VU
7	<i>Macaca mulatta</i>	Rhesus Macaque		NT
8	<i>Macaca arctoides</i>	Stump-tailed Macaque	R	VU
9	<i>Macaca assamensis</i>	Assam Macaque	R	VU
10	<i>Macaca nemestrina</i>	Pig-tailed Macaque	R	VU
11	<i>Trachypithecus francoisi hatinhensis</i>	Ha Tinh Leaf-eating Monkey	R	VU
12	<i>Trachypithecus francoisi ebenus</i>	Black Langur	K	VU

No.	Scientific name	English name	Red Book of Vietnam (1992)	Red list of IUCN (1997)
13	<i>Pygathrix nemaeus nemaeus</i>	Rhed shanked Douc	E	EN
14	<i>Hylobates concolor leucogenis</i>	White cheeked Gibbon	E	DD
15	<i>Hylobates concolor siki</i>	Siki Gibbon		EN
16	<i>Cuon alpinus</i>	Asian Wild Dog	E	VU
17	<i>Helarctos malayanus</i>	Malayan Sun Bear	E	DD
18	<i>Selenarctos thibetanus</i>	Asiatic Black Bear	E	VU
19	<i>Aonyx cinerea</i>	Small-clawed Otter	V	NT
20	<i>Lutra lutra</i>	Common Otter	T	
21	<i>Lutra perspicilata</i>	Smooth-coated Otter	V	VU
22	<i>Melogale personata</i>	Chồn bạc má bắc	R	
23	<i>Arctictis binturong</i>	Binturong	V	
24	<i>Arctogalidia trivirgata</i>		R	
25	<i>Viverra zibetha</i>	Large Spotted Civet	E	
26	<i>Chrotogale owstoni</i>		R	VU
27	<i>Felis marmorata</i>	Marbled Cat		DD
28	<i>Felis temmincki</i>	Clouded Leopard	R	
29	<i>Neofelis nebulosa</i>	Leopard	E	VU
30	<i>Panthera pardus</i>		E	
31	<i>Panthera tigris</i>	Tiger	E	EN
32	<i>Elephas maximus</i>	Elephant	V	EN
33	<i>Sus bucculentus</i>		K	
34	<i>Tragulus javanicus</i>	Cheo cheo nam dương	V	
35	<i>Megamunticus vuquangensis</i>	Giant munjac	R	
36	<i>Bos gaurus</i>	Gaus	E	
37	<i>Capricornis sumatraensis</i>	Serow	V	VU
38	<i>Pseudoryx nghetinhensis</i>		E	EN
39	<i>Manis javanica</i>	Malayan Pangoln		NT
40	<i>Hylopetes alboniger</i>		R	
41	<i>Petaurista petaurista</i>	Giant Flying Squirrel	R	
<b>Total</b>			<b>37</b>	<b>24</b>

**Legend:**

**Vietnam's Red Data Book:**

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

K: Insufficiently Known

**IUCN Red List of Threatened Animals:**

CR: Critically Endangered

EN: Endangered

VU: Vulnerable

NT: Near Threatened

DD: Data deficient

## Birds

- Phong Nha - Ke Bang supports 302 species in 57 families and 18 orders, including 15 species listed in Vietnam's Red Data Book and 20 species listed in the 1997 IUCN Red List of Threatened Animals. In particular, there is so good evidence for the *Lophura hatinhensis* and *Lophura imperialis* species at Phong Nha - Ke Bang. (Table 13).

**Table 14: List of threatened bird species at Phong Nha - Ke Bang**

No.	Scientific name	English name	Red Book of Vietnam (1992)	Red list of IUCN (1997)
1	<i>Ichthyophaga humilis</i>	Lesser Fishing Eagle		NT
2	<i>Aceros nipalensis</i>	Rufous-necked Hornbill		VU
3	<i>Aceros undulatus</i>	Wreathed Hornbill	T	
4	<i>Alcippe rufogularis</i>	Rufous-throated Fulvetta		NT
5	<i>Berenicornis comatus</i>	Long-crested Hornbill	E	
6	<i>Buceros bicornis</i>	Great Indian Hornbill	T	
7	<i>Carpococcyx renauldi</i>	Coral-billed Ground Cuckoo	T	NT
8	<i>Cissa hypoleuca</i>	Eastern Green Magpie		NT
9	<i>Jabouilleia danjoui</i>	Danjous Babbler	T	VU
10	<i>Lophura diardi</i>	Siamese Fireback Pheasant	T	VU
11	<i>Lophura edwardsi</i>	Edward's Pheasant		CR
12	<i>Lophura hatinhensis</i>	Vietnamese Pheasant	E	EN
13	<i>Lophura imperialis</i>	Imperial Pheasant	E	CR
14	<i>Lophura nycthemera berliozii</i>	Silver Pheasant	E	
15	<i>Macronous kelleyi</i>	Grey-faced Tit-Babbler		NT
16	<i>Magaceryle lugubris</i>	Greater Pied Kingfisher	T	
17	<i>Niltava davidi</i>	Fukien Niltava		NT
18	<i>Pavo muticus</i>	Green Peafowl		VU
19	<i>Picus rabieri</i>	Red-collared Woodpecker		VU
20	<i>Pitta cyanea</i>	Blue Pitta	R	
21	<i>Pitta elliotii</i>	Elliot's Pitta	T	NT
22	<i>Pitta soror</i>	Blue-backed Pitta		NT
23	<i>Ptilolaemus tickelli</i>	Tickell's Hornbill		NT
24	<i>Rheinartia ocellata</i>	Crested Argus	T	VU
25	<i>Stachyris herberti</i>	Sooty Tree Babbler		VU
26	<i>Strix leptogrammica</i>	Brown Wood Owl	R	
27	<i>Urocissa whiteheadi</i>	White-winged Magpie		NT
	<b>Total</b>		<b>15</b>	<b>20</b>



**Legend:**

**Red Data Book of Vietnam:**

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

K: Insufficiently Known

**IUCN Red List of Threatened Animals:**

CR: Critically Endangered

EN: Endangered

VU: Vulnerable

NT: Near Threatened

**Reptiles and Amphibians**

Initial field-surveys of Phong Nha - Ke Bang have recorded 59 reptile species belonging to 16 families and 2 orders, and 22 Amphibian species belonged to 6 families and 1 order. Of these species 18 are listed in Vietnam's Red Data Book and 6 species are listed in the 1997 IUCN Red List of Threatened Animals (Table 14).

**Table 15. List of threatened reptiles and amphibians at  
Phong Nha - Ke Bang**

No.	Scientific name	Vietnamese name	RDB of Vietnam (1992)	Red list of IUCN (1997)
1	<i>Acanthosaura lepidogaster</i>	Ô rô vảy	T	
2	<i>Bombina maxima</i>	Cóc tía	R	
3	<i>Bufo galeatus</i>	Cóc rừng	R	
4	<i>Bungarus fasciatus</i>	Rắn cạp nong	T	
5	<i>Cistolemmys galbinifrons</i>	Rùa hộp trán vàng	V	
6	<i>Cuora trifasciata</i>	Rùa hộp ba vạch	V	EN
7	<i>Gekko gekko</i>	Tắc kè	T	
8	<i>Indotestudo elongata</i>	Rùa núi vàng	V	VU
9	<i>Manouria impressa</i>	Rùa núi viền	V	VU
10	<i>Naja naja</i>	Rắn hổ mang	T	
11	<i>Ophiophagus hannah</i>	Rắn hổ chúa	E	
12	<i>Palea steindachneri</i>	Ba ba gai		NT
13	<i>Physignathus cocincinus</i>	Rồng đất	T	
14	<i>Platysternum megacephalum</i>	Rùa đầu to	R	
15	<i>Ptyas korros</i>	Rắn ráo thường	T	
16	<i>Ptyas mucosus</i>	Rắn ráo trâu	V	

17	<i>Python molurus</i>	Trăn đất	V	NT
18	<i>Rana andersoni</i>	Chàng An đéc sơn	T	
19	<i>Sacalia quadriocellata</i>	Rùa bốn mắt		VU
20	<i>Varanus salvator</i>	Kì đà hoa	V	
	<b>Total</b>		<b>18</b>	<b>6</b>

**Legend:**

***Red Data Book of Vietnam:***

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

***IUCN Red List of Threatened Animals:***

EN: Endangered

VU: Vulnerable

NT: Near threatened

**Fish**

- Comparing with fish fauna of Phong Nha - Ke Bang with other Vietnam' protected areas, Phong Nha - Ke Bang has the largest number of species, with 72 species, belonging to 23 families and 11 orders (Bach Ma National Park has 33 species, Ba Be National Park has 42 species, Vu Quang Nature Reserve has 58 species and Pu Mat Nature Reserve has 54 species).
- In the Phong Nha - Ke Bang area, there are many different fish habitats. 4 strictly endemic fish species have just been discovered that are known only from Phong Nha - Ke Bang or a neighboring area. These species include *Chela quangbinhensis*
- The eel fish *Anguilla bengalensis* is an economically -valuable fish species found at Phong Nha - Ke Bang. This species is found in caves, along the rivers and in streams in the Phong Nha - Ke Bang area. In the Phong Nha - Ke Bang area, every year fisherman catch about 30-70 of this fish species.

**Butterflies**

- An initiative survey by the Vietnam - Russia Tropical Center (Funded by WWF) recorded 259 butterfly species in 11 families. Almost all major butterfly taxa in Vietnam can be found at Phong Nha - Ke Bang, (see appendix)

## Socio-economic features

### Population inside the core zone

There are two villages in the core zone of Phong Nha - Ke Bang National Park, village number 39 or Arem village, Tan Trach commune, Bo Trach district and Yen Hop village, Thuong Hoa commune, Minh Hoa district. These villages are home to 95 households and 475 people (table 15).

**Table 16: Population and ethnic composition at villages in the core zone of Phong Nha - Ke Bang National Park**

Village	Household	Population	Ruc ethnic group	Arem ethnic group	Ma Coong ethnic group
Yen Hop	59	324	324		
Arem	36	151		132	19
<b>Total</b>	<b>95</b>	<b>475</b>	<b>324</b>	<b>132</b>	<b>19</b>

Before 1962, the Arem and Ruc ethnic groups lived in the deep forest, in houses made of bamboo and leaves, or in the rocky caves. These people lived by gathering forest products or hunting. After 1992, Vietnam's Government set up new settlements for these people: village 39 for the Arem and Ma Coong people, and Yen Hop village for the Ruc people, but they still face many difficulties in their lives. The customs and way of life of the Arem, Ma Coong and Ruc ethnic groups have a very different of life than other ethnic groups in Vietnam.

The tools of these ethnic groups are very simple. Their clothes were made of the bark of a toxic forest tree: *Antiaris toxicaria* and lianas. The customs and way of life of the Arm and Ruc ethnic groups are in need of protection if they are not to disappear forever.

### Population in the Buffer Zone of Phong Nha - Ke Bang National Park

Phong Nha - Ke Bang National Park is situated in 12 communes: Hoa Son, Trung Hoa and Thuong Hoa, Minh Hoa district; Tan Trach, Thuong Trach, Son Trach, Phuc Trach, Xuan Trach and Phu Dinh, Bo Trach district; and

Truong Son, Quang Ninh district. These communes comprise the buffer zone of Phong Nha - Ke Bang National Park. The total buffer zone area is 195,400 ha, with a total population of 52,001 people (table 16).

**Table 17: Area and population structure of 12 communes in the buffer zone of Phong Nha - Ke Bang National Park**

No.	Commune	Population			Labour		
		Total	Men	Women	Total	Men	Women
1	Dân Hoá	4446	2220	2226	2020	1002	1018
2	Hoá Sơn	1434	707	727	661	315	346
3	Trung Hoá	4755	2362	2392	2236	1101	1135
4	Thượng Hoá	2545	1260	1285	1160	543	617
5	Tân Trạch	151	72	79	70	34	36
6	Thượng Trạch	1308	635	673	624	294	330
7	Phúc Trạch	8794	4305	4489	4187	1968	2219
8	Xuân Trạch	4926	2421	2505	2351	1094	1257
9	Sơn Trạch	8235	4005	4230	3937	1854	2083
10	Phú Định	2405	1187	1218	1148	540	608
11	Hung Trạch	10081	4901	5180	4812	2248	2564
12	Trường Sơn	3396	1665	1731	1637	798	839
	<b>Total</b>	<b>52476</b>	<b>25740</b>	<b>26735</b>	<b>24843</b>	<b>11791</b>	<b>13052</b>

(The population includes both the core zone and the buffer zone)

### **Characteristics of ethnic groups at Phong Nha - Ke Bang**

The Phong Nha - Ke Bang area is not only famous for its cave system, beautiful landscape and high biodiversity, it is also famous for the minority groups living in the area. Besides the Kinh (majority Vietnamese) ethnic group, there are two main ethnic groups: the Van Kieu and Chut (table 17).

**Table 18: Ethnic composition of the buffer zone communes of Phong Nha-Ke Bang National Park**

Commune		Kinh	Van Kieu group				Chut group				Total
			Van Kieu	Khua	Ma Coong	Tri	Sach	May	Ruc	Arem	
Dân Hoá	People	17		3446				983			4446
	%	0.4		77.5				22.1			100.0
Hoá Sơn	People	876					558				1434
	%	61.1					38.9				100.0
Trung Hoá	People	4727					28				4755
	%	99.4					0.6				100.0
Thượng Hoá	People	1965					187		324	69	2545
	%	77.2					7.3		12.7		100.0
Tân Trạch	People				19					132	151
	%				12.6					87.4	100.0
Thượng Trạch	People	15	20		1212	46				15	1308
	%	1.1	1.5		92.7	3.5				1.1	100.0
Phúc Trạch	People	8794									8794
	%	100.0									100.0
Xuân Trạch	People	4926									4926
	%	100.0									100.0
Sơn Trạch	People	8126	109								8235
	%	98.7	1.3								100.0
Phú Định	People	2405									2405
	%	100.0									100.0
Hưng Trạch	People	10081									10081
	%	100.0									100.0
Trường Sơn	People	1592	1804								3396
	%	46.9	53.1								100.0
Total	People	43524	1933	3446	1231	46	773	983	324	216	52476
	%	82.9	3.7	6.6	2.3	0.1	1.5	1.9	0.6	0.4	100.0

### *The Van Kieu Ethnic Group:*

- The Van Kieu has the largest population of all the ethnic groups living in the northern Truong Son range (except Kinh group). Based on the "The Ethnic Minority Groups in North Vietnam" (Nguyen Dinh Khoa, 1976), the Van Kieu belong to the Mon - Kho Me language group, a native group native to Indochina, which includes such groups as the Van Kieu, Khua, Ma Coong, Tri and So.
- Among the above ethnic groups, the Van Kieu is largest and most widely distributed in the Truong Son range. The Tri and the Ma Coong ethnic groups are distributed in Thuong Trach and Tan Trach communes, Bo Trach District and Laos. The Khua ethnic group is mostly distributed in Dan Hoa commune, Minh Hoa district.

### *Chut ethnic group:*

Ha Van Tan and Pham Duc Duong in the article "About languages of Viet - Muong" in Ethnology Magazine volume 1 - 1997 wrote that the Chut language is the oldest one in the Viet - Muong language group and that the Chut language split from the Viet - Muong language in the 10<sup>th</sup> or 11<sup>th</sup> century.



















- Nguyen Quoc Loc (1984), the author of the book "The ethnic minority groups of 3 provinces: Quang Binh, Quang Tri and Thua Thien-Hue" wrote: There are about 2 million people of ethnic minority groups living in the 3 above provinces; including: about 60.000 people (3%) belonging to the following ethnic minority groups: the Van Kieu, Ca Tu, Ta Oi and Chut. Compared with the 54 other ethnic groups in Vietnam, the Chut is a small one, ranked 44<sup>th</sup> in order. The Chut ethnic group includes many ethnic sub-groups, such as the Sach, May, Ruc and Arem.
- In the language of the Chut ethnic group, the meaning of "Ruc" is the place that has an underground stream and "Arem" means rocky cave or rocky arch. The Arem and Ruc people are not only the smallest groups of the Chut ethnic group, they are also two of smallest ones in Vietnam. They live isolated from other communities in the limestone karst area. In 1998, the Arem group had only 216 people, and the Ruc group had only 324 people.

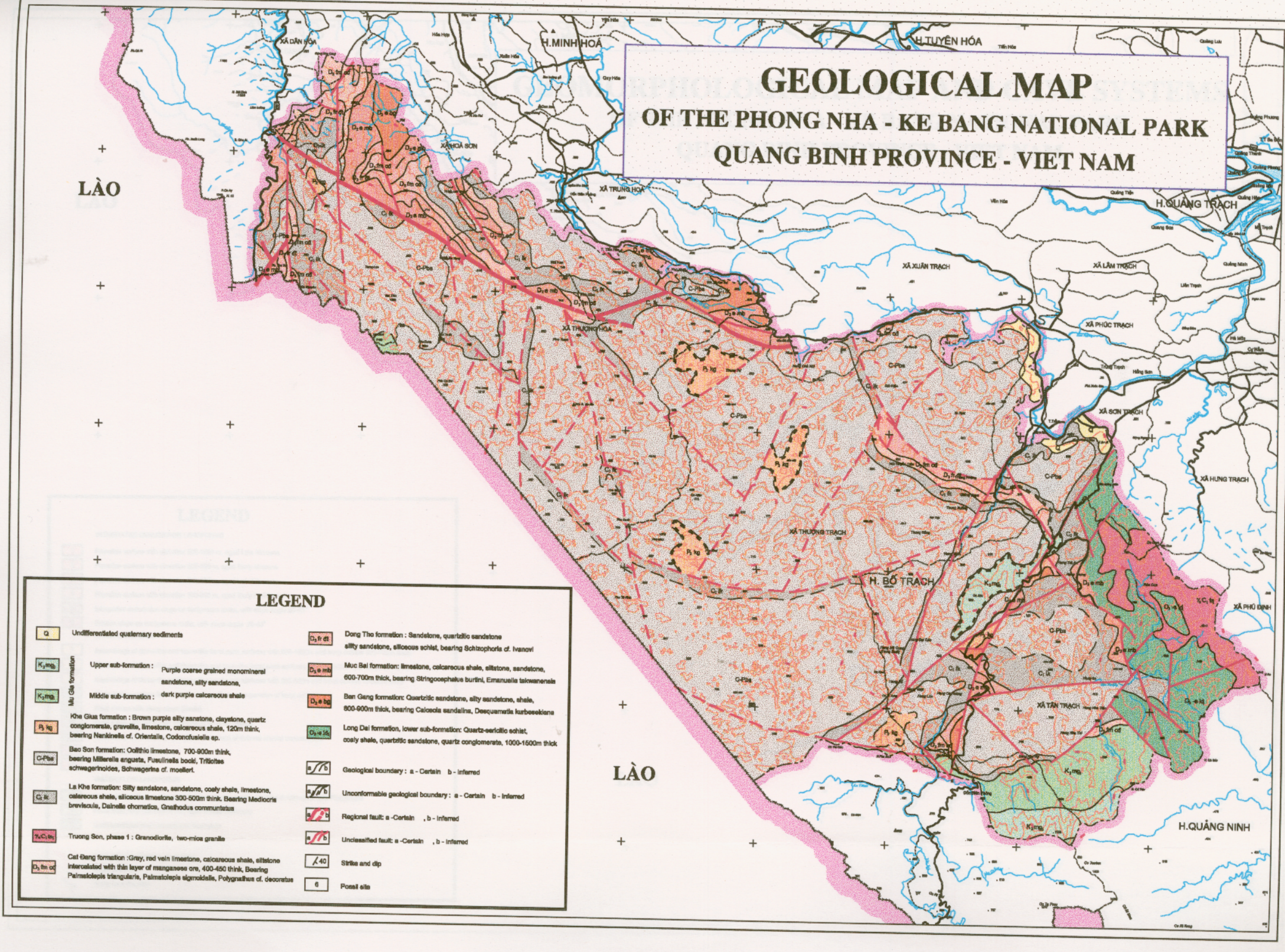
# GEOLOGICAL MAP OF THE PHONG NHA - KE BANG NATIONAL PARK QUANG BINH PROVINCE - VIET NAM

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## LEGEND

- |   |  |  |  |
|---|--|--|--|
|  Q                                | Undifferentiated quaternary sediments  |  D <sub>1</sub> ft dt | Dong Tho formation : Sandstone, quartzitic sandstone, silty sandstone, siliceous schist, bearing <i>Schizophoria cf. Ivanovi</i>                           |
|  K <sub>2</sub> mb                | Mai Gia formation<br>Upper sub-formation : Purple coarse grained monomineral sandstone, silty sandstone,<br>Middle sub-formation : dark purple calcareous shale  |  D <sub>1</sub> e mb  | Muc Bai formation: limestone, calcareous shale, siltstone, sandstone, 600-700m thick, bearing <i>Stringocephalus burini</i> , <i>Emanuella taiwanensis</i> |
|  K <sub>1</sub> mb                |  |  D <sub>1</sub> e lg  | Ben Gang formation: Quartzitic sandstone, silty sandstone, shale, 800-900m thick, bearing <i>Calocles sandalina</i> , <i>Desquamaria karbeskiana</i>       |
|  B <sub>1</sub> lg                | Khe Gua formation : Brown purple silty sandstone, claystone, quartz conglomerate, gravelite, limestone, calcareous shale, 120m thick, bearing <i>Nankinella cf. Orientalis</i> , <i>Codonofusiella sp.</i>   |  D <sub>1</sub> e lg  | Long Dai formation, lower sub-formation: Quartz-sericite schist, coaly shale, quartzitic sandstone, quartz conglomerate, 1000-1500m thick                  |
|  C-Pba                            | Bao Son formation: Oolitho limestone, 700-900m thick, bearing <i>Millereia angusta</i> , <i>Fusulinella bocki</i> , <i>Tritolites schwagerinoides</i> , <i>Schwagerina cf. moelleri</i> .  |  a/b                  | Geological boundary : a - Certain b - Inferred   |
|  C <sub>1</sub> lk                | La Khe formation: Silty sandstone, sandstone, coaly shale, limestone, calcareous shale, siliceous limestone 300-500m thick. Bearing <i>Medicocris breviscula</i> , <i>Dainella chromatica</i> , <i>Gnathodus communatus</i>                            |  a/b                  | Unconformable geological boundary : a - Certain b - Inferred   |
|  X <sub>1</sub> C <sub>1</sub> th | Truong Son, phase 1 : Granodiorite, two-mica granite   |  a/b                  | Regional fault : a - Certain , b - Inferred  |
|  D <sub>1</sub> fm of             | Cat Bang formation : Gray, red vein limestone, calcareous shale, siltstone intercalated with thin layer of manganese ore, 400-480 thick, Bearing <i>Palmitolepis triangularis</i> , <i>Palmitolepis sigmoidalis</i> , <i>Polygnathus cf. decoratus</i> |  a/b                  | Unclassified fault : a - Certain , b - Inferred  |
|   |  |  / 40                 | Strike and dip   |
|   |  |  6                    | Poosal site  |



# GEOMORPHOLOGICAL MAP AND CAVE SYSTEMS OF THE PHONG NHA - KE BANG NATIONAL PARK QUANG BINH PROVINCE - VIET NAM

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## LEGEND

### INTEGRATED DENUDATION LANDFORMS

- 1 Planation surface with elevation 900-1200 m, aged Late Miocene
- 2 Planation surface with elevation 600-800 m, aged Early Miocene
- 3 Planation surface with elevation 200-400 m, aged Late Pliocene
- 4 Planation surface with elevation 100-200 m, aged Early Pleistocene
- 5 Integrated dedudation slope on terrigenous rocks, with slope angle 20-40°
- 6 Erosion slope on terrigenous rocks, with slope angle 20-40°

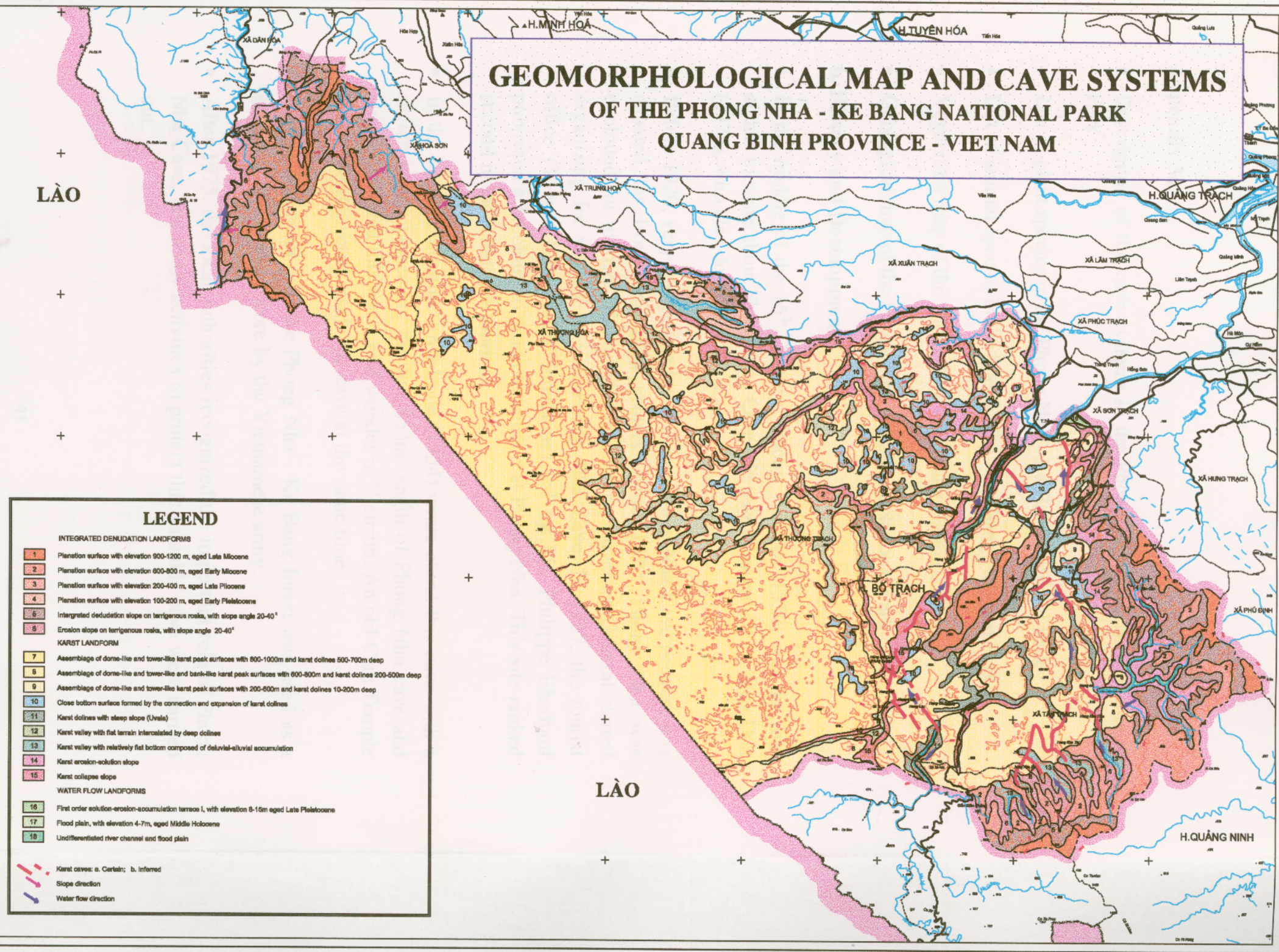
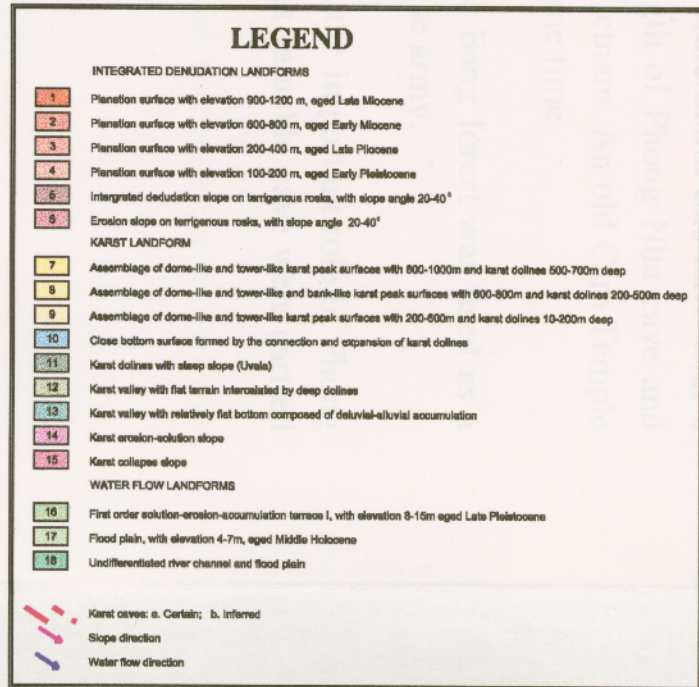
### KARST LANDFORM

- 7 Assemblage of dome-like and tower-like karst peak surfaces with 800-1000m and karst dolines 500-700m deep
- 8 Assemblage of dome-like and tower-like and bank-like karst peak surfaces with 600-800m and karst dolines 200-500m deep
- 9 Assemblage of dome-like and tower-like karst peak surfaces with 200-600m and karst dolines 10-200m deep
- 10 Close bottom surface formed by the connection and expansion of karst dolines
- 11 Karst dolines with steep slope (Uviale)
- 12 Karst valley with flat terrain intercalated by deep dolines
- 13 Karst valley with relatively flat bottom composed of deluvial-alluvial accumulation
- 14 Karst erosion-solution slope
- 15 Karst collapse slope

### WATER FLOW LANDFORMS

- 16 First order evolution-erosion-accumulation terrace I, with elevation 8-16m aged Late Pleistocene
- 17 Flood plain, with elevation 4-7m, aged Middle Holocene
- 18 Undifferentiated river channel and flood plain

- Karst caves: a. Certain; b. Inferred
- Slope direction
- Water flow direction





### **Appendix 3a**

- Description of the cave systems in the Phong Nha - Ke Bang National Park
- List of plant species in the Phong Nha - Ke Bang National Park
- List of animal species in the Phong Nha - Ke Bang National Park
- Vegetation map of the Phong Nha - Ke Bang National Park
- Geological map of the Phong Nha - Ke Bang National Park

#### **b. History and Development**

- In the middle of the 16<sup>th</sup> Century, Duong Van An (1550) was the first author to write about Phong Nha Cave. He was followed by Le Quy Don (1776), who also described this Cave.
- Before 1920, very few people knew about Phong Nha Cave because it is situated far from residential centers. After 1920, Phong Nha was exploited for tourism. From 1920 to 1930 the Governor-General started organizing for visitors to visit Phong Nha Cave. In 1937, the tourist office (Tourist Colonial en Indochine) led by Mr. Philippe Eberhard published a brochure to promote tourism at Phong Nha. This site ranked second in Indochina for tourism.
- In the book "Indochine", Madrolle (1954) wrote about this cave with a sketch map representing the full 853m length of Phong Nha cave and emphasized that this was a rare wonder in Vietnam. An old Cam Temple was also discovered inside the cave at the same time.
- During American war, the Phong Nha - Ke Bang forest was used as a garrison and weapons store by the Vietnamese army.
- After 1975, the local authorities recognized the important role of Phong Nha Cave, and many activities to protect this valuable cave were carried out.

- Tourism activities have been reorganized since 1990, and the number of tourists has increased year by year. A guesthouse with 20 rooms was built near the Xuan Son ferry and a team of boatmen is willing to take visitors to Phong Nha Cave.
- Phong Nha Nature Reserve (5000ha) was listed in Vietnam's Special - Use Forest System by Decision 194/CT dated 9 August 1986. By 1991, the reserve area had been extended to 41,132ha. The management plan was approved for the reserve. The management board was set up in 1993. In 2000, the management plan has been approved, and a management board has been established too.
- From 1996 to 1998, many biodiversity surveys have taken place in the Phong Nha - Ke Bang area. The results of these provided good information for the management plan for Phong Nha - Ke Bang National Park. This plan was approved in 2000 and a management board for the national park has been set up by Quang Binh Provincial People's Committee.

**c. Form and date of most recent records of property**

- Before 1990, there were only a few studies on geography and geology.
- On 9 August 1986, Phong Nha Nature Reserve (5000 ha) was declared in Vietnam's Special Use Forest System by Decision 194/CT.
- On 12 December 1986, Phong Nha and Xuan Son Ferry were declared in National Heritage System by Decision No 236-VH/QD from the Ministry of Culture and Information
- From 1990 to 1997, research and survey activities at Phong Nha - Ke Bang cave system were conducted by the British Cave Research Association in cooperation with the Faculty for Geology and Geography of Vietnam National University.
- In 1991, the Forest Inventory and Planning Institute (FIPI) carried out surveys of vegetation cover, flora, fauna and socio-economic characteristics of the area in order to prepare a management plan for Phong Nha Nature Reserve.

- In 1993, the Vietnam's Government approved the management plan for the reserve, and a management board was set up by Quang Binh province.
- From 1991 to 1995, a survey of primate species was conducted by a group of zoologists from FIPI and Xuan Mai Forestry College.
- From 1996 to 1997, a group of scientists conducted research on the biodiversity of the Phong Nha area and organized a symposium on biodiversity conservation along the Laos-Vietnam frontier, sharing the experiences on forest and biodiversity management of the two neighboring countries.
- In 1997, the Department of Science, Technology and Environment of Quang Binh province carried out environmental assessment activities in Phong Nha Nature Reserve.
- Based the results of the above surveys, the Forest Inventory and Planning Institute implemented a project entitled "Project for establishing the Phong Nha- Ke Bang National Park in period 2000 to 2005".
- In 1999, a group of scientist led by R.J. Timmins produced a report entitle "A preliminary assessment of the conservation importance and conservation priorities of Phong Nha - Ke Bang National Park". This project was funded by DANIDA/the Netherlands Embassy.
- In 1999, scientists from the Vietnam - Russia Tropical Center conducted a "zoological - botanical expedition to the Ke Bang area". LINC/WWF Project was the sponsor of this project.

### **Appendix 3c**

- Decision N° 315/UB of the Quang Binh People's Committee dated 1 August 2000, approved the management plan of Phong Nha - Ke Bang National Park.
- Official Dispatch N° 741/BNN-KH of the Ministry of Agriculture and Rural Development dated 8 March 2000 on proposing Prime Minister to approve the management plan of Phong Nha - Ke Bang National Park.

- Agreement Official Dispatch N° 1330/BKHCMNT-MTG dated 19 May 2000 by the Ministry of Planning and Investment on proposing Prime Minister to change the Phong Nha Nature Reserve to the Phong Nha - Ke Bang National Park.

#### **d. Present state of conservation**

- Phong Nha Special Use Forest was approved by the Vietnamese Government, with a total area of 5,000 ha in Decision N° 194/CT dated 9 August 1986.
- In 1991, the management plan for Phong Nha Nature Reserve was approved by the Ministry of Forestry (now part of the Ministry of Agriculture and Rural Development) and the People's Committee of Quang Binh province with a total area of 41,132 ha.
- The Management Board of Phong Nha Nature Reserve was established in 1993 and its responsibility is to put into effect the protection program following the Management Plan for Phong Nha Nature Reserve.
- Recently, a Relict and Landscape Management Board was established, with duties to protect the cave system and manage tourism.
- At the present time, many caves are inaccessible. Hence they are in original condition.
- Forest guard stations and the mobile patrol units have been established for implementing all protection activities in Phong Nha - Ke Bang National Park.

#### **Appendix 3d**

- Decision number 194/CT promulgated on 9 August 1986 by the Council of Ministers, approved 73 Protected areas, including Phong Nha Nature Reserve in Quang Binh province.
- Decision N° 236/VHQD of the Ministry of Culture and Information dated 12 December 1986.

- The Land use and zoning plan map of Phong Nha - Ke Bang National Park, scale: 1/100,000

**e. Policies and programmes related to the presentation and promotion of the property**

- The State Law on Forest Protection and Development dated 12 August 1992 was declared by the State Council.
- The State Law on Protection and Use of Historical, Cultural and Landscapes Relics was declared by the State Council on 31 March 1994.
- In the Biodiversity Action Plan for Vietnam, approved by the Vietnamese Government in 1995, Phong Nha was classified as a priority protected area.
- Research Programme of British Cave Association and Hanoi Nation University for study and assessment of the Phong Nha cave systems.
- Project RAS/93/102 for biodiversity assessment of Phong Nha - Ke Bang area.
- Project LINC/WWF, 1998-1999 for linking conservation of Phong Nha - Ke Bang National Park with that of Hin Namno National Biodiversity Conservation Area in Laos.
- Vietnamese Government and local authorities have formed some projects for restoration of the natural ecosystem, for the conservation of Phong Nha - Ke Bang National Park, and for the development of tourism in the Phong Nha area.
- The local authorities have launched some programmes to decrease the high human-pressure on the forest and the caves, and to increase the living standards of people living in the buffer zone.

**4. Management**

**a. Ownership**

- The Socialist Republic of Vietnam is the owner the whole area

- The Phong Nha - Ke Bang National Park Management Board, under jurisdiction of Quang Binh Provincial People's Committee.
- The local authorities are in charge of the management of the buffer zone.

#### **b. Legal status**

The whole area inside Phong Nha - Ke Bang National Park including land, forest resources, landscape, caves and historical relics with a total area of 147,945 ha is owned by the state according to the following decisions:

- Decision N<sup>o</sup> 194/ CT dated 9/8/1986 by the Chairman of the Council of Ministers on the establishment of Phong Nha Nature Reserve.
- Decision N<sup>o</sup> 941 QD/UB dated 18 November 1993 by the People's Committee of Quang Binh province on establishing the management board of Phong Nha Nature Reserve.
- Decision N<sup>o</sup> 236 dated 12 December 1986 by the Minister of Culture and Information to recognize Phong Nha-Xuan Son as a national relic landscape area.
- Decision N<sup>o</sup> 914 QD/UB dated 3 December 1998 by the People's Committee of Quang Binh province on approval of the technical and economic management plan for Phong Nha Nature Reserve.
- Decision N<sup>o</sup> 315/UB dated 1 August 2000 by the Quang Binh People's Committee on approval of the management plan of Phong Nha - Ke Bang National Park.
- Official Dispatch N<sup>o</sup> 741/BNN-KH of the Ministry of Agriculture and Rural Development dated 8 March 2000 on proposing Prime Minister to approve the management plan of Phong Nha - Ke Bang National Park.
- Agreement Official Dispatch N<sup>o</sup> 1330/BKHCMNT-MTG dated 19 May 2000 by the Ministry of Planning and Investment on proposing Prime Minister to change the Phong Nha Nature Reserve to the Phong Nha - Ke Bang National Park.

## **Appendix 4b**

Including all references and documents

Including contents of the above references and documents.

### **c. Protective measures and means of implementing them**

- At the present time the management board of Phong Nha - Ke Bang National Park has two sections with different tasks.
- The forest resources and biodiversity protection activities are overseen by the management board of Phong Nha - Ke Bang National Park in the following ways:
  - ✓ Set up nine forest guard posts and a mobile patrol unit, the main duties of them are to prevent illegal hunting and tree cutting.
  - ✓ To put into effect education programmes for increasing the awareness of local people and authorities about nature conservation.
  - ✓ To implement the programmes in the buffer zone (with a total area of 195,400ha) to improve the living standards of local people and involve them in forest and biodiversity conservation.
- The conservation of the cave systems, historical relic landscapes and the development of tourist services are conducted by the Phong Nha historical relic and landscape management board.
- In generally, both management boards lack equipment and good condition to fulfil their duties.

**d&e. Agency with management authority - Level at which management is exercised (e.g., on property, regionally) and name and address of responsible person for contact purposes.**

#### **• Government Agencies:**

1. Ministry of Agriculture and Rural Development: Government institution for forestry, agriculture and water resources management the whole country (for all over the country)

Minister: Le Huy Ngo

Address: 2A - Ngoc Ha - Ba Dinh - Hanoi

Tel: 84-4-845417

Fax: 84-4-8454319

2. Ministry of Culture and Information: Government institution for culture and information including world heritage sites for the whole country.

Minister: Nguyen Khoa Diem

Address: 51-53 Ngo Quyen - Hai Ba Trung - Hanoi

Tel: 84-4-262487

Fax: 84-4-8267101

3. Department of Conservation and Museology: Government institution under the jurisdiction of the Ministry of Culture and Information has responsibility for museum and cultural protection sites and world heritage sites all over the country.

Director: Dang Van Bai

Address: Address: 51-53 Ngo Quyen - Hai Ba Trung - Hanoi

Tel: 84-4-8267611

Fax: 84-4-8252929

4. Forest Protection Department: Government institution under the jurisdiction of the Ministry of Agriculture and Rural Development has responsibility for management and protection of all forest areas in the country.

Director: Nguyen Ba Thu

Address: 2A- Ngoc Ha - Ba Dinh - Hanoi

Tel: 84-4-7335680

Fax: 84-4-7335685

• **Quang Binh Province**

1. The People's Committee of Quang Binh Province: Government management in Quang Binh province

Chairman: Dinh Huu Cuong



Address: The People's Committee of Quang Binh Province - Dong Hoi town

Tel: 84.52.822341

Fax: 84.52.822792

2. The Forest Protection Department of Quang Binh Province: This government institution has responsibility for management and protection of forest areas in Quang Binh province

Director: Dang Ngoc Kinh

Address: Quang Binh Forest Protection Department - Dong Hoi town

Tel: 84.52.824554

Fax:

3. Conservation and Museology Department of Quang Binh Province: This government institution has responsibility for museum and cultural protection in Quang Binh province.

Director: Nguyen Van Loi

Address: Conservation and Museology Department - Dong Hoi town

Tel: 84-52-822682

Fax:

4. Department of Science Technology and Environment of Quang Binh Province: Government institution for sciences, technology and environment in Quang Binh province.

Director: Tran Thanh Toan

Address: Department of Science Technology and Environment, Dong Hoi town

Tel: 84-52-822598

Fax: 84-52-822808

- **Phong Nha - Ke Bang National Park**

1. Phong Nha - Ke Bang Management Board: This government institution under the jurisdiction of the People's Committee of Quang Binh Province has directly responsibility for the management of the whole Phong Nha - Ke Bang National Park.

Director: Cao Xuan Chinh

Address: Phong Nha - Ke Bang National Park, Bo Trach district, Quang Binh province

Tel:

Fax:

**f&j. Agreed plans related to property (e.g., regional, local plan, conservation plan, and tourism development plan)- Property management plan and statement of objectives (Copy to be annexed)**

- Decision N<sup>o</sup>: 845/TTg of the Prime Minister on the approval of the Biodiversity Action Plan for Vietnam in which, Phong Nha - Ke Bang is classified as a priority protected area for conservation.
- The Master Plan for economic development in Quang Binh Province for the period 1997-2010, defining the objectives for land use strategy in the Phong Nha- Ke Bang area to protect the area's environment, landscape and biodiversity value.
- Transboundary Biodiversity Protection Plan, a result of cooperation between the Laos and Vietnam, in particular, Quang Binh province (on the Vietnamese side) and Khammoune Province (on the Laotian side). The main purpose of this plan is the integrated conservation of the large limestone area in central Vietnam and Laos.
- Quang Binh province has a programme for the protection of limestone resources in the watershed of the Phong Nha -Ke Bang area.
- A plan for improving the living standards of local people in the buffer zone aimed at decreasing human pressure on the forest resources and biodiversity.
- A plan for establishing and developing a tourist branch of Quang Binh Province, including the organization of tourist tours, and establishing tourist service agencies.
- A plan for the construction of a transportation system for tourism.

**g&h. Sources and levels of finance - Sources of expertise and training in conservation and management techniques.**

- Most of the staff responsible for the conservation and management of the site are graduates of different colleges and universities, such as the Forest College, the National Economic University and Hanoi National University.
- The finances are mainly provided from the Government budget, and are concentrated on setting up initial infrastructure, and for other programmes as follows:
  - ✓ Construction of the office of the Management Board.
  - ✓ Implementation of projects for biodiversity assessment, investigation of caves, upgrading relics, etc:
  - ✓ Organizing and guiding the tourism to caves and relics in the area.
  - ✓ Management of the National Park and protection its biodiversity.
- The sources of finance :
  - ✓ Government sources are mainly provided for the construction of offices, for payment of salaries and for the other activities of the management boards: phase 1 from 1993 to 1999 was invested about 6,000,000,000 Vietnamese Dong (about 420,000 USD); phase 2 from 2000 to 2005 is investing 21,000,000,000 Vietnamese Dong (equivalent 1,500,000 USD)
  - ✓ A source of 327 Programme provides about 100,000 USD for activities of the buffer zone.
  - ✓ Quang Binh provincial sources provide about 600,000 USD for activities of the tourism.
  - ✓ Another source of finances is the sale of tickets to visitors and other tourist service: estimated about 100,000 USD per year.
  - ✓ International NGOs or donors will provide funds for survey and research programmes, such as the LINC project with 147,000 USD.

### **i. Visitor facilities and statistics**

The organization system and tourism services of Quang Binh province are as follows:

- The Trading and Tourism Department of Quang Binh province is the Government Office responsible for managing all tourism activities in the area:
- ✓ There are 7 tourism and hotel companies in Quang Binh Province.
- ✓ The Tourism Services Unit has 9 guesthouses
- ✓ There are 4 private hotels
- ✓ There are 280 international standard rooms
- ✓ Area of the management plan and statement of objectives (copy to be annexed)
- The hotel and tourism services are always willing to serve visitors including those to the Phong Nha - Ke Bang area
- Visitors mainly come from Hanoi, Da Nang, Nha Trang, Ho Chi Minh and Da Lat cities.
- In the recent years, the number of foreign tourists coming to Phong Nha - Ke Bang has increased year on year. Before 1994, the number of tourists was less than 1,000 persons per year. In 1995, it increased to 5,000 persons, including a few foreign tourists. In 1997 there were of 28,000 tourists including 1,900 foreign tourists.

### **Tourism equipment of the Tourism Management Board**

- There are 8 vehicles with capacities of 4 to 15 seats for tourist transportation
- There are motor boats for transporting visitors along the Son River.
- To ensure visitor safety, the forest guards of Son Trach commune, Bo Trach district are placed on tourist security duty. At the present time, a

rescue team for tourists has not been established, but one will be formed in the near future.

#### **Appendix 4i**

List of hotels and guesthouses, and the number of tourists visiting Phong Nha - Ke Bang in recent years.

#### **k. Staffing levels (professional, technical, maintenance)**

A total staff of the Phong Nha - Ke Bang National Park is 221 as follows:

- **Leaders: 3**

1 director and 2 deputy director

- **General section: 12.** This section is in charge of administrative, finance and personnel services.
- **The Forest Protection Bureau** comprises 9 guard stations, 2 mobile patrol units with a total of 122 staffs. This section has responsibility for all protection activities in the park.
- **The Science and Technology Section** comprises 14 staffs, and is in charge of the implementation of research programmes, museum and experiment in the park.
- **The Culture and Tourism Management Section** comprises 70 staffs, and has responsibility for the management of cultural relics and tourism.

#### **5. Factors affecting the Property**

##### **a. Development Pressures (e.g., encroachment, adaptation, agriculture, mining)**

- Phong Nha - Ke Bang National Park is very far from the industrial center and residences, so that it is not be impacted by the development pressures.
- There are plans to develop National Highway close to Phong Nha - Ke Bang, but it will not affect the Nature Park.

## **Solutions**

- Based on the master plan for Quang Binh Province, all development programmes have to pay attention to nature and environmental protection,
- The rock exploitation factories is moved outside of Phong Nha - Ke Bang National Park.

### **b. Environmental Pressures (e.g., pollution, climate change)**

- Phong Nha - Ke Bang is situated in a high rainfall zone (about 3000mm per year), so transportation on the Son River is rather difficult in the rainy season (August to November).
- The site area is affected by the dry hot southwesterly wind from May to September.
- Due to the steep topography of the area, soil erosion will be extensive and rapid if forest cover is lost.
- Phong Nha - Ke Bang is a very important watershed area with a lot of underground rivers flowing through the cave systems in the area. The dry season flow of the rivers would be reduced by deforestation.
- Increase use of motor boats for tourist transport is causing water pollution.

## **Solutions**

- Strengthening forest protection to prevent illegal wood cutting, and stop shifting cultivation.
- Implementing a forest rehabilitation programme incorporating natural and artificial regeneration measures in the watershed area of Phong Nha - Ke Bang National Park.
- Promoting the reforestation, afforestation, forest and forest land allocation programme in the buffer zone according to the national programmes, 327 and 661, as well as carrying out the "Famine Eradication and Poverty Reduction" Programme.

- Limiting the number of motor boats, used on the Son River.

**c. Natural disasters and preparedness (earthquakes, floods, fires, etc.)**

- The national park is watershed area. Hence, flooding often occurs. Annually, in rainy season from September to November, many caves are flooded.
- Forest fires often happen in the dry season.

**Solution**

- Promoting the control forest fire and shifting cultivation in the area. Increasing the popular educational programme about forest protection for local people.
- Strengthening the protection of natural forest, reforestation and afforestation of watershed areas in the south and southwest of Phong Nha - Ke Bang National Park and the buffer zone.

**d. Visitor / tourism pressures**

- The number of visitors and boats are increasing every year, causing environmental pollution of caves and damaging the biodiversity of the area.
- The amount of waste increases year by year due to the increasing number of tourists.

**Solution**

- Promulgating the regulation of tourist activities in this site
- Training for officers and tourist guides.
- Forbidding motor boat and fuel light use inside the caves.
- Establishing strict regulations for visitors.
- Establishing sites for waste collectors.
- Designing suitable eco-tours in the area.

#### **e. Number of inhabitants within property, buffer zone**

- There are only two villages of the Arem and Ruc ethnic groups in the south and northeast of the site.
- In the buffer zone, the pressure on forest resources is increasing due to the annually increasing population as well as increasing demand for forest resource.

#### **Solution**

- Strengthening the propagation and education of the heritage protection for the local people living surrounding the site.
- Establishing a project to support the Arem and Ruc people on agricultural production, handicraft and eco-tourism development for involvement of them in forest protection.
- Implementing the national program 661 (5 millions Reforestation Program) for improving living standard of local people who are living in buffer zone and limiting the impacts to World Heritage.

#### **6. Monitoring**

##### **a. Key indicators for measuring state of conservation**

- Nature conservation at Phong Nha - Ke Bang is the priority task of the management board, therefore an assessment of forest resources is very necessary. Monitor the effectiveness of protection activities in the area, should be based on the following key indicators:

##### **Total area of forest and vegetation**

- More than 90% of the Phong Nha - Ke Bang area is covered by natural forest, including 124,717 ha of tropical limestone forest occupying 84.3% and 17,520 ha of tropical hill forest occupying 11.8%. Vegetation is classified into 11 types and subtypes, of which the most important ones for conservation are: Tropical dense moist evergreen forest on limestone, Low tropical montane evergreen forest on limestone above 800m asl., and Tropical dense moist evergreen forest on hills.
- The area and condition of natural forest, and the number of threatened plant and animal species are the key indicators for evaluating the



protection of Phong Nha - Ke Bang National Park. If the area of forest, especially primary forest decreases, it is proved that many serious protection problems appeared.

### **Biodiversity**

- Phong Nha - Ke Bang has a high biodiversity value, with diverse flora and fauna. This is a region with many endemic and economically valuable species of plant, such as *Diospyros salletii*, *Burretiodendron hsienmu* and *Sindora tonkinensis*, and many threatened animal species as Tiger, wild Dog and Gaur. In particular, the large limestone area is good habitat for many primate species and this is the richest area for primate species in Indochina. In this area, there are 10 species and 2 families of primates. Among these are 3 taxa endemic to Indochina: *Trachypithecus francoisi hatinhensis*, *Pygathrix nemaeus nemaeus* and *Hylobates leucogenys siki*.
- There are of habitat and the abundance of endemic and threatened species are key indicators of the effectiveness of protection measures in the area.
- At present, some groups of the endemic primate *Trachypithecus francoisi hatinhensis* live in the cliff in front of Cho Mong forest guard station. This is evidence of improved protection.

### **Inhabitant within the property**

- Inside the national park, there are of only 475 people of the Arem and Ruc ethnic groups. Some of these people still live in the forest, in limestone caves, earning their living by hunting and gathering forest products. The local authorities are encouraging these people to move into settlements.

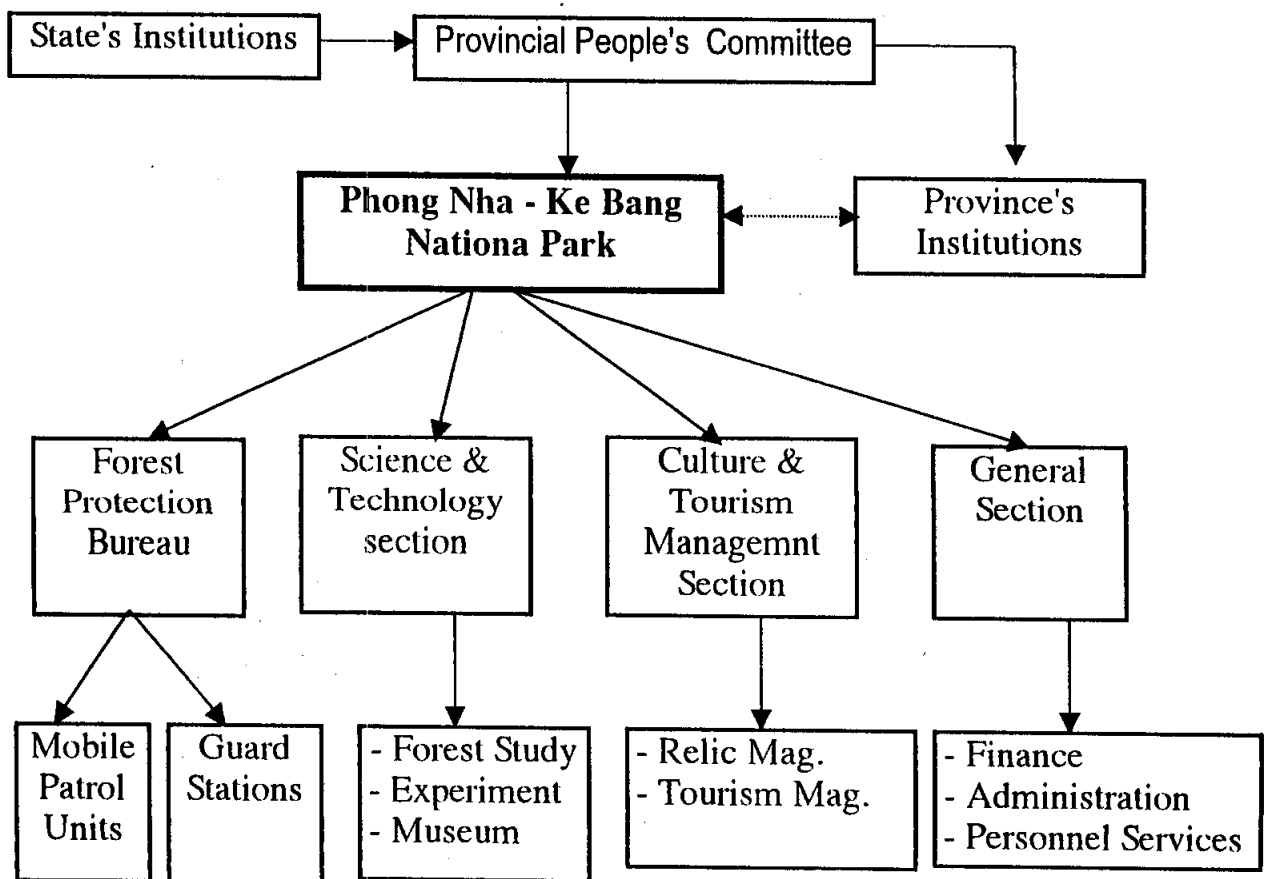
### **Pollution status of air and water in the caves**

- A project of Gianh River watershed was established by the Ministry of Agriculture and Rural Development for planning the catchment area of Gianh River.
- There are no any industrial factories, so that the water and air are not be polluted.

- Before 1994, there were less than 1,000 visitors per year. In 1995, the number of visitors increased to 7,000, and in 1996 to 12,500 (including 400 foreigners). In 1997, 28,000 tourists visited this area (including 900 foreigners). The increasing number of visitors and the increasing quantity of litter, is one reason for air and water pollution in the caves.
- To limit environment pollution, monitoring air and water quality in the caves is very necessary. This will supply updated data and information on environmental pollution in the area in order to apply effective solutions to protect the World Natural Heritage Site.

**b. Administrative arrangements for monitoring property**

- In the administration sectors, the highest level with responsibility for managing and monitoring activities at the site is the People's Committee of Quang Binh Province. The institutional framework for management and monitoring of the site as follows:



- The Phong Nha - Ke Bang Management Board is under the jurisdiction of the People's Committee of Quang Binh Province.

- Such provincial institutions as: The Tourist Department, the Cultural and Information Department, the Department of Science Technology and Environment, the Provincial Forest Protection Department and the Department of Agriculture and Rural Development provide support and expertise to the Phong Nha - Ke Bang Management Board.

### **Structure of the Phong Nha - Ke Bang Management Board:**

- The Forest Protection Bureau with the guards and mobile patrol units has responsibility all protection activities in the park.
- The General Section is in charge of administrative, financial and personnel services.
- The Science and Technology Section is in charge of the implementation of research programmes, museum and experiment in the park.
- The Culture and Tourism Management Section has responsibility for the management of cultural relics and tourism.

### **c. Results of previous reporting exercises**

- Phong Nha Nature Reserve was declared by the Council of Ministers in 1986. Phong Nha Cave Area was also listed at the national heritage system as a Relic and Landscape Area in 1992. In 1994, the management plan for Phong Nha Nature Reserve was approved. The protection activities of Phong Nha - Ke Bang area have achieved the following results:
- Establishment of two management boards with guard station and a mobile patrol unit. The cave systems of Phong Nha - Ke Bang have been kept intact and avoided damage from tourism. The local authorities have allowed groups of scientists to study the cave system, as evidenced by the drawing of the cave systems of Phong Nha - Ke Bang area conducted by scientists of The British Cave Research Association (1990-1997). Studies on the biodiversity of Phong Nha - Ke Bang were implemented by the groups of scientists, such as the RAS 93/102/WWF/UNDP project (1996-1997), Vietnam - Russia Tropical Centre (1999), field - survey groups of Fauna and Flora International (Timmins et al.), Forest

Inventory and Planning Institute (FIPI) programme for investigation of the forest and biodiversity for preparation of the management plan for Phong Nha - Ke Bang National Park. A study on geology was carried out by the Geological Faculty of Hanoi National Natural Sciences University.

- Reducing the bad impacts on the environment of the Phong Nha - Ke Bang area.
- Enhancing the communication and education activities in order to involve local people in the forest and environmental protection programme. Prohibiting shifting cultivation and fishing explosives.
- Expanding Phong Nha Nature Reserve and completing the management plan for Phong Nha - Ke Bang National Park, and the approval of this by Quang Binh Provincial People's Committee and the Vietnamese Government in 2000.

#### **Appendix 6c**

- Summary of research results on Phong Nha - Ke Bang area

#### **7. Documentation**

##### **a. Photographs, slides, and where available, film/video**

Photographs are supplemented

Slides are supplemented

Video film: 1

**These documents are available from the following institutions:**

Vietnam Pictorial

Address: 79 Ly Thuong Kiet - Hanoi - Vietnam

Vietnam Television Office

Address: 59 Giang Vo - Hanoi - Vietnam

Forest Inventory and Planning Institute (FIPI)

Address: Thanh Tri District - Hanoi - Vietnam

**b. Copies of property management plans and extracts of other plans relevant to the property**

1. The Ministry of Science Technology and Environment, 1992. Red Book of Vietnam, Part of Fauna. The Publisher of Science and Technique, Hanoi.
2. The Ministry of Science Technology and Environment, 1996. Red Book of Vietnam, Part of Flora. The Publisher of Science and Technique, Hanoi.
3. Nguyen Binh, 1961. Brief Introduction of Mountainous Minority People of Quang Binh Province - Ethnology 23, Hanoi 1961.
4. Nguyen Ngoc Chinh 1993. Proposing the Vietnamese Nature Reserves as the World Natural Heritage. Forestry Magazine N<sup>o</sup> 10, 1993
5. Nguyen Quoc Loc 1979. The Ethnic composition of Binh Tri Thien Province (now, Quang Binh Quang Tri, Thua Thien Hue provinces). Ethnology N<sup>o</sup> 9 - 1979.
6. Nguyen Quoc Loc 1984. The Minority Ethnic Groups of Binh Tri Thien Province Thuan Hoa Publishing House, 1984.
7. The Rare and precious plant species should be protected in Vietnam. Profession Information - Ministry of Forestry, 1997.
8. A - Jarratt ,1992. BSE Vietnam report. Hang Cha An.
9. Andy Mackie, 1997. BSE Vietnam 97. Upstream Hang Vom system. Tiger cave, over cave, Pigmy cave.
10. Anon, 1993. Management plan of Phong Nha Nature Reserve Quang Binh province. Unpublished report to Ministry of Forestry - Hanoi.
11. Aubre'ville A. et Leroy - F (reducteur). 1972 - 1975 - 1980 - Flore du Cambodge du Laos et du Vietnam

12. British Speleological Expedition, 1992. All... Exploration of Hang Vom.
13. British Speleological Expedition, 1990. Vietnam Report 1990.
14. British Speleological Expedition, 1992. Vietnam Report 1992.
15. British Speleological Expedition, 1994. Vietnam Report 1994.
16. British Speleological Expedition, 1997. Vietnam Report 1997.
17. Callister. Paul, 1997. BSE Vietnam 97. Over Cave - Pigmy cave.
18. D. Gallivan, 1994. BSE Vietnam 1994. Hang Tien (Tien Cave)
19. Dany Bradshaw, 1994. BSE Vietnam 1994. Hang En
20. Deborah Limbert and R. Skorupka, 1994. BSE - Maze cave.
21. Deborah Limbert, 1990. BSE 1990 - Vietnam 1990.
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**c. Address where inventories, records and achieves are held**

1. Forest Inventory and Planning Institute (FPI): All of Maps and Management Plans of Phong Nha - Ke Bang  
Address: Thanh Tri District - Hanoi - Vietnam
2. Society Science and Information Institute: Where ancient books are available

Address: Trang Thi Street - Hanoi - Vietnam.

3. World Wide Fund for Nature (WWF)

Address: 7 Yet Kieu street- Hanoi - Vietnam.

4. The World Conservation Union(IUCN)

Address: 13 Tran Hung Dao Street - Hanoi - Vietnam

5. Ministry of Culture and Information

Address: 51-53 Ngo Quyen street - Hanoi - Vietnam

6. Hanoi National University

Address: Nguyen Trai street - Hanoi - Vietnam

7. Institute for Ecology and Biology Resources

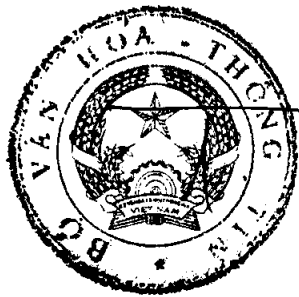
Address: Hoang Quoc Viet street - Hanoi - Vietnam

**8. Signature on Behalf of the State Party**

**For the Socialist Republic of Vietnam Government**

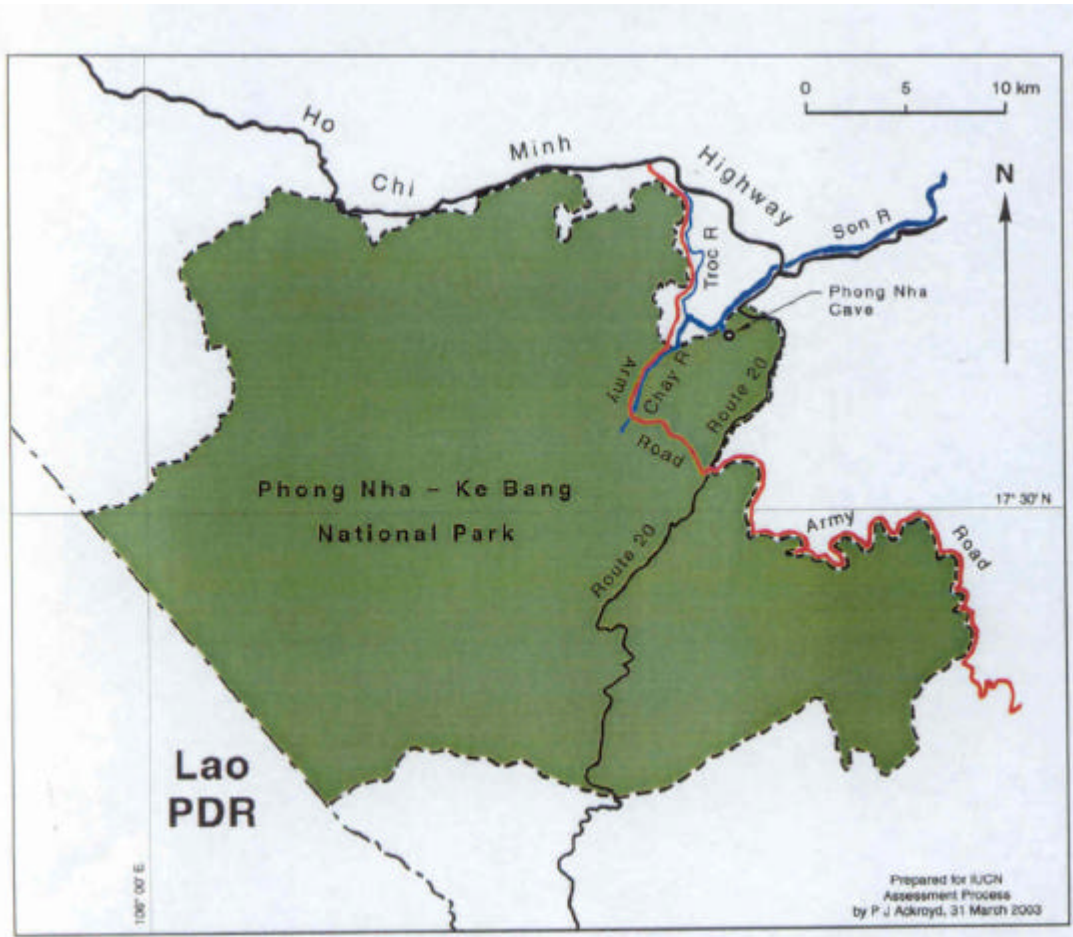
**Vice Minister of the Ministry of Culture and Information**

**Vice Chairman of Vietnam National Committee of UNESCO.**



**Prof. Dr. Luu Tran Tieu**

**Map 2: Detailed Map of Site**









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(APPENDIX)  
PART 1

WORLD HERITAGE LIST  
NOMINATION FORM

**THE PHONG NHA-KE BANG  
NATIONAL PARK  
VIETNAM**

## CONTENTS: PART I

### **Appendix 2a**

1- Geological and Geomorphologic characteristics of Phong Nha - Ke Bang area

### **Appendix 3a**

Description of Phong Nha Cave systems (Based on documents of British Cave Research Association)

UNIVERSITY NATIONAL VIET NAM HA NOI  
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**GEOLOGICAL AND GEOMORPHOLOGIC  
CHARACTERISTICS OF  
PHONG NHA - KE BANG AREA**

HA NOI 2000

## INTRODUCTION

The Phong Nha - Ke Bang area together with its surroundings has a complicated and long geological development history from Cambrian to present. Through important tectonic megacycles and block faulting and folding phases, there were formed continuous rolling mountains due to the uprising movements, and sedimentary basins due to subsiding ones. Here the tectonic circumstances as the cause of all causes to create the diversity in geology, topography and geomorphology, in hydrographic network and the diversity and magnificence in tourist caves in limestone formations in Phong Nha - Ke Bang area which are developed in age from Devonian to Permian. The Son river has the red color of the weathered terrarossa originating from the limestone area and merges with Rao Nam and Rao Nay rivers originating from the area of terrigenous rocks, reflecting the basic difference and creating a diversity in the same Gianh river basin. The diversity in geology, the rugged topography and multiform geomorphology are the pre-requisite entailing other specific properties, i.e. the biological diversity, the beautiful but mystic landscape, primitive wild forests like natural museums abounded with secrets which few people know.

The report "*Geological and geomorphologic characteristics of Phong Nha - Ke Bang area*" is an integrated research work carried out by geoscientists and geomorphologists of the Faculties of Geology and Geography of the Hanoi University of Science, Vietnam National University, Hanoi with inheritance from the results of many years researches of Vietnamese and foreign geologists, geographers and geomorphologists with various objectives and tasks. In the mean time, the research team carried out additional surveys, investigations, processed and compiled individual data into a work with logical content in the concept of systems approach comprising all aspects from geography, paleontology to topography - geomorphology and geology of cave.

The report comprises the following parts:

- Natural geography - economy -population
- Stratigraphy, sediments and their area of distribution
- Paleontological characteristics
- Petrology and magmatism
- Geological structure and geological development history
- Mineral resources

- Geomorphologic and topographic characteristics and evolution in relation with neotectonic movements

To complete this report, the authors have received assistance and creation of favorable conditions from the authorities, the Departments of Cultures, of Science, Technology and Environment of Quang Binh province, the Rectorate of the Hanoi University of Science, Vietnam National University, Hanoi, the Dean of the Faculties of Geology and Geography of the Hanoi University of Science. On this occasion, the authors would like to express sincere thanks to all of them.

## Chapter 1

# NATURAL GEOGRAPHY - ECONOMY - POPULATION

### 1.1. Natural geographic characteristics

The study area occupies most of the area of Quang Binh province (Fig. 1), with the following coordinates:

17 °20' - 17 ° 47' N

105° 46' - 106° 24' E

#### 1.1.1. Topography

Based on the degree of dissection and the elevation of the terrain the Phong Nha - Ly Hoa area can be divided into 4 topographic levels:

- + *Medium high mountain topography* has an elevation over 800 m, covering about 2,600 km<sup>2</sup>, occurs in two main mountain ranges: 1) Hoanh Son mountain range: extends in W-E direction, with slope of 35 - 40°; 2) Truong Son mountain range extending from SW of Dong Hoi through Mu Da, Ca Xen and developed in NW-SE direction along the Vietnam - Laos border. The terrain here is strongly dissected, with rugged and craggy morphology, steep slope, with karst development.
- + *Low mountain topography* is distributed in the central area of Quang Binh, consisting of mountain ranges extending in NW-SE direction, concordant with the trend of the geological structure, with elevation 400 - 800 m. These are Ong Ma, Nui Den, Dai Du, Da Mao mountain ranges, characterized by slopes of 20 - 35 °, separated by narrow valleys.
- + *Hilly topography* is the transitional topography between the mountain and plain levels, with elevation 20 - 250 m, covering an area of 750 km<sup>2</sup>. It consists of individual hills or hummocks extending in NW-SE direction, low and small undulating hills with low slope.
- + *Plain topography* is distributed along the coast line, extending from Ngang Pass to Le Ninh, with elevation 4 - 10 m. The land surface is gently incline seawards. The width of the plain varies, near the shore there are elevated sand dunes.

#### 1.1.2. Hydrographic network

The hydrographic network in the area is rather dense, consisting mainly of 4th and 5th order streams, flowing mainly in NW-SE and W-E directions. The rivers flowing in W-E direction consist of Son, Nam, Dinh, etc, rivers, all originating from Truong Son mountain range and flowing to the sea. These rivers have steep slope, narrow bed, with high flow in rainy season, thus often causing high floods. During the dry season the rivers and streams usually have low flow, the small streams are usually dry. The rivers flowing in NW-SE direction consist of the Gianh (Rao Nay) river system, the Ron river system, etc. originating from the high areas of Truong Son mountain range and flowing along geologic faults. All rivers have high slopes, with narrow channel in the upstream, so their flow velocity is very high. The flow of the rivers and streams vary seasonally. The water in the rivers and streams in the rainy season is high and in dry season is very low, even depleted.

### 1.1.3. Climate

The Phong Nha - Ke Bang area has a severe climate, divided into two clear seasons.

- + *Rainy season* usually starts later than in the Northern provinces, lasting from August to February. The rainfall in this season is high, causing frequent floods. August, September and October have greatest rainfall (320 - 370 mm/month), with high average number of rainy days (14 - 22 days/month) together with sin typhoons coming from the East sea, causing great losses to the area. In November and December occur lasting drizzle rains and Northeasterly winds, in some years lasting to the end of January, creating unpleasant weather.
- + *Dry season* is clearly expressed from March to July. The small streams during this season have practically no water. The winds blow in two main directions: The winds blowing from the Southeast bring cool and pleasant climate; the winds from the Southwest, also called the Lao winds, occur from May to July. As they blow across Truong Son mountain range, it is dry and hot, making the air stuffy.

The mean annual temperature in the area is 23 - 25 °C, minimum 10 - 13 °C, maximum 35 - 37 °C, in some years up to 38 - 40 °C. The humidity is low, in average 25,1 %.

## 1.2. POPULATION AND ECONOMY



### **1.2.1. Population**

The population of the area is about 60,000, unevenly distributed. Most of the population is concentrated in the coastal, plain areas, in towns and townships and river valleys (beyond the study area). The population is diverse in ethnic composition, consisting mainly of Kinh group. Besides there are some other ethnic groups such as Sach, Nguon, Van Kieu, Ruc, etc. The cultural level of the Kinh people is relatively high. The cultural level of other ethnic groups in general is still limited. Backward traditions and customs still exist here and there.

### **1.2.2. Economy**

The economy of the area (beyond the study area) is unevenly developed. The agriculture depends much on the water supply sources and the weather. Every year the coastal plain area is invaded by a large amount of sand due to the action of winds. As for industry, mostly small industries and handicrafts such as rattan and bamboo ware making craft, basketry, brick and tile production, tea and rubber processing. Livestock, poultry, fishing are strongly developed. The commercial network has been expanded, however it has still not extended to the remote and isolated areas. Many localities still lack electricity.

## **1.3. COMMUNICATIONS AND TRANSPORT**

The communication network is developed in the plain area. There is a railway from Thanh Lang Xa to Le Ninh. The study area is crossed by National Highway No 1 in the coastal area. Some roads to Laos which have been rehabilitated together with old roads which exist since the wartime (Road No 20, Road 15) and newly built roads have formed a relatively dense communication network. But in general the road system is still not good. The main cause of this is the sin dissection of the terrain, severe climate, usually occurrence of floods in the rainy season which destroy the roads and cause difficulties for travelling. As regards water ways, small boats can move along river systems up to higher areas. But during the rainy season, the water level is high, the movement of these means of transport is difficult. As the rivers have high gradient and narrow channels, bigger means of transports cannot move far up.

### **Figure 1. Location map of the study area**

Scale 1: 3,000,000

1. Main roads; 2. Railway; 3. National border; 4. Rivers; 5. Study area; 6. City; 7. Capital city

## Chapter 2

### STRATIGRAPHY, SEDIMENTS AND THEIR AREA OF DISTRIBUTION

The bulk of sediments in the Phong Nha - Ke Bang area consists of carbonate rocks. They are rather complicated in composition. Besides, intercalating in the limestone massifs and surrounding there are many formations composed of various terrigenous sediments. Also due to this complexity, it is not always possible to distinguish clearly the formations subdivided through detailed thematic researches in this area. Therefore, here we introduce mainly the stratigraphic units which have been established and used by the North Vietnam Geological Mapping Division at various times, with supplementing new data obtained from the recent researches.

Stratigraphic units presented below are integrated into groups, corresponding with various stages of the regional geological development history: Lower Paleozoic (Long Dai formation  $O_3-S_1ld$ ); Middle Paleozoic (Rao Chan formation  $D_1rc$ , Bản Giang formation -  $D_2ebg$ , Múc Bai formation  $D_2gmb$ , Minh Le formation  $D_2g-D_3frml$ , Cat Dang formation  $D_3cd$ , Phong Nha formation  $D_3-C_1pn$ ); Upper Paleozoic (Bac Son formation  $C_{1,2}bs$ , Khe Giua formation  $P_2kg$ ); Mesozoic (Mu Gia formation  $Kmg$ ) and Cenozoic (undifferentiated Quaternary system).

#### 2.1. LOWER PALEOZOIC

##### UPPER ORDOVICIAN - LOWER SILURIAN

The Lower Paleozoic formations in the area are distributed in the SE of the study area, only consisting of the terrigenous sediments of Long Dai formation.

**Long Dai formation ( $O_3-S_1ld$ ).** In the study area are exposed only the sediments pertaining to the lower part of this formation, mainly comprising biotite-feldspar-sillimanite gneiss, quartz-two-mica schist, quartzitic sandstone, quartz-two-mica sandstone, quartz schist with cordierite, with a thickness of about 900 m. The relationship of this formation with older rocks cannot be observed (Fig. 2.1)

The  $O_3-S_1$  age of Long Dai formation has been determined on the basis of Graptolithina fossils discovered on the section along le Ky stream and Khe Gioi section: *Demirastrites convolutus* (Hisinger), *Monograptus hali* (Barrande), *Pristiograptus* sp., *Oktavites spiralis* (Geinitz) and one fossil of Trilobita SW of Vit Thu Lu: *Cyclopyge* sp.

The Long Dai formation has boundary with the rocks of younger formation.

(Picture 1)

**Figure 2.1.** Outcrop PN-2 (17°32' 21" N; 106° 17'19" E).

Highway No 20. Strongly sheared quartzitic sandstone of Long Dai formation (Photo: Tran Nghi, Ta Hoa Phuong, 1999).

## 2.2. MIDDLE - UPPER PALEOZOIC

### 2.2.1 DEVONIAN SYSTEM

In the study area, Devonian sediments are widespread and are divided into the following stratigraphic units: Rao Chan formation ( $D_{1rc}$ ), Ban Giang formation ( $D_{2ebg}$ ), Muc Bai formation ( $D_{2gmb}$ ), Minh Le formation ( $D_{2g}$ - $D_{3frml}$ ) and Cat Dang formation ( $D_{3fm}$   $cd$ ) and part of Phong Nha formation ( $D_{3fm}$ - $C_{1tpn}$ ).

The Rao Chan, Ban Giang and Minh Le formations are composed mainly of terrigenous sediments, while the Muc Bai formation is composed of terrigenous intercalated with carbonate sediments and the Cat Dang and Phong Nha formations mainly of carbonate rocks.

Rao Chan formation ( $D_{1re}$ ) was established by Tran Tinh (1978). It is cropped out in the NNE of the Phong Nha - Ke Bang limestone massif.

This formation consists mainly of quartz-sericite schist, clay-sericite shale, calcareous claystone of black grey, blue grey color, intercalated with sequences or beds of quartzitic sandstone, calcareous shale or black biogenic limestone. the limestone yields abundant Tabulata fossils: *Gerphuropora* aff. *krekovesis* Dubal., *Favosites multiformis* Dubat., *F. multiplicatus* Yanet, *Favosites* aff. *ambigus* Tehern., *Thammopora* aff. *incerta* Regnell., *T. plumosa* Yanet; one species of Tetracoralla (Rugosa): *Spongophyllum* ef. *halysitoides* Etheridge and some species of Lo tang (stromatoporoidea): *Stachyodes* ef. *costulata* Lec., *S.* sp., *Paralleolopora* sp. The thickness of this formation reaches about 1,500 m (Fig. 2.2).

(Picture 2)

**Figure 2.2.** Outcrop PN-15 (17° 38'12" N, 106° 17'19" E).

Highway No 15. Black thin-bedded bituminous shale, weathered to motley yellow and black color, of Rao Chan formation (Photo by Tran Nghi, Ta Hoa Phuong 1999).

In general, the sediments of Rao Chan formation has a facies transition in lateral direction, while in other sections fine terrigenous sediments are predominant (Figure 2.3).

**Figure 2.3.** Black bituminous shale of Rao Chan formation ( $D_{1rc}$ )

Under 2 nicols, the rock is seen to be composed of microgranular quartz intermingled with organic matter of brownish black color, with fine parallel schistose foliation. Exaggerated by 40 times (Photo by Tran Nghi, 1999).

With the above abundant fossil assemblage, the Rao Chan formation has been placed to Lower Devonian. The rocks of Rao Chan formation overlie with unconformity the Dai Giang formation ( $S_2-D_1dg$ ) dg beyond the limits of the study area and is overlain by Ban Giang formation ( $D_2ebg$ ).

**Ban Giang formation ( $D_2ebg$ )** was established by Tran Tinh (1978), cropped out in the North of the Phong Nha - Ke Bang limestone massif.

This formation is composed mainly of grey, yellow, firm quartz sandstone, quartzitic sandstone, in some places intercalated with pockets of siliceous rocks, beds of siltstone, calcareous siltstone, black shale. The total thickness reaches near 1,000 m. In the sediments of this formation, especially in the sequences of siltstone and shale various fossils have been found: Tetracoralla: *Calecela sandalina* Lin.; stems of Crinoidea: *Hexacrinites* aff. *humilicarinatus* Yelt., *Hexacrinites* aff. *biconcavus* Yelt. et Dubat., Brachiopoda: *Atrypa kakvensis* Khodalevich, Bivalvia: *Pleria* sp. and ancient fishes: *Lyhoalepis duckhoai* Janvier. Based on the above fossils, this formation has been placed in Middle Devonian, Eifelian stage.

This formation occurs with conformity on Rao Chan formation and is overlain by Muc Bai formation ( $D_2gmb$ ).

**Muc Bai formation ( $D_2gmb$ )** was established by Tran Tinh (1978), cropped out in the North of the Ke Bang limestone massif. The sediments of this formation are characterized by an alternation between sequences of black, dark grey limestone, calcareous shale, with ones of yellow grey siltstone, sandstone. In the calcareous shale in some places there are pockets of black siliceous rocks, whereas in the sandstone - pockets of blue grey limestone.

The fossil assemblage met in the rocks of this formation is very abundant. In the lowest part of the formation are met fossils characterizing Givetian stage,

however there are also some associating Eifelian fossils: *Undispirifer undiferus* (Roemer), *Atrypa vulgariformis* Aleks., *Quydatatrypa triangula* (Copper), *Spinatrypa balechatica* Aleks., etc. The rocks in the upper part of the formation yield typical Givetian fossils such as: *Stringocephalus burtini* Defr., *Caliopora battersbyi* (M.E.H.), *Seoliopora denticulata* (M.E.H.) together with species characterizing Late Givetian such as: *Ambothyris cicer* (Eichw.), *Kelusia volhynica* (Kelus) etc. In addition, there appear also some representatives of Givetian- Frasnian in the uppermost part of the formation such as: *Emanuella transversa* Grabau, *E. samsonoweisi* (Kelus).

The sediments of the Muc Bai formation occur conformably on the rocks of Ban Giang formation, and is overlain by the sediments of Minh Le formation.

**Minh Le formation (D<sub>2g</sub>-D<sub>3frml</sub>)** was established by Pham Huy Thong et al. (1999). In the study area, the sediments of this formation crop out in the East and the NW of Ke Bang limestone massif. Some small outcrop areas of this formation are in between the limestone in the SE of the study area.

This formation consists mainly of light grey, medium to thin bedded medium grained quartz sandstone intercalated by beds of siltstone and shale containing black coaly matters. In some places in the area one can see a sequence of terrigenous siliceous sediments in the uppermost of the section of this formation.

In the sediments of this formation there have been discovered many Brachiopoda fossils: *Megachonetes* sp., *Schizophoria* cf. *ivanovi*, *Adolfia* sp.; Tentaculites: *Styliolina* sp., *Homoctenus* sp.; especially at the entrance of Hoi Da cave (near Minh Le railway station a nice flora fossil outcrop has been found, containing *Proculatisporites* sp., *Bergeria* (*Lepidodendropsis*) sp. and spores of: *Apiculatisporites* sp., *Geminospora* sp., *Grandispora* sp., *Favispora* cf. *rotunda* Lu, *Gymbosporites magnifica* (McGregor).

The above fossil assemblage allows to place in Minh Le formation to Givetian stage of Middle Devonian to Frasnian stage of Upper Devonian (D<sub>2g</sub>-D<sub>3frml</sub>). This formation occurs with conformity on Muc Bai formation and is overlain by Cat Dang formation.

**Cat Dang formation (D<sub>3cd</sub>)** was established by Nguyen Quang Trung et al. (1999). This formation crops out in a narrow band in the North and the SE of the study area.

This formation consists mainly of diverse carbonate sediments, of which the banded limestone and motley limestone occupy a considerable portion. In addition there is also grey limestone, in some places intercalated with thin sequences of siliceous limestone or siliceous schist. The thickness of this formation is about 250 m.

The rocks of Cat Dang formation yield Stromatoporoidea fossils: *Stachyodes* aff. *costulata* Lee., *S. lagowiensis* Gog., *Anostylostroma?* *erassa* Hung and especially have abundant microfossils of Conodonta of *rhenana*, *linguiformis*, *triangularis*, *crepida*, *marginifera*, *trachytera* zones and *gracilis* - *sigmoidalis* assemblage aged from Frasnian to the end of Famennian (D<sub>3</sub>fr-fm).

The Cat Dang formation occurs with conformity on the siliceous schist of Minh Le formation. Its upper contact with La Khe formation (C<sub>1</sub>lk) has not been observed. According to the regional geological data the contact is unconformable.

Especially in the study area there are some nice geological sections exposed at the entrances of caves on the SW slope of Xom Cay Da limestone mountain (in the old topographic map registered as Xom Nha), about 3 km west of Quy Dat township (Fig. 24). In this section the continuous chronostratigraphic boundary between the two stages Frasnian and Famennian (Upper Devonian) has been discovered based on the results of research on the Conodonta fossil group. The continuous deposition as well as the Conodonta fossil zones discovered within the above mentioned boundary is the peculiar feature of this section, giving it the international significance in the biostratigraphic study of Late Devonian. Therefore the above limestone mountain massif needs to be protected as a natural heritage with great scientific value.

**Figure 2.4. Xom Nha limestone massif (Cay Da hamlet, West of Quy Dat)**

Photo by Ta Hoa Phuong, 1996

In Xom Nha limestone massif, Nguyen Huu Hung et al., 1980, have discovered an assemblage of Stromatoporoidea - Conodonta fossils aged Frasnian - Famennian. Later, Nguyen Huu Hung Nguyen Huu Hung (Le Hung et al. 1991) established Xom Nha formation to indicate the carbonate sediments containing the Stromatoporoidea - Conodonta fossil assemblage aged Frasnian - Famennian

cropping out in Xom Nha, Thanh Lang and in Dong Dai mountain, Chuc A area. Pham Kim Ngan (1986) dealt with the Frasnian/Famennian boundary ( F/F) in Quy Dat area, mainly on the basis of the result of analyzing 4 Conodonta specimens from the above mention boundary section. In ascending order the author has met the representatives of the following zones: *Pa.gigas* (Specimen QĐ16/1), *Pa. triangularis* (Specimen QĐ16/2a) and *Pa. crepida* (Specimen QĐ16/3).

Ta Hoa Phuong and Doan Nhat Truong (1995) discovered a very abundant Conodonta fossil assemblage belonging to gigas zone in the lower part of the Xom Nha section, on the left wall of a karst cave on the SW slope of this mountain massif. Together with the above mentioned Conodonta assemblage, in these specimen Stromatoporoidea fossils aged Frasnian have been also found, and determined by Nguyen Huu Hung to consist of: *Stachyodes* aff. *costulata* Lee., *S. lagowiensis* Gog., *Anostylostroma? crassa* Hung sp. nov. (Specimen XN106). One limestone sample collected in high part of a large limestone block in front of the above mentioned cave entrance contain abundant Conodonta pertaining to the upper part of *triangulatis* zone ( Specimen XN125). At that time Ta Hoa Phuong and Doan Nhat Truong ( 1995) considered that the F/F boundary passed between the locations where the above mentioned fossil samples were collected, i.e. between the gigas and *triangulatis* zones.

Ta Hoa Phuong and Nguyen Huu Hung (1997) collected in the area of F/F boundary 7 samples of Stromatoporoidea, 2 samples of Tentaculites and 69 limestone samples to be prepared for determination of Conodonta. The result of studying the Conodonta samples from this section have been appraised by Prof. Dr. W. Ziegler (Senckenberg Research Institute, FRG) a world leading expert in Conodonta.

Fig. 2.5.

Fig. 2.6

**Fig. 2.5. and 2.6. Xom Nha section, limestone of Cat Dang formation**

Photo by Ta Hoa Phuong

*Detailed description of Xom Nha section:*

This section is surveyed in the area around a cave on the NW slope Xom Nha limestone mountain massif. This is a nice cave, with its floor a few meter above the ground level. We have collected in ascending order 42 limestone samples (Q1-Q42) from the cliff on the left of the cave entrance with a total thickness of 5.27 m and 27 samples (Q43-Q69) at the entrance and inside of the cave with a total thickness of 84 m. The following description introduces mainly the cave entrance section where the most complete fossils of Conodonta zones have been found at the F/F boundary (Fig. 2.5 and 2.6).

In ascending order the strata and their fossils are described as follows:

- 1) Grey, dark grey, thick-bedded recrystallized limestone with uneven grain size and unclear bedding plane. This sequence is 200 cm thick. In the lowest part of the sequence (samples Q43- Q45) no fossil has been discovered. within the uppermost 75 cm of the sequence (samples Q46 - Q48), the following Conodonta fossils belonging to the lower part of *rhenana* zone have been found: *Ancyrodella nodosa* Ulrich & Bassler, *A. ioides* Ziegler, *Ancyrognathus triangularis* Youngquist, *Palmatolepis rhenana rhenana* Bischoff, *Pa. rhenana nasuta* Muller, *Pa. hassi* Muller & Muller, *Pa. jamieae* Ziegler & Sandberg, *Pa. foliacea* Youngquist, *Pa. xomnhaensis* Ta sp, nov.
- 2) Grey, dark grey, pelitic and recrystallized fine grained limestone intercalated with marl, medium to thick-bedded (20- 75 cm). This sequence is 525 cm thick, containing abundant Conodonta fossils of various zones from *rhenana* to *crepida*.

In ascending order are met:

- In the first three layers of the sequence (total thickness of 135 cm) Conodonta fossils of *rhenana* zones have been discovered: *Palmatolepis rhenana rhenana* Bischoff, *Pa. jamieae* Ziegler & Sandberg (Q49); *Ancyrodella nodosa* Ulrich & Bassler, *Pa. hassi* Muller & Muller, *Pa. boogaardi* Klapper & Foster, *Pa. juntinaensis* Han, *Pa. hassi* Muller & Muller, *Ancyrodella nodosa* Ulrich & Bassler (Q50); *Ancyrodella nodosa* Ulrich & Bassler, *A. ioides* Ziegler, *Palmatolepis boogaardi* Klapper & Foster, *Pa. rhenana rhenana* Bischoff (Q51).
- In the following two layers (with total thickness of 60 cm) the following Conodonta fossils of *linguiformis* zones have been found: *Palmatolepis*



*linguiformis* Muller, *Pa. rhenana rhenana* Bischoff, *Pa. rhenana brevis* Ziegler, *Pa. rhenana nasuta* Muller, *Pa. gigas* Miller & Youngquist, *Pa. subrecta* Miller & Youngquist, *Pa. hassi* Muller & Muller, *Pa. juntinaensis* Han, *Pa. ederi* Ziegler & Sandberg, *Pa. eureka* Ziegler & Sandberg, *Palmatolepis foliacea* Youngquist, *Ancyrodella nodosa* Ulrich & Bassler, *A. ioides* Ziegler and some shells of *Homoctenus* sp. (Q 52); *Pa. rhenana rhenana* Bischoff, *Pa. rhenana nasuta* Muller, *Pa. gigas* Miller & Youngquist, *Pa. subrecta* Miller & Youngquist, *Pa. linguiformis* Muller (Q 53).

- In the subsequent layer of the sequence (70 cm thick) not many fossils have been found, there appeared *Palmatolepis triangularis* Sannemann which is the indicative species of the zone with the same name. In five specimens prepared from this layer, (Q54-Q58), *Palmatolepis triangularis* Sannemann, *Pa. subperlobata* Branson & Mehl, *Icriodus alternatus* Branson & Mehl have been found.
  - In the four following layers (with total thickness of 210 cm) in general fossils are rare and have not been investigated in detail. With 5 specimens prepared from these layers (Q59-Q63) the following Conodonta fossils belonging to *triangularis* zone have been found: *Palmatolepis triangularis* Sannemann, *Pa. subperlobata* Branson & Mehl, *Pa. delicatula clarki* Ziegler, *Pa. delicatula postdelicatula* Schulke, *Icriodus alternatus* Branson & Mehl.
  - The uppermost layer of sequence 2 (60 cm thick) contains an multiple assemblage of, consisting of the forms of the upper part of *triangularis* zone and the lower part of *crepida* zone: *Palmatolepis triangularis* Sannemann, *Pa. triangularis* → *crepida*, *Pa. triangularis* → *tenuipunctata*, *Pa. subperlobata* Branson & Mehl, *Pa. delicatula platys* Ziegler & Sandberg, *Pa. delicatula jii* Ta subsp. nov., *Pa. wernerii* Ji & Ziegler, *Pa. delicatula postdelicatula* Schulke, *Pa. weddigei* Ji & Ziegler, *Pa. minuta loba* Helms, *Pa. quadrantinodosalobata* Sannemann, *Pa. regularis* Cooper, *Ancyrolepis* sp. (Q64-Q65).
- 3) Grey, dark grey limestone, marl intercalated with siliceous limestone, medium to thin-bedded. The total thickness is 245 cm. Abundant Conodonta assemblage is only found in the uppermost layer of the sequence. In sample

Q68 are contained multiple Conodonta forms of *marginifera* zone: *Pa. glabra glabra* Ulrich et Bassler, *Pa. glabra lepta* Ziegler & Hud., *Pa. glabra elongata* Holmes, *Pa. glabra prima* Ziegler & Hud., *Pa. glabra pectinata* Ziegler, *Pa. marginifera marginifera* Helms, *Pa. perlobata perlobata* Ulrich & Bassler, *Pa. perlobata schindewolfi* Muller, *Pa. quadrantinodosa quadrantinodosa* Branson & Mehl, *Pa. quadrantinodosa inflexoidea* Ziegler, *Pa. tenuipunctata* Sannemann, *Pa. marginifera sinensis* Ji & Ziegler.

- 4) Grey, light grey, motley grey limestone, in some places banded, medium and thick-bedded. This is the main limestone sequence of the Xom Nha mountain massif. In the rocks of the lower part of this sequence are still met representatives of *marginifera* zone: *Palmatolepis marginifera marginifera* Helms, *Pa. glabra pectinata* Ziegler, *Pa. glabra glabra* Ulrich & Bassler, *Pa. glabra distorta* Branson & Mehl (Q69) (Fig. 2.7).

**Fig. 2.7. Stratigraphic column of the F/F boundary area at Xom Nha section**

***Stratigraphic analysis of Xom Nha section:***

- 1) The issue of boundaries between Devonian chronostratigraphic units in general and that of F/F boundary in particular always receive attention from many stratigraphers and is the topic of annual discussion of SDS under the International Stratigraphic Committee. Until 1985, the F/F boundary was determined to coincide with the bottom of the middle sub-zone of Conodonta *Pa. triangularis* zone (W. Ziegler, G. Klapper, 1985). Most recently that boundary was redefined to coincide with the boundary between two Conodonta zones: *Pa. linguiformis* and *Pa. triangularis* (J.W. Cowie, W. Ziegler, J. Remane, 1989). Here attention should be paid to *Pa. linguiformis* zone which is a new zone separated from the uppermost part of previous *Pa. gigas* zone, the remaining part of *Pa. gigas* zone now bears the name of *Pa. rhenana* zone.
- 2) The above mentioned result of Conodonta samples analysis is the basis for determining the F/F boundary in Xom Nha according to the latest regulations of the International Stratigraphic Committee:

- In the lowermost layers of the above described section interval (Samples from Q46 to Q51) is found the indicative form of *Pa. rhenana* zone and its associating forms such as: *Ancyrodella nodosa* Ulrich & Bassler, *A. ioides* Ziegler, *Ancyrognathus triangularis* Youngquist, *Palmatolepis rhenana rhenana* Bischoff, *Pa. rhenana nasuta* Muller, *Pa. hassi* Muller & Muller, *Pa. jamieae* Ziegler & Sandberg, *Pa. foliacea* Youngquist, *Pa. boogaardi* Klapper & Foster, *Pa. juntinaensis* Han.

The presence of *Palmatolepis foliacea* Youngquist (the most common species in *jamieae* zone and lower *rhenana* sub-zone) in samples Q46-Q48 and *Palmatolepis juntinaensis* Han (the species occurs from the middle part of upper *rhenana* subzone) in sample Q50 allowed us for the time being to place the lowermost layer of this section interval to lower *rhenana* subzone (Q46-Q48), and the remaining part belongs to upper *rhenana* subzone (Q49-51). In the strata corresponding with lower *rhenana* subzone in the section interval on the escarpment on the left side of the cave entrance are found Stromatoporoidea forms which have been referred to above (samples XN106, Q7). This is a rare case where both above mentioned fossil groups are met in the same place.

- In the subsequent two layers of the section, together with Conodonta forms which have been found in *rhenana* zone, appears *Palmatolepis linguiformis* Muller which is the indicative species of the zone with the same name. It is the uppermost zone of Frasnian, identified for the first time in Vietnam
- In the samples from Q54 to Q63 of the subsequent stratigraphic interval fossils in general are rare, however from the sample in the lowermost part (Q54) the indicative species of *Pa. triangularis* zone-- the lowermost zone Famennian. Thus, in the section interval described above, the F/F boundary coincides with the boundary between the two zones *Pa. linguiformis* and *Pa. triangularis*, in conformity with the new decision of SDS.
- Samples Q64 and Q65 from the uppermost part of the subsequent layer contain Conodonta forms which can be found in the uppermost part of the *triangularis* zone and the lower part of *crepida* zone. Possibly this layer has pertained to *Pa. crepida* zone as it contains those Conodonta forms which occur only in *crepida* zone such as *Pa. quadrantinodosalobata* Sannemann, *Pa. regularis* Cooper. However we have not met any typical *Pa. crepida*,

only transitional forms between *Pa. triangularis* and *Pa. crepida*. The boundary between *crepida* zone and *triangularis* zone so far has not been defined.

- The lower part of the subsequent stratigraphic interval (samples Q66-Q67) in general is poor in fossils. The abundant Conodonta assemblage of *marginifera* zone is present only in two uppermost samples of the section interval (samples Q68-Q69). Thus, in this section interval the indicative species of *Pa. rhomboidea* zone which is in between *Pa. crepida* zone and *Pa. marginifera* zone has not been defined.
  - Sample Q69 was collected from the lowermost layer of grey, light grey, motley grey or banded, medium to thick-bedded limestone sequence. This is the main limestone sequence forming the Xom Nha limestone massif, with a thickness of 80-100m. Conodonta fossils of the subsequent zone (*Pa. trachytera* zone) are met only in the uppermost layers of the limestone sequence being described.
- 3) In Steinbruch Schmidt section of FRG (one of the two sections proposed to be the place of standard F/F boundary) there is a obvious change in the composition of the sediments and fossils. This is considered an event in the depositional process and a crisis in the development of the living world (Kellwasser crisis). Before this boundary, a series of living creatures (including Conodonta) were killed, and after it - new forms appeared. In Xom Nha section, at the F/F boundary no obvious change in the composition of sediments is seen, however, the crisis in the development of Conodonta here is similar to at the Steinbruch Schmidt section. This is an interesting thing requiring further detailed investigation.

#### 2.2.2. upper Devonian - lower carboniferous

The D<sub>3</sub>-C<sub>1</sub> sediments have been studied by Le Hung (1984), and from them Phong Nha formation (D<sub>3</sub>-C<sub>1</sub> *pn*) has been established.

**Phong Nha formation (D<sub>3</sub>-C<sub>1</sub> *pn*)** crops out in the area the entrances of Phong Nha cave, Toi cave, along Chay river and along the initial section of Highway No 20. The formation is subdivided into 3 members:

- **Member 1:** Mainly composed of grey, massive or thick-bedded limestone. Its thickness is about 100 m). The limestone of member contains Tetracoralla, Tabulata, Brachiopoda, Foraminifera of *Cystophrentis* - *Quasiendothyra*

complex aged Famennian, Late Devonian. This limestone member has comprises the entrance of famous Phong Nha cave and also that of Hang Toi cave in the SW of Phong Nha. At the entrance of Hang Toi cave there is a big limestone boulder which contains densely compacted *Tetracoralla* fossils of genus *Cystophrentis* which are very easy to recognized. Whereas the limestone at the entrance of Phong Nha cave contains large amount of Tabulata fossils of genus *Syringopora*, *Tetracoralla* (*Cystophrentis* sp., *Fedorowskia phongnhaensis* Khoa and Foraminifera: *Septatournayella* cf. *rauserae* Lipina, *S. potensa* Durkina, *Septabrunsiina* sp., *Quasiendothyra* cf. *radiata* Reitlinger (Fig. 2.8).

Fig. 2.8. Outcrop PN 17. Member 1, Phong Nha formation  
(Photo by Tran Nghi, 1999)

- **Member 2:** The bottom of this ember consists of some layers of grey, medium-bedded limestone, intercalated with thin layers of calcareous shale, when weathered is given brown and purple brown color. These layers contain many small Brachiopoda fossils with the size of a chopstick. The main part of this member is composed of dark grey limestone, marl, siliceous limestone of, medium and thin-bedded, the siliceous component increasing upwards. The thickness of this ember is 140 m. The rocks of this member contain remains of Foraminifera of *Bisphaera* zone aged Turnesian (Early Carboniferous) such as *Bisphaera malevkensis* Birina, *B. elegans* Visarionova, *Endothyra* sp. and some forms of Gastropoda (Fig. 2.9).

Fig. 2.9. Member 2, Phong Nha formation (Left bank of Chay river)  
(Photo: by Tran Nghi, 1999)

- **Member 3:** The uppermost member is a sequence of terrigenous siliceous sediments, consisting of grey siliceous schist, siliceous claystone, shale, with thickness 30m. In this member fossils are rare. One fossil of Trilobita aged Early Carboniferous has been newly found (Fig. 2.10, 2.11, 2.12)

Fig. 2.10. Member 3, Phong Nha formation (Left bank of Chay river)  
(Photo by Tran Nghi, Ta Hoa Phuong 1999)

Fig. 2.11. Fine grained, banded limestone, intercalated with cryptocrystalline and microcrystalline limestone. Phong Nha formation. N<sup>+</sup>, exaggerated by 40 times. (Photo by Tran Nghi, 1999)

Fig. 2.12. Cryptocrystalline massive limestone, with uneven recrystallization. Large cylindrical calcite crystals oriented disorderly like phenocrysts on cryptocrystalline calcite groundmass, exaggerated by 40 times. (Outcrop PN 17 - Entrance of Hang Toi cave, Phong Nha formation).

(Photo by Tran Nghi, 1999)

### 2.2.3. Carboniferous system, lower division

The lower part of the Carboniferous system in the study area consists of carbonate, terrigenous, siliceous sediments, belonging to La Khe formation.

**La Khe formation (C<sub>1</sub> lk)** was established by A.M. Mareichev and Tran Duc Luong (Dovjikov et al., 1965). The sediments of this formation crop out as narrow bands in Ke Bang limestone massif, as well as in its NW and SE. According to the Stratigraphic Regulations of Vietnam currently in force, the black grey limestone sequence in the uppermost part of the section of La Khe formation as originally described by A.M. Mareichev and Tran Duc Luong has been detached to merge with Bac Son formation (C-P bs).

La Khe formation consists of layers of limestone, marl, siliceous limestone, calcareous shale containing organic matters of grey to black grey color. The total thickness of this formation is about 230m. The sediments of this formation contain abundant Foraminifera fossils: *Tournayella discoides* (?), *Septatournayella segmentata*, *Dainella* cf. *chomatica*, *Brunsia spirillinoides* and some remains of poorly preserved Brachiopoda (Fig. 2.13).

Fig. 2.13. Outcrop PN-16 (N: 17° 36' 46"; E: 106° 18' 40"). Highway 15. Marbleized massive microgranular. Recrystallized hypidiomorphic and allotriomorphic calcite. La Khe formation. N<sup>+</sup>, exaggerated by 40 times (Photo by Tran Nghi, 1999)

The above Foraminifera complex allows to attribute this formation to Lower Carboniferous. The rocks of La Khe formation overlies with unconformity the rocks of older formations and pass upwards to the carbonate sediments of Bac Son formation.

#### 2.2.4. Carboniferous - Permian

Carboniferous - Permian formations constitute the bulk of the Phong Nha - Ke Bang massif, consisting of two formations: Bac Son and Khe Giua.

**Bac Son formation (C-P *bs*)** was established by Nguyen Van Liem (1979), comprising the upper part of La Khe formation according to the previous concepts in Dovjikov (1965) and the whole amount of Muong Long "suite" according to the concept of Nguyen Xuan Duong (1979).

Bac Son formation consisting of 3 members in ascending order as follows

- *Member 1*: Black limestone, limestone containing Crinoidea stems, siliceous limestone, medium and thick-bedded, bearing Foraminifera, Tetracoralla, aged Viséan (C<sub>1v</sub>) (Fig. 2.14).

Fig. 2.14. Hang Chay cave. Old sea level mark (Middle Holocene maximum transgression)

In the limestone of Bac Son formation (Photo by Tran Nghi, 1999)

Fig. 2.15. Outcrop PN 5. Highway 20. Limestone of Bac Son formation (Photo by Tran Nghi, 1999)

- *Member 2*: Grey, light grey limestone, dolomitic limestone, thick-bedded and massive, bearing Foraminifera fossils, aged C<sub>1v</sub>-C<sub>2</sub> (Fig. 2.15).

- *Member 3*: Light grey, medium and thick-bedded limestone. bearing Foraminifera, Tetracoralla, aged Permian (P<sub>1-2</sub>).

The total thickness of Bac Son formation varies within 600-1000 m.

The rocks of Bac Son formation are overlain with unconformity by the coarse clastic sediments of Khe Giua formation in some locations in the West of Quang Binh.

#### 2.2.5. Upper Permian

In the study area, the Upper Permian sediments are cropped out as narrow bands in Phong Nha - Ke Bang massif, consisting of only Khe Giua formation.

**Khe Giua formation ( $P_2 kg$ )** was established by Le Hung et al. in 1981 with the name " Khe Giua suite ", composed mainly of light grey, black grey thin to medium -bedded limestone. The strata and their fossils in ascending order consist of:

1. Light grey, ash grey limestone with siliceous breccia and siliceous pockets, containing many big size Foraminifera fossils: *Verbeckina verbecki* (Geinitz.), *Parafusulina* sp.
2. Calcareous breccia with cement being lime or siliceous lime, no fossils have been found in this part.
3. Grey medium-bedded marl, limestone containing fossils Fusulinida: *Nankinella* cf. *orientalis* K.M Maclay, *Lasiodiscus* aff. *teumuis* Reich., *Pisolina* cf. *subspherica* Sheng., *Pachijphloia* cf. *ovata* Lang., *Nodosaria* cf. *acena* Machay., *Nipponitella* sp., *Parageinitziana* sp.

The above mentioned fossils collected characterize the age of Late Permian. The sediments of Khe Giua formation overlie with unconformity the carbonate sediments of Bac Son formation, and in turn are overlain with unconformity by Cretaceous sediments. The incomplete thickness of this formation as it is exposed in the study area is about 30 m.

### 2.3. Mesozoic

#### Cretaceous system

Mesozoic formations in the study area consist mainly of terrigenous sediments of Mu Gia formation aged Cretaceous.

**Mu Gia formation ( $K mg$ )** was established by Tran Duc Luong, Nguyen Xuan Bao et al. (1988). Its sediments crop out in the NW and SE corners of the study area.

This formation consists of a basal conglomerate layer (with quartz, quartzitic pebbles, calcareous and siliceous cement) and layers of calcareous shale, carbonate siltstone, sandstone, siliceous limestone of red brown to grey color. The total thickness of the formation is about 700m (Fig. 2.16, 2.17).



Fig. 2.16. Outcrop PN - 7. Conglomerate of Mu Gia formation  
(Photo by Tran Nghi, 1999)

Fig. 2.17. Outcrop PN - 7. Siltstone of Mu Gia formation  
(Photo by Tran Nghi, 1999)

In the sediments of this formation have been found Bivalvia fossils: *Plicatounio* sp., *Trigonioides* sp., which are similar to those of Muong Pha lan (Laos) aged Cretaceous.

The sediments of Mu Gia formation overlie with unconformity the older rocks and if the Quaternary sediments are excluded, in the study area the Mu Gia formation is considered as the youngest.

#### 2.4. Cenozoic

undifferentiated Quaternary system

##### Dong Hoi formation ( $N^3_1 - N^1_2 dh$ )

- Dong Hoi suite ( $N^3_1 dh$ ): Komarova N.I. Pham Van Hai, 1980; Trinh Danh, 1984, 1985, 1993 (in Tong Duy Thanh, Le Hung et al. 1987).

- Ai Nghia formation (*Nan*): Nguyen Van Trang et al. 1985

- Dong Hoi formation ( $N^3_1 - N^1_2 dh$ ): Trinh Danh (in Phan Cu Tien et al. 1989; in Vu Khuc, Bui My et al. 1989; Tong Duy Thanh, Vu Khuc et al. 1994; Phạm Kim Ngan et al. 1994), Trinh Danh, Pham Van Hai, 1995.

The sediments of Dong Hoi formation crop out only in Dong Hoi area, the remaining parts have been discovered through drill cores in Bac Ly (Quang Binh), Le Ninh, Ba Don areas (Table 2.1)

**Table 2.1. Depth of occurrence of Dong Hoi formation**

Boreholes	Location	Depth (m)		Thickness (m)
		From	To	
BH 273 T256	Dong Hoi	-250	0	250
BH 257 T256	Dong Hoi	-45	0	45
BH 241 T256	Dong Hoi	-42	0	42
BH 241 T304	Dong Hoi	-42.5	-25	40
BH 305 T256	Dong Hoi	-50	0	50
BH 6 (Đ 207)	Tu Loan	-110.2	-38.7	73.3
BH 1 (Đ 207)	Le Ninh	-154.4	-66.6	92.8
BH 5 (Đ 207)	Duy Ninh	-111	-70	41

The typical section of the Dong Hoi formation is the section of BH 273-T256 (Dong Hoi) and supplemented by other sections in Le Ninh, Ba Don areas.

The Dong Hoi formation is subdivided into 3 members:

**Member 1:** Overlying with unconformity the ancient rock formations are conglomerate, gravelite, occasionally intercalated with layers of silt, kaolin clay. At the bottom are usually multicolored conglomerate (with brown, brown grey, red, pink colors). Following are layers of conglomerate, gravelite, sericitic schist, medium-grained sandstone. The cobbles are in size from a few cm to 20-30 cm, poorly rounded and poorly sorted, the cement being yellow grey, brownish grey clay usually mixed sand or gravel. The thickness of this member is 30-160m. In borehole 249-T280 at the depth interval 83-70m and borehole 273-T256 at the depth interval of 250-92m, spores and pollens of: *Polypodium sp.*, *Polytycarya sp.*, indet., *Cystopteris sp.*, *Ginkgo sp.*, *Alnus sp.*, *Corylus sp.*, *Platycarya.*, *Nyssa sp.*, *Rhus sp.*, *Ilex sp.*, *Sabal sp.*, have been found.

**Member 2:** Kaolin-bearing claystone, sandstone intercalated with layers of conglomerate, with motley yellow, red, white colors. Occasionally are met small carbonaceous veins (1-2 mm) of brown color (according to the result of DTA by Au Duy Thanh). The total thickness of this member is 50-120m. In this member there is a Hamamelis - Castanopsis - Dipterocarpus palynological complex with the following percentage of basic components:

- Tropical and subtropical zone plant spores and pollens: 41-46%.
- Sub-tropical - temperate zone plant spores and pollens: 56-62%, of which the hygrophylous plant spores and pollens account for 65-80%. Thus, this assemblage characterizes the humid subtropical climate. Besides the basic forms defining the names for this complex there are here other characteristic form as follows: *Polypodium sp.*, *Cyathea sp.*, *Lygodium sp.*, *Selaginella sp.*, *Pinus sp.*, *Tsuga sp.*, *Podpcarpus sp.*, *Magnolia sp.*, *Myrica carolinensisiformis Gladk.*, *Mallotus sp.*, *Morus sp.*,

The leaf imprints collected from the depth intervals -20-18,8m of borehole 241-T304 (Dong Hoi) comprise *Ficus aff. tiliifolia Heer*, *Benzoin sp.*, *Diopyros brachysepala A.Br.*, *Dicotylophyllum sp.*, *Graminophyllum sp.*, determined by Trinh Danh to give the age of Late Miocene.

**Member 3:** Claystone, siltstone sandstone intercalated with conglomerate, gravelite. In Le Ninh - Ba Don area, according to the data of BH 1,2,5,6 this member is an alternated sequence of layers of sandstone, siltstone, claystone of greenish grey, brown grey, yellow grey, 50-100m thick, containing plant humus,

coal and Mollusca shell fragments. In this member in borehole 1, at depth interval -85-81m, Nguyen Thi A has identified pollens *Cycas sp.*, *Taxodium sp.*, *Quercus sp.*, *Castanea sp.*, *Carya sp.*, *Platycarya sp.*, giving the age of Neogene (N)

The Neogene (Late Miocene - Early Pliocene) age of Dong Hoi formation was determined based on the palynological and floral data, which have been described and compared with the corresponding complexes in Khe Bo and Tien Hung formations.

As regards depositional environment, the Dong Hoi formation was deposited in the humid subtropical climatic conditions, where the materials filled the re-mountain depressions. The kaolin was formed partly by the weathering of feldspar-rich cobbles and partly due to the deposition of the kaolin-rich sediments.

In stratigraphic relationship: they overlie the Devonian sediments (Photo 6) and are overlain with unconformity by the Middle Pleistocene - lower part of Upper Pleistocene alluvial, alluvial-marine sediments.

#### **Middle Pleistocene - lower part of Upper Pleistocene sediments (Q<sub>II-II'</sub>)**

- Le Ninh formation (ap Q<sub>I-II</sub><sup>m</sup>): Nguyen Quang Trung et al., 1983

- Middle - Upper Pleistocene Q<sub>II-III</sub>: Pham Van Hai (in Pham Kim Ngan et al.), 1994.

In Dong Hoi - Le Ninh area, these sediments are the bottom-liner of the plain. They overlie rocks of various ages, are not exposed on the surface and have been encountered in boreholes (Table 2.2).

**Table 2.2. Depth of occurrence of Middle Pleistocene - lower part of Upper Pleistocene sediments in Quang Binh area.**

Boreholes	Location	Depth (m)		Thickness (m)
		From	To	
BH1 (Đ 207)	Le Ninh	-61.4	-38	23.4
BH6 (Đ 207)	Tu Loan	-39.7	-30.4	9.3
BH5 (Đ 207)	Duy Ninh	-67	-40	27

These sediments consist of cobbles, pebbles, gravel mixed with rubble and clay of yellow, white grey, 10-30 m thick. The cobbles, pebbles and gravel are mainly composed of quartz, siliceous rocks, sandstone, granite, with size 3-4 cm,

occasionally 10 cm, poorly rounded and sorted; the rubbles are sharply angular. These sediments contain no fossils. Their dating is based mainly on their stratigraphic position and lithologic characteristics. The sediments described here have similar composition with the cobbles, pebbles and gravel in Bac Bo, Thanh Hoa, Nghe Tinh plains which have been proved to have the age Middle Pleistocene - Early Late Pleistocene.

#### Sediments in the upper part of Upper Pleistocene ( $Q_{III}^2$ )

- Tu Loan formation (ap QII-III<sup>1</sup>): Nguyen Quang Trung et al., 1983.

- Upper Pleistocene sediments: Pham Van Hai (in Pham Kim Ngan et al.), 1994.

These sediments have large distribution area in the study area, overlying all sediments formed earlier. At the margin of the plain, where the plain is bound with the hilly area, they form the second terraces with elevation 10-15 m. Boreholes have encountered them at the following depth: (table 2.3).

**Table 2.3. Depth of occurrence of the sediments in the upper part of Upper Pleistocene in Quang Binh**

Boreholes	Location	Depth (m)		Thickness (m)
		From	To	
BH1 (Đ 207)	Le Ninh	- 38.0	- 28.5	9.5
BH5 (Đ 207)	Duy Ninh	- 40.0	- 27.3	127
BH6 (Đ 207)	Tu Loan	- 30.0	- 18	124

These sediments consist of silty sand, sand, clay of motley color, 10 -13m thick. The main minerals include: quartz 52%, amphibole, biotite, ilmenite, pyrite. The clay minerals include: Hydromica, kaolin, montmorillonite. The Late Pleistocene age of these sediments has been determined mainly on the basis of their stratigraphic position and lithologic composition. In particular: In boreholes these motley formations overlie the Middle Pleistocene -lower part of Upper Pleistocene sediments ( $Q_{II-III}^1$ ) and are overlain with unconformity by the Lower-Middle Holocene sediments. In the west of the plain they form the second terrace with elevation 10 -15m, at the same level with the second terrace in Thanh Hoa - Nghe Tinh.

Fig. 2.18. Sand levee ( $Q_{III}^2$ ) with parallel horizontal bedding on the Northern side of Nhat Le river (Photo by Tran Nghi, 1995)

The sand levee sediments aged  $Q_{III}^2$  met along Gianh river (Fig. 2.18) and Sen Thuy river (Fig. 2.19) consist of yellow, cross-bedded sand,

Fig. 2.19. White sand aged Holocene overlying the yellow sand terrace aged  $Q_{III}^2$  with elevation of 10m at Sen Thuy, Quang Binh (Photo by Tran Nghi, 1995)

#### Lower - Middle Holocene sediments ( $Q_{IV}^{1-2}$ )

- Tu Loan formation (am, m  $Q_{IV}^{1-2}$  tl): Nguyen Quang Trung et al., 1983
- Lower- Middle Holocene sediments ( $Q_{IV}^{1-2}$ ): Pham Van Hai (according to Pham Kim Ngan et al.), 1994.

The Lower-Middle Holocene sediments include:

##### a/ Alluvial and alluvial-marine sediments

These sediments have wide distribution area, forming the surface of narrow plains in Quang Binh, mainly on to West of National Highway 1A, with elevation 2,5 - 4m. In boreholes they are met at the following depths (Table 2.4).

**Table 2.4. Depth of occurrence of Lower - Middle Holocene marine sediments in Quang Binh**

Boreholes	Location	Depth (m)		Thickness (m)
		From	To	
BH1 (Đ 207)	Le Ninh	- 11.5	- 5	6.5
BH5 (Đ 207)	Duy Ninh	- 27.3	2.5	23.8
BH6 (Đ 207)	Tu Loan	- 18	-2	16
BH 241 -T 256	Dong Hoi	- 2.5	0	2.5

In lithological composition, these sediments are composed gravel, sand, silt-clay mixed with gravel of white, greenish grey colors, 2 - 2,5m thick. Silt constitutes 58,6%, clay 30,4%, sand 8,1%, gravel and pebble 2,9%. They contain Engelhardtia - Lygodium - Castanopsis palynological complex with the following percentage of the main components as follows:

- Tropical and subtropical zone plant spores and pollens: 54-57%.

- Sub-tropical - temperate zone plant spores and pollens: 42-45%,

of which the hygrophylous plant spores and pollens account for 83-92%. Besides the predominant forms defining the names for this complex there are here other characteristic forms such as: *Cyathea sp.*, *Pteris sp.*, *Adiantum sp.*, *Pinus sp.*,

*Magnolia sp.*, *Michelia sp.*, *Lithocarpus sp.*, *Buttneria sp.*, *Dacrydium sp.*, *Podocarpus sp.*.

These silt-clay layers contain abundant Foraminifera and shallow sea Mollusca: *Elphidium advenum* Cush., *Elphidium hispidulum* Cúh., *Elphidiella* sp., *Triloculina* Orb., *Pyrgo sp.*, *Quinqueloculina sp.*, *Ammonia beccari* (L.), *Ostrea sp.*, *Anadara sp.*, *Turritella sp.*

The Early-Middle Holocene age of these sediments is determined on the basis of comparing the fossil complexes contained in them with other ones in similar sediments of other plains in Vietnam (Bac Bo, Nam Bo), as well as those in Thailand (Dheeradilo KP. et al, 1989), Malaysia (Kamaludin H., 1994).

#### **b/ Land sediments**

According to the available data, alluvial, lacustrine, palustrine sediments are mainly developed on the left side of Nhat Le river in Quan Hau area. These sediments are not exposed on the surface but are covered by Upper Holocene sediments. A typical section of these sediments is the section at the depth interval -40 -20m of borehole 233 (South of Quan Hau), consisting of clay, silty clay of dark grey color, 20m thick, containing a palynological complex with composition similar to the one found in the marine sediments described above.

In stratigraphic contact, in BH 233 they are seen to overlie the Devonian sediments and are overlain by Upper Holocene sediments.

#### **Upper Holocene sediments (Q<sub>IV</sub><sup>3</sup>)**

These sediments are accumulated on the surface of the present plain with various genetic types: flood plain sediments, alluvial-lacustrine sediments, marine-eolian sediments, marine sediments in the form of coastal white sand levees being eroded and destroyed by the current transgression (Fig. 2.20 and 2.21)

#### **a/ Flood plain sediments (a Q<sub>IV</sub><sup>3</sup>)**

These sediments have not large distribution area, mainly developed along Nay river, and the flood plain in the river mouth areas. They are composed of sand, clayey sand of grey, light brown color, mixed with much plant humus, 2-4m thick

Fig. 2.20. Various generations of sand levees with elevation of 10m in the coastal area of Quang Binh  
(Photo by Tran Nghi, 1995)

Fig. 2.21. Sand levees being eroded in Le Thuy, Quang Binh  
(Photo by Tran Nghi, 1995)

***b/ Alluvial - lacustrine sediments (al Q<sub>IV</sub><sup>3</sup>)***

These sediments are distributed on the Southern side of Nhat Le river, in Quan Hau area (BH 233 at the depth interval of -20 -0m, 20m thick) consisting of sand, silty sand of black grey color, containing the Lygodium - Poaceae - Myrtus palynological complex with the following basic components:

- Tropical and subtropical zone plant spores and pollens: 70-85%.

- Sub-tropical - temperate zone plant spores and pollens: 15-20%,

of which the hygrophylous plant spores and pollens account for 70-75%. Besides the predominant forms defining the names for this complex there are here other characteristic forms such as: Cyathea sp., Lygodium sp., Pteris., Platycarya sp., Rubiaceae gen. indet., Pinus sp., Magnolia sp., Morus sp., Myrica sp..

***c/ Marine-eolean sediments (mv Q<sub>IV</sub><sup>3</sup>)***

These are sand bars extending along the present coastline from Ngang pass to Tan Dinh. The sand is composed mainly of quartz of light grey, occasionally light yellow color, well rounded and well sorted.

***d/ Marine - palustrine sediments (mb Q<sub>IV</sub><sup>3</sup>)***

These sediments are formed in lagoons, coastal swamps, with a total thickness 0,5 -2m. The sediments are composed of clay, sand of black grey color, with spores and pollens of Poaceae - Sonneratia - Rhizophora complex, with general composition similar to that of the complex in the above mentioned alluvial-lacustrine sediments. However, the difference is that in the composition of this complex there are also pollens of salt water plants: Sonneratia sp.. Rhizophora. These sediments also contain many Mollusca and Foraminifera.

## Chapter 3

### PALEONTOLOGICAL CHARACTERISTICS

#### 3.1. Paleontological complexes found in the area

In Phong Nha - Ke Bang area are widespread mainly the sedimentary rocks aged from Ordovician to Quaternary, which contain abundant fossils. Practically in all stratigraphic levels have been discovered fossils with age dating significance for rocks, even there are biostratigraphic sections which are considered not only as exemplary ones for Vietnam but also as significant ones for international correlation, for example the Xom Nha section which has been presented above. The Xom Cay Da limestone mountain massif west of Quy Dat (where the Xom Nha section is located), which is worthy for the State and the province to pay attention and protect as a natural heritage with great significance for geoscientific research, is one of rare sites in the world which have a continuous boundary between two chronostratigraphic units, i.e. the Frasnian and Famennian stages (F/F boundary), at a beautiful location, easy to observed and the limestone contains abundant Conodonta microfossils.

Below are presented the typical fossil complexes of each stratigraphic unit (Fossil samples are presented in photo plates from 1.1 to 1.10).

##### **3.1.1 *Graptolithina complex* O<sub>3</sub>-S<sub>1</sub>**

Within the study area is cropped out only the lower part of Long Dai formation (O<sub>3</sub>-S<sub>1</sub> *ld*), mainly composed of quartzitic sandstone, where no fossils have been found. However, in the South of Quang Binh, in the geological section along Le Ky stream, paleontologists have found an abundant Graptolithina fossil complex, consisting of the following species: *Demirastrites convolutus* (Hisinger), *Monograptus halli* (Barrande), *Oktavites spiralis* (Geinitz), *Monograptus* sp., *Gliptograptus* sp., *Pristiograptus* sp.

Besides, In the SW of Vit Thu Lu one form of Trilobita, *Cyclopyge* sp. and some poorly preserved Bivalvia has been found. This fossil complex corresponds to the age interval of Late Ordovician - Early Silurian (O<sub>3</sub>-S<sub>1</sub>).

##### **3.1.2. *Tabulata, Rugosa, Stromatoporoidea fossil complex* D<sub>1</sub>**

Rao Chan formation (D<sub>1</sub> *rc*) includes the sediments in the lowermost part of the Devonian section in the study area, consisting mainly of terrigenous sediments, with rare fossils. The fossils of this formation have been mainly found in limestone layers at Khe Lop section, comprising:



- *Gerphuropora* aff. *krekovesis* Dubat., *Favosites multiformis* Dubat., *F. multiplicatus* Yanet, *Favosites* aff. *ambigus* Tchern., *Thamnopora* aff. *incerta* Regnell., *T. plumosa* Yanet (Tabulata).

- *Spongophyllum* cf. *halisitoides* Etheridge (Rugosa).

- *Stachyodes* cf. *costulata* Lec., *S. sp.*, *Paralleolopora* sp. (Stromatoporoidea).

By analysing the above mentioned fossil complex, it is allowed to attribute the Rao Chan formation to Lower Devonian.

### 3.1.3. *Tetracoralla, Crinoidea, Bivalvia, Brachiopoda and ancient fish fossil complex D<sub>2e</sub>*

In the sediments of Ban Giang formation (D<sub>2e</sub> bg) the following fossils have been found:

- *Calceola sandalina* Lin. (Tetracoralla).

- *Hexacrinites* aff. *humilicarinatus* Yalt., *Hexacrinites* aff. *biconcavus* Yelt. et Dubat. (Crinoidea).

- *Pteria* sp. (Bivalvia).

- *Atrypa kakvensis* Khodalevich (Brachiopoda).

- *Lyhoalepis duckhoai* Janvier. (Ancient fish).

Based on the above fossils, this formation has been attributed to Middle Devonian, Eifelian stage.

### 3.1.4. *Brachiopoda, Tabulata, Tetracoralla, Stromatoporoidea, Chaetetida fossil complex D<sub>2g</sub>*

This fossil complex is met in the rocks of Muc Bai formation (D<sub>2g</sub> mb) being very abundant, comprising:

- *Undispirifer undiferus* (Roemer), *Atrypa vulgariformis* Aleks., *Desquamatia ventrycosa* Kelus, *D. transversa* Hoe, *D. hunanensis* (Grabau), *Reticulariopsis pachyrhynchoides* (Grabau), *Tingella suchana* Vecvers., *Quydatatrypa triangula* Copper, *Spinatrypa balchatica* Aleks., *S. asperaeformis* Aleks., *S. bodini* (Mans.), *Stringocephalus burtini* Defr., *Ambothyris cicer* (Eichw.), *Kelusia volhynica* (Kelus), *Emanuella transversa* (Grabau), *E. ronensis* (Mans.), *E. samsonoweisi* Kelus, *E. takwanensis* (Kays.), *E. plicata* (Grabau), *E. pseudopachyrhincha* Tchern., *E. pseudovolhynica* (Mans.), *Schizophoria sTriassicula* Schloth., *S. ivanovi* (Tchern.), *S. Triassiciformis* Krin., *Chonetipustula orientalis* Zuong et Rzons., *Gypidula calceola* (French), *Athyris suphana* Tien., *Renselandia gibbosa* Cloud. (Brachiopoda).

- *Caliopora battersbyi* (M.E.H.), *C. cf. taltiensis* Yanet, *Scoliopora denticulata* (M.E.H.), *S. formosa* Tchud., *S. muricata* Tchud., *Thamnopora polyforata*, *T. nicholssoni* (Frech), *T. polygonalis* (Mansuy), *Alveolites cf. admirabilis* Tongdzuy (Tabulata).

- *Temnophyllum varicum*, *T. raocaiense* (Tetracoralla).

- *Actinostroma bifarium*, *A. geniatum*, *Stachyodes radiata*, *S. caepitosa*, *Idiostroma quydatensis* Hung et Mistiaen, *Vacuustroma minuta* Hung et Mistiaen, *V. concentrica* Hung et Mistiaen (Stromatoporoidea).

- *Chaetetes aff. magnus* Lec., *Ch. yunnanensis* (Mans.) (Chaetetida)

The above mentioned fossil complex is characteristic for the age of Givetian (D<sub>2g</sub>).

### **3.1.5. Brachiopoda, Tentaculites, flora fossil complex D<sub>2g</sub>-D<sub>3</sub>.**

This fossil complex is relatively abundant, found in the sediments of Minh Le formation (D<sub>2g</sub>-D<sub>3 ml</sub>) comprising:

- *Megachonetes* sp., *Schizophoria cf. ivanovi* (Tchern.), *Adolfia* sp. (Brachiopoda).

- *Styliolina* sp., *Homoctenus* sp. (Tentaculites)

- *Protolepidodendron* sp., *Bergeria (Lepidodendropsis)* sp., *Taeniocrada* sp., *Apiculatisporites* sp., *Geminospora* sp., *Grandispora* sp., *Favispora cf. rotunda* Lu, *Gymbosporites magnifica* (McGregor) (flora and spores).

The above mentioned fossil complex allows to attribute the Minh Le formation to Middle Devonian Givetian stage to Upper Devonian (D<sub>2g</sub>-D<sub>3 ml</sub>).

### **3.1.6. Stromatoporoidea, Conodonta fossil complex D<sub>3</sub>**

The Conodonta fossils found in the rocks of Cat Dang formation (D<sub>3 cd</sub>) comprise:

- *Stachyodes aff. costulata* Lec., *S. lagowiensis* Gog., *Anostylostroma ? crassa* Hung (aged Franian - D<sub>3fr</sub>) (Stromatoporoidea).

- The biozones include *Palmatolepis rhenana*, *Pa. linguiformis*, *Pa. triangularis*, *Pa. crepida*, *Pa. marginifera*, *Pa. trachytera* and assemblage *Pa. gracilis*-*Pa. sigmoidalis* (aged from Franian to end of Famennian) (Conodonta).

### **3.1.7. Tetracoralla, Tabulata, Foraminifera fossil complex D<sub>3</sub>-C<sub>1</sub>.**

The rocks of Phong Nha formation (D<sub>3</sub>-C<sub>1 pn</sub>) contain abundant fossil complex, comprising:

- *Cystophrentis* - *Quasiendothyra* complex (aged Famennian - D<sub>3fm</sub>), comprising representatives of genera: *Cystophrentis*, *Fedorowskia*,

*Quasiendothyra*, *Syringopora*, *Fedorowskia* (Tetracoralla, Foraminifera, Tabulata)

- *Bisphaera* zone (aged Turne - C<sub>1t</sub>), comprising representatives of genus *Bisphaera* (Foraminifera)

### 3.1.8. Foraminifera, Conodonta fossil complex C<sub>1</sub>.

This fossil complex is abundant, found in La Khe formation (C<sub>1 lk</sub>) comprising:

- *Brunsia spirillinoides* (Grozd. et Gleb.), *Tournayella discoides* Daia, *Plectogyra similis* (Raus. et Reit.), *Mediocris breviscula* (Gein.), *Lituotubella glomospirioides* Raus., *Chernyshinella glomiformis* Lip., *Planoendothyra tschikamanica* (Mal.), *Septatournayella segmentata*, *Dainella* cf. *chomatican* (Foraminifera).

- *Gnathodus commutatus* (Br. et M.), *Polygnathus bischoffi* Rhodes. (Conodonta)

The above fossil complex characterizes the age of Early Carboniferous (C<sub>1</sub>).

### 3.1.9. Foraminifera fossil complex C-P

The fossils found in the rocks of Bac Son formation (C-P *bs*) are mainly Foraminifera with their maximum prosperity, and can be divided into the following levels:

- In the lowermost part of the formation are: *Pseudostaffella antiqua* (Dutk.) *Killerella marblensis* Thamps., *M. carbonica* Grozd. et Gleb., *Eostaffella angusta* Kir., *Pseudoendothyra (Parastaffella) involuta* Liem, *Quydatella staffellaeformis* Liem, *Profusulinella primitic* Sosn. (aged Baskia - C<sub>2b</sub>).

- In the middle part: *Profusulinella rhomboidea* (Lee et Chen), *Pr. quydaltensis* Liem, *Pr. parva* (Lee et Chen), *Pr. paracursos* (Depr.), *Fusulinella sosninae* Liem, *F. bocki* Mocller, *Pseudostaffella quadrata* (Depr.), *Ps. ovata* (Raus.), *Schubertella inflata* Rauser (aged Moscovi - C<sub>2m</sub>).

- In the upper part: *Triticites* cf. *schwageriniformis* Raus., *Quasifusulina* sp., *Obsoletas* sp., *Schubertella* sp., *Ozawainelda angulata*, *Schwagerina* cf. *moclleri* Raus., *Sch.* sp., *Pseudoschwagerina* sp., *Pseudofusulina* sp., *Triticites* sp., *Neoschwagerina* sp., *Parafusulina* sp. (aged C<sub>2</sub> - P<sub>1</sub>).

### 3.1.10. Foraminifera fossil complex P<sub>2</sub>.

In the limestone of Khe Giua formation (P<sub>2 kg</sub>) are contained many Foraminifera fossils: *Verbeckina verbecki* (Geinitz), *Parafusulina* sp., *Nankinella* cf. *orientalis* K.M Maclay, *Lasiodiscus* aff. *teumuis* Reich., *Pisolina* cf. *subspherica* Sheng., *Pachijphloia* cf. *ovata* Lang., *Nodosaria* cf. *acena* Machay., *Nipponitella* sp., *Parageinitziana* sp.

The above mentioned fossil complex characterizes the age of Late Permian (P<sub>2</sub>).

### 3.1.11. *Bivalvia fossil complex K.*

In the sediments of Mu Gia formation (K mg) the following Bivalvia fossils have been formed: *Plicatounio* sp., *Trigonioides* sp. (aged Cretaceous).

### 3.2. Annotation to paleontological photo plates

#### Plate 1-1

##### 1. *Atrypa (Desquamata) vantriosa* Kelus

1a - Ventral side, 1b - brachial side, 1c - umbonal side, 1d - Lateral side, x1, Specimen MH. 1310/3, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

##### 2. *Ambocoelia umbonata* (Conrad)

2a - Ventral side, 2b - Brachial side, 2c - anterior side - 2d umbonal side, x 1,

Figure 2. Brachial side, x 5. Specimen MH.6011, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

##### 3. *Echinocoelliina incurva* Cooper & William

3a - Ventral side, 3b - Brachial side, 3c - anterior side, 3d - umbonal side, x1,

Figure 3. Brachial side, x5. Specimen MH.6011/1, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong

##### 4. *Calvinaria cracowiensis* (Gurich)

4a - Ventral side, 4b - Brachial side, 4c - Umbonal side, 4d - posterior side, 4e - lateral side, x 1. Specimen TS.607, Minh Le formation, Nha hamlet, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

##### 5. *Strophoconetes cf. hoabinhensis* Mans.

Cast in ventral valve, x1. Specimen HM.2419/1a, Ban Giang formation, Ly Hoa area, Quang Binh province. Collection by Pham Huy Thong.

##### 6. *Chonetes cf. sTriassicella* Dalman

Cast in brachial valve, x1. Specimen MH.2419/1b, Ban Giang formation, Ly Hoa area, Quang Binh province. Collection by Pham Huy Thong.

##### 7. *Chonetes hardrensis* Phill.

External imprint of brachial valve, x1. Specimen MH.2419/1c, Ban Giang formation, Ly Hoa area, Quang Binh province. Collection by Pham Huy Thong.

8. *Plicochonetes* sp.

External imprint of brachial valve, x1. Specimen MH.1659, Ban Giang formation, Ly Hoa area, Quang Binh province. Collection by Pham Huy Thong.

9. *Chonetes kwangsiensis* Wang

External imprint of ventral valve, x1. Specimen MH.2453, Muc Bai formation ?, Ly Hoa area, Quang Binh province. Collection by Pham Huy Thong.

10. *Megachonetes* sp.

Cast in ventralvalve, x1. Specimen MH.6930/1, Muc Bai formation ?, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

11. *Nakamuraia* sp.

Left valve, x1. Specimen MH.1569, Mu Gia formation, Mu Gia area, Quang Binh province. Collection by Pham Huy Thong.

12 -15. *Peregrinoconcha* sp.

(12-14 - Left valves, x1. Specimen MH.1569, 13, 15 - Right valves, x1). Specimen MH.1569, Mu Gia formation, Mu Gia area, Quang Binh province. Collection by Pham Huy Thong.

plate 1-2

1. *Emanuella vohynica* Kelus

1a - Ventral side, 1b - Brachial side, 1c - umbonal side, 1d - posterior side, 1e - lateral side, x1.

Specimen MH.1419, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

2. *Emanuella takwanensis* (Kayser)

2a - Ventral side, 2b - Brachial side, 2c - umbonal side, 2d - posterior side, 2e - lateral side, x1.

Specimen MH.1419, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

3. *Emanuella ronensis* (Mansuy)

3a - Ventral side, 3b - Brachial side, 3c - umbonal side, 3d - posterior side, 3e - lateral side, x1.

Specimen MH.1310/3, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

4. *Schizophoria sTriassicula* Schlotheim

4a - Ventral side, 4b - Brachial side, 4c - umbonal side, 4d - posterior side, 4e - lateral side, x1.

Specimen MH.2172/1, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong.

5. *Schizophoria ivanovi* Tchem.

5a - Ventral side, 5b - Brachial side, 5c - umbonal side, 5d - posterior side, 5e - lateral side, x1.

Specimen MH.2172/1, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong

6. *Atrypa (Desquamata) kansuensis* (Grabau)

6a - Ventral side, 6b - Brachial side, 6c - umbonal side, 6d - posterior side, 6e - lateral side, x 1.

Specimen MH.2172/1, Muc Bai formation, Quy Dat area, Quang Binh province. Collection by Pham Huy Thong

Plate 1-3

- 1 - *Palmatolepis rhenana rhenana* Bischoff. Superior side, x 46. Upper *rhenana* sub-zone. Specimen Q51-6.
- 2- *Palmatolepis gigas* Miller & Youngquist. Superior side, x 32. Zone *linguiformis*. Specimen Q53-10.
- 3 - *Palmatolepis juntinaensis* Han. Superior side, x 85. Zone *linguiformis*. Specimen Q52-6.
- 4 - *Palmatolepis ederi* Ziegler & Sandberg. Superior side, x 44. Zone *linguiformis*. Specimen Q52-1.
- 5 - *Palmatolepis triangularis* Sannemann. Superior side, x 54. Zone *triangularis*. Specimen Q56-2.
- 6 - *Palmatolepis linguiformis* Muller. Superior side, x 44. Zone *linguiformis*. Specimen Q53-2.
- 7 - *Palmatolepis quadrantinodosalobata* Sannemann. Superior side, x 54. Zone *crepida*. Specimen Q64-1.

8 - *Palmatolepis triangularis* --> *Pa. crepida*. Superior side, x 46. Zone *crepida*.  
Specimen Q64-8.

9 - *Palmatolepis trachytera* Ziegler. Superior side, x 54. Zone *trachytera*.  
Specimen Q99-7.

Location of specimen collection: All of the above specimens were collected from the SW slope section of Xom Nha limestone mountain, (Quy Đạt, Quang Binh), in limestone of Cat Dang formation ( $D_3cd$ ).

#### Plate 1-4

1. *Lyhoalepis duckhoai* Janvier. Ventral carapace, incomplete, viewed from the back (x1).

2. *Lyhoalepis duckhoai* Janvier. Ventral carapace, incomplete, viewed from the back (x1).

3. *Lyhoalepis duckhoai* Janvier. A piece of left carapace viewed from the top (x2,5).

4. *Lyhoalepis duckhoai* Janvier. Lateral part of an anterior ventral plate (x2).

The above specimens (Figures 1 to 4) were collected from the sediments of Ban Giang formation ( $D_2ebg$ ) on Ly Hoa pass, Bo Trach, Quang Binh.

5. *Protolapidodendron* sp. và *Bergeria (Lepidodendropsis)* sp. (x1); 5a - *Protolapidodendron* sp.(x3), 5b - *Bergeria (Lepidodendropsis)* sp.(x3).

6 -7. *Bergeria (Lepidodendropsis)* sp. (x1).

The above specimens (Fig. 5-7) were collected from the sediments of Minh Le formation ( $D_2g - D_3frml$ ) at the entrance of Hoi Da, near Minh Le railway station, Quang Trach, Quang Binh.

#### Plate 1-5

1-6. *Fedorowskia phongnhaense* Khoa.

1, 2a, 4a, 3, 5. 6 - Cross section through the pocket; 2b, 4b - Longitudinal section through the pocket.

Location of specimen collection: Phong Nha formation ( $D_3-C_1 pn$ ), limestone at the entrance of Phong Nha cave, Quang Binh.

#### Plate 1.6

(The photos in the plate are of actual size, in particular Fig. 4 has x2 size)

1. *Schizophoria sTriassicula* Schlotheim

1a. Ventral valve

1b. Brachial valve

1c. Lateral side

1d. Anterior side

Specimen MH. 2, 3 km West of Quy Dat, Quy Dat area, Quang Binh province. Middle part of Muc Bai formation, zone *burtini - battersbyi*  
Collection by Paleontology - Stratigraphy Section, (RIGMR).

2. *Gypidula calceola vietnamica* Zuong et Rzonsnickaja

2a. Ventral valve

2b. Brachial valve

2c. Lateral side

2d. Anterior side

Specimen MH. 1, 3 km west of Quy Dat 3 km, Quy Dat area, Quang Binh province. Lower part of Muc Bai formation, zone *undiferus - orientalis*

Collection by Paleontology - Stratigraphy Section, (RIGMR)

3-4. *Chonetipustula orientalis* Zuong et Rzonsnickaja.

3. Ventral valve

4. Outer frame of ventral valve

Specimen MH.1, 3 km west of Quy Dat, Quy Dat area, Quang Binh province.

Collection by Geological Subdivision 207.

Lower part of Muc Bai formation, zone *undiferus - orientalis*

5. *Calvnaria cracoviensis* (Gurich)

5a. Brachial valve

5b. ventral valve

5c. anterior side

5d. lateral side 5e. anterior side

Specimen MH. 4, 2.5 km west of Quy Đat, Quy Dat area, Quang Binh province.

Formation Ngoc Lam, zone *calvinaria cracoviensis*

Collection by Paleontology - Stratigraphy Section, (RIGMR).

Plate 1.7

1. *Desquanmata kansuesis* (Grabau)

1a. Ventral 1b. Brachial valve

1c. Lateral valve

1c. Anterior side

Specimen MH.2, Quy Dat area, Quang Binh province

Middle part of Muc Bai formation, zone *burtini - battersbyi*

Collection by Paleontology - Stratigraphy Section, (RIGMR)..

2. *Desquanmata ventricosa* Kelus.

2a. Ventral valve 2b. Brachial valve

2c. Posterior side

2d. Lateral side 2e. Anterior side

Specimen MH.2, Quy Dat area Quang Binh province. Collection by Geological Subdivision 207.

Middle part of Muc Bai formation, zone *burtini - battersbyi*



Figure 3. *Emanuella takwanensis* Kayser

3a. Ventral valve    3b. Brachial valve    3c. Anterior side

Specimen MH.2, Quy Dat area Quang Binh province. Collection by Geological Subdivision 207.

Upper part of Muc Bai formation, zone *Vacuustroma thanhlangense*

Figure 4. *Emanuella ronensis* Mansuy.

4a. Ventral valve    4b. Brachial valve

4c. Lateral side    4d. Posterior side 2e. Anterior side

Specimen MH.3, Quy Dat area, Quang Binh province

Upper part of Muc Bai formation, zone *vacuustroma thanhlangense*

Collection by Geological Subdivision

5. *Ambocoelia cf. umnpnata* Conrad

5a. Ventral valve    5b. Brachial valve

5c. Lateral side    5d. Anterior side

Specimen MH.3 Quy Dat area Quang Binh province

Upper part of Muc Bai formation, zone *vacuustroma thanhlangense*

Collection by Geological Subdivision 207.

Plate 1.8

1-4 *Idisostroma quydatensis* sp. nov.

Muc Bai Formation, near Quy Dat. (Collection by Nguyen Huu Hung)

5-6 *Vacuustroma concentrica* sp., nov.

Muc Bai Formation, near Quy Dat. (Collection by Nguyen Huu Hung)

Plate 1.9

1. *Platiferostroma phongnhaense* sp.nov.

Phong Nha Formation. Entrance of Phong Nha cave, Quang Binh  
(Collection by Nguyen Huu Hung)

2-3. *Rosenella aff. miniarensis* Riabinin, 1932

Phong Nha Formation. Entrance of Phong Nha cave, Quang Binh  
(Collection by Nguyễn Huu Hung)

Plate 1.10

1. *Septatournayella evoluta* Lespecimeneva. (DC-KS VCS1/1), x100

2. *Seprunsiina (Septabrunssina) minuta* (Lipina). (DC-KS VCS1/22), x 90

3,4. *Septatournayella segmentata* Dain. 3 - (DC-KS VCS1/6), x100; 4 -  
(DC-KS VCS1/19), x 80.

5. *Chernyshinella glomiformis* (Lipina). (DC-KS VCS1/16), x 95

- 6,7. *Septatournayella (Septabrunsiina)* sp., 6- (DC-KS VCS1/17), x100; 7- (DC-KS VCS1/21), x 80.
8. *Sepbrunsiinella (Septabrunsiina)?* sp., (DC-KS VCS1/30), x135
9. *Chernyshinella Crassitheca* Lipina. (DC-KS VCS1/10), x90;
- 10, 11. *Sepbrunsiina (Septabrunsiina)* sp., 10- (DC-KS VCS1/17), x100; 11- (DC-KS VCS1/21), x 100.
12. *Baelenia* sp., (DC-KS VCS1/13), x 80
13. *Baelenia* sp., (DC-KS VCS1/19), x 108
14. *Sepbrunsiina (Septabrunsiina) kibgirica* (Reitlinger). (DC-KS VCS1/25), x 68
15. *Chernyshinella* sp. (DC-KS VCS1/15), x 140
16. *Sepbrunsiina ?* sp. (DC-KS VCS1/10), x 75
17. *Sepbrunsiina (Septabrunsiina)* sp., (DC-KS VCS1/7), x 68
18. *Sepbrunsiina (Septabrunsiina)* sp (DC-KS VCS1/30), x 105
- 19, 20. *Sepbrunsiina (Septabrunsiina)* sp., (DC-KS VCS1/12), x 90; 20 (DC-KS VCS1/4), x 105
21. *Sepbrunsiina (Septabrunsiina)* sp., (DC-KS VCS1/4), x 62
- 22, 23. *Sepbrunsiina (Septabrunsiina)* sp., 22- (DC-KS VCS1/24), x 68; 23- (DC-KS VCS1/11), x 88.

All of the above specimens were collected from the limestone of Bac Son formation, in Ke Bang limestone massif)

## Chapter 4

### Petrographic characteristics and magmatism

The magmatic intrusions in the Phong Nha - Ke Bang area are not much developed, consisting mainly of a granite - granodiorite massif of Truong Son complex ( $\gamma C_1ts$ ).

The magmatic rocks of Truong Son complex aged Early Carboniferous. They crop out in Dong Hoi uplifted block, in the SE of the study area, penetrating the sediments of Long Dai formation, forming an extensive zone of contact metamorphism.

**Dong Hoi massif:** is located to the West of the town of the same name. The massif has a dome-like structure, with an area of about 300 km<sup>2</sup>. It is composed of quartz diorite, granodiorite, biotite granite, two-mica granite together with dykes and veins of aplite and pegmatite. In general the rocks Dong Hoi massif are similar to those in Truong Son massif. However, here the melanocratic rocks are predominant, the assimilation of magma in the top part is not complete, forming hybridized zones which are widespread everywhere in the area of the massif. Nguyen Xuan Tung... (1977) described that in the South of the massif is metagranosyenite containing amphibole, belonging to Ban Chieng complex, piercing in the granodiorite of Dong Hoi massif, however they have not been investigated in detail.

The Dong Hoi granitoid has penetrated the terrigenous sediments of Long Dai formation ( $O_3 - Sld$ ) and formed a zone of contact metamorphism up to 2-3 km wide. Near the contact are micaceous staurolite schist passing to feldspar-biotite-quartz hornfels then to shale which practically has not been metamorphosed. In the outer contact zone are developed many non-ore tourmaline- quartz pegmatite veins.

Petrographic and mineralogical characteristics of the main rock types

Quartz-biotite diorite is rarely met, seen only in some places at the margin of the massif. In Dong Hoi massif, quartz - biotite diorite is met more frequently and is concentrated near the SE margin of the massif. According to Nguyen Xuan Tung... (1977), the quartz diorite of Dong Hoi massif is the earliest phase which has been penetrated by granodiorite, however we have not been able to observe this but can only see them occur together with biotite granite, biotite granodiorite, which are differentiated from granite by very low quartz content and high biotite content and consequently their darker color than that of granite. The rocks are of

fine to medium grained, porphyritic texture, deep black color, with biotite content over 10 %, unstable quartz content from below 10% to 15%, with higher quartz content the rocks pass into granodiorite and granite. Plagioclase accounts for a maximum percentage from 40 to 60%, of idiomorphic prism form, with clear zonation.

***Melanocratic biotite granodiorite, biotite granite:*** are the main components of the complex. They are closely combined, without having clear boundary, being differentiated from each other by the amount of quartz or silica or the correlation between the contents of plagioclase and potassium feldspar. The rocks are coarse grained, crystalline, porphyritic with rectangular feldspathic phenocrysts 1-2 cm to 5-6 cm long, arranged nearly in the same direction. The groundmass is composed of quartz, felspar, mica with idiomorphic granular texture. In the composition of the rocks, plagioclase accounts for the highest proportion, most idiomorphic, usually with clear zonation, with the core being andesine (N" 45-56), the margin being oligoclase (N" 14-20) occasionally up to albite. The biotite is highly idiomorphic, usually being large plates with clear shape or small flakes accumulated in masses in between other minerals, with strong pleochroism: Ng- Reddish dark brown; Np - Pinkish light yellow. Potassium feldspar is mainly orthoclase, occasionally microcline with network twinning. Potassium feldspar is relatively fresh, its crystal face is rarely peltized, at the margins of large potassium feldspar plates usually there are grains of idiomorphic plagioclase, biotite and quartz. Besides, in the composition of the rock occasionally there are also small flakes of muscovite, accessory minerals such as apatite, zircon, rutile, sphene and small grains of magnetite.(Fig. 4.4 and 4.5)

***In two-mica granite*** the amount of muscovite is elevated (3-10%) consisting of plates, scales, with clear shape evenly intercalated with biotite or occasionally intergrowing with biotite. The content of potassium feldspar is dominant over plagioclase. The rock is leucocratic, fine- to medium-grained, equigranular or weakly porphyritic. The rock usually is of hypidiomorphic, occasionally passing to completely allotriomorphic granular texture. (Fig. 4.2 and 4.3)

***Leucocratic granite and aplite:*** are met in many places inside the massif or in the form of dykes in the outer contact zone, with size varying from a few centimeters to tens of centimeters. The rocks leucocratic fine-grained (aplite) to medium-grained (leucocratic granite). Potassium feldspar predominates, occasionally by many times over plagioclase. Plagioclase usually is albite or

albite-oligoclase. Biotite is very little or practically absent. In the rock are usually met tourmaline, garnet with clearly angular or skeletal form. (Fig. 4.1)

*Pegmatite* penetrates in the inner and outer contact zones. It is composed of quartz, felspar, biotite and large plates of muscovite. Near Kim Cuong village (Truong Son massif) are met some veins of greisenized pegmatite containing cassiterite crystals.

*In chemical composition*, Truong Son complex consists of a rock assemblage from intermediate passing to acidic, rich in alumina, usually with high mafic content similar to the rocks of Phia Bioc complex. Compared with the rocks of Ngan Son and Muong Lat complexes the granitoids of Truong Son complex are mostly more basic. The rocks are usually saturated with alumina, which is expressed in the compositional vectors on the Zavaritski diagram which are always directed to the left.

On the QAP diagram the main components of the complex is granite, less granodiorite, the rocks pertain to the calc-alkaline type and are mainly S-granites. As regards the possible mineralization of the complex, besides cassiterite concentrated in some greisenized pegmatite veins, it is very note-worthy that in both Truong Son and Dong Hoi massifs there are small dispersion haloes of scheelite, monazite, xenotime.

Truong Son complex is attributed to Middle - Late Paleozoic according to the following data:

- The granitoids of both Truong Son and Dong Hoi massifs in many places are seen to penetrate and cause thermodynamic metamorphism of the terrigenous sediments of Long Dai formation ( $O_3-S_{1d}$ ).
- In the East of Truong Son massif as well as in the NW of Dong Hoi massif, the basal conglomerate of La Khe formation ( $C_1 lk$ ) which has not been metamorphosed there are felspar gravel grains completely identical in properties with the feldspar in the granitoid of the complex being described (Tran Tinh, et al., 1997; Nguyen Quang Trung, 1981).
- The isotope age of some biotite samples in the granites of the complex is within 281-377 Ma (see the geological map).

Fig. 4.1. Leucocratic allotriomorphic coarse grained granite of Dong Hoi massif  
N<sup>+</sup>, x40  
(Photo by Tran Nghi, Tran Trong Hoa, 2000)

Fig. 4.2. Leucocratic, coarse grained allotriomorphic

two-mica granite, with plagioclase being sericitized, of Dong Hoi massif N<sup>+</sup>, x40  
(Photo by Tran Nghi, Tran Trong Hoa, 2000)

Fig. 4.3. Coarse grained allotriomorphic and hypidiomorphic  
two-mica granite, biotite being limonitized, of Dong Hoi granite massif N<sup>+</sup>, x40  
(Photo by Tran Nghi, Tran Trong Hoa, 2000)

Fig. 4.4. Medium-grained granite, with hypidiomorphic and idiomorphic texture,  
with quartz being allotriomorphic, plagioclase idiomorphic and hypidiomorphic,  
of Dong Hoi massif  
N<sup>+</sup>, x40 (Photo by Tran Nghi, Tran Trong Hoa, 2000)

Fig. 4.5. Medium grained granodiorite, with hypidiomorphic and idiomorphic  
texture,  
plagioclase being zonated, idiomorphic, sericitized, encrusted on the quartz  
background, of Dong Hoi massif  
N<sup>+</sup>, x40 (Photo by Tran Nghi, Tran Trong Hoa, 2000)

#### ***b. Paleontological and archeological relics in Phong Nha - Ke Bang area and its surroundings***

Paleontological and pre-historic and protohistoric archeological relics in Quang Binh province are very rich and have been given attention and investigated since the twenties of the last century up to present. These relics consist of sites with ancient fauna fossils dating back to Pleistocene Epoch hundreds thousand years ago, of which some genera and species, such as Orang-Outang..., have been extinct and are no more seen within the territory of Vietnam. From later epochs there are relics pertaining to Hoa Binh culture dating from more or less 10 thousands years ago, belonging to the Stone Age with a series of limestone caves. Following are the archeological relics belonging to the Stone and Bronze Ages scattered in the plain and coastal areas, of which the typical are the relics belonging to Bau Tro culture and other sites belonging to Dong Son culture... The archeological relics in the underground and in caves are a valuable tourist resources. Through these relics,

visitors can understand thoroughly and profoundly the natural history as well as the history of formation and development of Man in this land since remote times, and understand the formation and development history of long-standing cultures in Quang Binh at present with the peculiar feature of the North Central and Central culture of our country.

To contribute to the arrangement of these relics in the overall tourist activities of Quang Binh province in general and the Ke Bang relic area in particular, we would like to list in the following the notable paleontological and archeological relic sites together with a location maps of those sites. We hope that on this basis, with more detailed investigations, combined with rehabilitation and reparation of key essential relics and a complete master plan, we put these relics into one of useful, interesting and healthy item of the integrated tourist program in Quang Binh.

#### **\* Paleontological relics pertaining to Pleistocene Epoch**

##### ***Hang Quyt***

This site belongs to Tuyen Hoa commune, Tuyen Hoa district, Quang Binh province. The relic is located in a cave, consisting of fauna fossils belonging to Pleistocene Epoch, discovered in 1963-1964 by a joint Vietnamese and East German survey team. In the deposits of this cave there are fossils of the following mammals:

Orang-Outang (*Pongo pygmaeus*), Hedgehog (*Hystrix subcristata*), Horned hog (*Tapius megatapius* Matthew et Granger), Rhinoceros (*Rhinoceros sinensis* Owen), Wild boar (*Sus scrofa* Lineaus), Deer (*Cervidae*), Roe (*Muntiacus muntiak* cf. *margae* Hooijer).

#### **\* Archeological relics**

***1. Minh Cam site:*** This site is located in a limestone cave in Minh Cam village Phong Hoa commune Tuyen Hoa district, with coordinates 17° 48' 45" North latitude and 106° 11' 15" East longitude.

This site was discovered and excavated by E. Patte (French) in 1922. In the cave there was only a burial a child of about 9 years old which had an appearance of a Negrito and a lower human jaw belonging to the Mongoloid race.

The utensils found in the cave included stone shoulder axes and adzes, all-polished quadrilateral axes, preformed axes and hammered tools, bone points, ornaments and pottery. The Minh Cam site may be both a burial and residence place of the population in the Neolithic.

2. *Bau Tro site*. Is a fresh water lake North of Dong Hoi town, 3 km away from the center of the town, with coordinates 17° 29' 22" North latitude and 106° 37' 22" East longitude.

E. Patte excavated this site in 1923 and found that the cultural layer is composed of salt water mollusk shell, mainly scallop, blood arc shell, etc.... In the cultural layer there are stone utensils such as axes, adzes, especially shoulder axes and adzes, blades hammered from stone cores, which might be stone knives. Besides, there are also hammer stones, U-shape section grinding table, fish back bone sections, awls made of animal bones...

The pottery wares here are crude, fired at low temperature, cord or basket impressed hatched, carved and colored patterns.

Bau Tro site is a residence site in the Central coastal zone. The residents in this culture lived by natural hunting-gathering and pertain to the Neolithic.

3. *Hang Rao cave site*. Was discovered and excavated by H. Mansuy and J. Fromaget 1923-1924.

Hang Rao cave is located in a limestone mountain SE of Rao Te, belonging to the tributary of Tooc river, at an one day walking distance West of Phong Nha. The cave is wide and is 8 m deep into the mountain body, its floor is 5.8 m higher than the stream water level. The cultural layer in this cave is 1.8 m thick. In the cultural layer are found many fresh water snail, mountain snail shells, and turtle carapaces and broken beast bones of various kinds. In the cave there is a remain of human skeleton and Late Neolithic archeological relics, similar to those found in Minh Cam cave

4. *Khe Tong site*: Also was excavated and investigated by Fromaget and H. Mansuy at the same time with the excavation of Hang Rao site. This site is located in the limestone mountain range extending along the right bank of Cac river, a tributary of Dai Giang river. It is located near the road from Quang Binh to Kham Muon (Laos), with coordinates 106°24' East longitude and 17°12' North latitude.

In the cave were found 4 shoulder adzes, 1 chisel, 1 preformed axe, 1 blade, terra-rossa, together with some pottery. According to the archeologists, the population of this cave also pertained to Neolithic, equivalent to the population in Bau Tro, Minh Cam and Hang Rao.

5. *Yen Lac cave site*: Was discovered and excavated by M. Colani 1930. The cave is at the coordinates 17°47'2" North latitude 106°39'43" East longitude, on



the bank of Nam river, an upstream tributary of the Gianh river, in Yen Lac village Yen Hoa commune Tuyen Hoa district.

In the cultural layer composed of fresh water mussel and snail shells mixed with many mammal bones 301 stone implements belonging to the Hoa Binh culture (dating back more or less 100 Ka) and also some artifacts of later period such as rope-marked pottery, fragment of polished stone bracelets....

**6. Kim Bang cave site:** Was also discovered while investigating the Yen Lac cave by Colani. The cave has a coordinates 17°46'10" North latitude and 106°46'44" East longitude, 2km SE of Yen Lac cave, in Vinh mountain, about 500 m South of Kim Bang, now Minh Hoa commune, Minh Hoa district.

In the cave there have been found stone choppers such as, side chopper, end chopper, tools made of 1/4 cobble, core shape tools, preformed axes, stone grates, hammer stones,... together with many animal bone remains. This site pertains to Hoa Binh - Bac Son culture.

**7. Xom Thon cave site:** is located in Xom Thon, on the right side of Nam river, 7 km from Yen Lac cave. The cave is located at the coordinates 17°43'45" North latitude and 106°58' East longitude, on the East slope of the limestone on the right side of Nam river, now in Thuong Hoa commune, Minh Hoa district.

M. Colani excavated this cave in 1930 and in the cultural layer were found large amount of snail shells together with artifacts similar to those in the above mentioned Kim Bang and Yen Lac caves.

**8. Xom Tham site:** is in Trung Hoa commune Minh Hoa district, with coordinates 17°44' North latitude and 106°37'6" East longitude. Was excavated by M. Colani in 1930. This site consist of two caves and one shelter next to each other.

The artifacts at this site pertain mainly to Hoa Binh cultures. However there are mixed also some artifacts from some later stages.

**9. Duc Thi site:** Is in Tan Ninh commune Quang Ninh district, with coordinates 104°14'49" East longitude and 17°16'41" North latitude, SW of Len Dong, on the right side of Rao Tru river a tributary of Long Dai river.

This site was excavated by M. Colani in 1930. This is a rock shelter, under which are contained a cultural layer and stone implements pertaining to Hoa Binh culture.

**10. Collection of archeological artifacts in Khuong Ha and Co Giang:** These two sites belong to Hung Trach commune, Bo Trach district. In May 1935 during

their road construction, the people here discovered many bronze artifacts and pottery urn graves similar to urn graves belonging to Sa Huynh culture together with many valuable artifacts belonging to this culture.

**11. Bau Khe site:** Is in Thanh Khe village, Thanh Trach commune, Bò Trach district. It is located on a fresh water lake 5 km South of Gianh river. M. Colani excavated this site in 1936. The artifacts are currently kept in History museum of Vietnam and belong to Bau Tro culture.

**12. Long dai vestige:** Is in Hien Ninh commune, Quang Ninh district, 106°38'15" East longitude and 17°19'42" North latitude.

In May 1945, Mr. Than Trong Phat, while excavating is underground shelter, discovered 5 bronze artifacts contained in a pottery vessel 200m downstream Long Dai bridge, consisting of bronze axes, lances...

**13. Ba Don I site:** Is located on the left side of Highway 1A heading to Ba Don township, within the campus of the Quang Trach district working school 45km North of Dong Hoi. It was discovered and excavated in April 1980. This site have artifacts belonging to Bau Tro culture.

**14. Ma Ung cave site:** Is 100 m SW of Quy Dat township of Minh. Hoa district. In the cave there is a relatively thick cultural layer consisting of fresh water mussels, snails and mammal bones. The cave was discovered by Ta Dinh Ha in 1985

**15. Khai cave site:** is 15km West of Ma Ung. In the cave there is a thick cultural layer and there have been found fragments of pottery belonging to Mai Pha culture in Lang Son.

**22. Co Thap cave site:** Is in Quy Hoa commune, Quy Dat district. This cave has a thick cultural layer, but it has not been excavated.

**23. Hang Tran, Hang Gio and Hung Than entrance sites**

Are in Tan Hoa commune (former Co Liem commune). These caves contain the artifacts belonging to Hoa Binh - Bac Son culture.

Besides the above sites, within the territory of Quang Binh there are also many archeological collections which have been discovered sporadically here and there. They are of archeological value, but are of no value in organizing excursions or tours.

We consider that more thorough surveys should be carried out at the known sites, and if possible excursion routes should be established; with re-excavation or new excavation some archeological sites in the with the principle to excavate and keep

the scene on the spot so that the visitors may see themselves the artifacts and the relics on the spot.

## LEGEND

Early Neolithic relics, Hoa Binh culture

Late Neolithic - Early Metal age relics

Sites with artifacts of Dong Son culture

National border

Province boundary

Road

Railway

River

Scale: 1: 750,000

**Fig. 5.1. Prehistoric and protohistoric archeological relics of Quang Binh**

### **I. Early Neolithic relics: Hoa Binh culture**

1. Hang Yen Lac (Yen Hoa commune - Minh Hoa)
2. Hang Kim Bang (Yen Hoa - Minh Hoa)
3. Hang Xom Thon (Thuong Hoa - Minh Hoa)
4. Hang Tran (Tan Hoa - Minh Hoa)
5. Hang Xom Tham (Lower layer) (Trung Hoa - Minh Hoa)
6. Stone roof Duc Thi (Lower layer) (Tan Ninh - Quang Ninh)
7. Hang Khe Toong (Lower layer) (Le Ninh district)

### **II. Late Neolithic - Early Metal age relics**

1. Bau Tro (Dong Hoi town)
2. Bau Khe (Thanh Trach - Bo Trach)
3. Con Thoc Loc (Son Trach - Bo Trach)
4. Ba Don I (Ba Don town - Quang Trach)
5. Ba Don II (Ba Don town - Quang Trach)

6. Con Nen (Quang Phuong - Quang Trach)
7. Bau Sen (Sen Thuy - Le Ninh)
8. Le Ky (Vinh Ninh - Quang Ninh)
9. Xom Thâm (upper layer) (Trung Hoa - Minh Hoa)
10. Hang Minh Cam (Phong Hoa - Tuyen Hoa)
11. Hang Rao (West Bo Trach mountain area)
12. Hang Khe Toong (upper layer) (West of Le Ninh)
13. Duc Thi rock shelter (upper layer) (Tan Ninh - Le Ninh)

### **III Sites with artifacts of Dong Son culture**

1. Khuong Ha (Hung Trach - Bo Trach)
2. Co Giang (Hung Trach - Bo Trach)
3. Long Dai (Hien Ninh - Le Ninh)
4. Thanh Thuy (Tien Hoa - Tuyen Hoa)
5. Hop Hoa (Trung Hoa - Minh Hoa)
6. Bau Khe (Thanh Trach - Bo Trach)
7. Da Ban (Quang Luu - Quang Trach)
8. Phu Luu (Quang Luu - Quang Trach)

### **Remarks:**

1. Neotectonic movements in the study area, which took place from Oligocene to Miocene, led intensive topographic dissection and formation of peneplains. That was the initial period for the impressive karst activities thanks to the development of major fault and fracture systems which was the first breakthrough facilitating the karst activities. Therefore the age of the Karst Phong Nha - Ke Bang karst system must be counted from Oligocene (36 Ma).

2) Karst activities also depend on tectonic uplift cycles and the sea level variation. Therefore, the age of the karstic caves must be considered to be equivalent with the age of the maximum transgression, which is expressed by sea level marks, surface water level marks left on the limestone cliffs as well as incision and solution erosion marks in the caves lying at the same level.

3) From Jurassic to Eocene the karstification process still occurred when the Phong Nha - Ke Table limestone massif was lifted up during the orogenic phases. However, as the block faulting activities were still weak, the cave system was not developed.

4) Within the river and stream valleys of the study area appeared many recent flood-plain and accumulative terrace deposits of various ages from Middle Holocene to Late Pleistocene. The deposits composed of red alluvium originating from the terra-rossa which is the limestone weathering products brought by the Son river. During the flood periods the river water is loaded with red suspended sediments, so the river has the name of "Son river " ("son" is rouge in Vietnamese).

### ***5.2.2. Geology of Phong Nha cave - Ke Bang***

#### ***1) The role of tectonic faults***

Tectonic faults are the mother which gave birth the main cave system and the opened fracture system due to the to the joint action of forces. There are two dominant fault trends in Phong Nha - Ke Bang area:

- NW-SE trend faults, reactivated in Cenozoic, originally were the old faults which decided the orientation of the Pre- Carboniferous - Permian sedimentary basins which extend in this direction (the Hang En, Hang Toi, Phong Nha, Khe Tiep,... caves)

- NE - SW trend faults: were formed due to the East sea spreading which occurred in Oligocene (Khe Ry, Vom caves)

These two fault trends have created two component conjugate fault trends: W-E and N-S. Besides, there are opened or semi-closed fractures generated due to the secondary conjugation of forces.

Due to the nature of limestone which has brittle deformation and, on the other hand, as the Phong Nha limestone aged Carboniferous - Permian is of platform type and massive structure, relatively pure, all of the above mentioned destructive actions do not extend in a straight lines, but in a twisting lines or in a dendritic form in the first part.

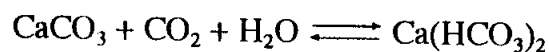
When two faults intersects, the cave will be expanded. This is more clearly seen in Phong Nha cave.

For the tectonic faults and fractures to become karstic caves with speleothems, two condition are required:

a) *Mechanic breakdown*: The limestone massif must be large enough, the faults must be relatively deep to form caves and thus the bottom of the cave is expanded thanks to the mechanical destruction, but the cave ceiling must be half closed, suitable for the speleothem formation in the chemical principle in the semi-dry environment similar to a "leaking roof".

b) *Chemical destruction*: the expansion and erosion of the two sides and the roof of the cave thanks to the actions of the underground rivers when the water level is highest (during the flood season and maximum transgression).

The erosion of the limestone in the cave (during the flood season) and the formation of travertine (in dry seasons) occurs in the chemical principle summarized by the following equation



The limestone erosion process occurs continuously in the environment where the limestone is soaked in water. The inland water has acidic reaction ( $\text{pH} < 7$ ) is more favorable for this equation to go toward the right side (solution of the limestone).

The process of forming travertine, stalagmite, stalactites, etc. is the precipitation of  $\text{CaCO}_3$ , i. e. the equation goes to the left side.

2) Geological age of caves

**Table 5.1. Geologic age dating of caves**

N	Names of caves	Elevation of cave bottom, m	Trend direction	Geologic ages
1	Khe Ry En	1500-1600	NW-SE	Oligocene (35 Ma)
		300		
2	Vom	360	SW-NE	Pliocene (5 Ma)
		0		
3	Over (belonging Vom cave system)	93	S-N	Q <sub>I</sub> (900 Ka)
		43		Q <sub>II</sub> (300 Ka)
		24		Q <sub>III</sub> (100 Ka)
		0		Q <sub>IV</sub> (present)

Table 1 shows that the relative elevation of cave bottom from the cave end to the entrance of Phong Nha cave (0m) decreases step by step and can be correlated with the age of the terraces and planation surfaces as analyzed above. A summary of elevation of numerous caves in the Phong Nha - Ke Bang limestone massif subject to the same geologic and geomorphologic evolution history we have 5 elevation levels:

- 1500-1600m aged Oligocene.
- 300-360m aged Pliocene.
- 93m aged Early Pleistocene.
- 43 m aged Middle Pleistocene.
- 24 m aged Village Late Pleistocene.

## Chapter 5

### Geologic structure and development history of the earth crust

#### 5.1. Geologic structure

The study area pertains mainly to Truong Son zone, which is separated with Hoanh Son zone by Song Ca - Rao Nay fault. The Truong Son zone consists of Dong Hoi uplifted block and Phong Nha - Quy Dat subsided block. The Dong Hoi uplifted block, which crops out in the SE of the study area, is composed of terrigenous sediments aged Ordovician - Silurian. In the central part of Dong Hoi uplifted block there is also a granitoid massif belonging to Truong Son complex which intruded and created a "dome-like anticline ". The Phong Nha - Quy Dat subsided block which is exposed in the central part of Truong Son zone, is composed of terrigenous sediments intercalated with carbonate ones, including the Upper Devonian banded limestone layer of Cat Dang formation ( $D_3 cd$ ). Overlying with unconformity these sedimentary rocks are the rocks of coal bearing carbonate and siliceous terrigenous formation, (La Khe formation -  $C_1 lk$ ) and carbonate formation (Bac Son formation -  $C-P bs$ ). Besides, taking part in the above subsided block are also Cretaceous sediments (Mu Gia formation -  $K mg$ ), and Quaternary sediments (Q).

Tran Van Tri (1977) has attributed this area to Truong Son fold system, belonging to Indochina fold belt.

In the study area the following structural units can be differentiated: (see the structural scheme).

##### 5.1.1. Fold structures

In the study area, pertaining to the Truong Son structural zone is Truong Son anticlinorium extending in NW-SE. This anticlinorium is basically formed by one folding phase at the end of Late Devonian - beginning of Early Carboniferous, then complicated by faulting activities. The core of the anticlinorium is composed of the most ancient sediments of Truong Son zone, its limbs are formed by Devonian - Carboniferous sediments. Besides, in the study area there are also some big anticlines, synclines and some other downfolds. In the following we will describe some typical folds:

##### *Dong Hoi dome-like anticline*

Dong Hoi dome-like anticline is of an elliptic form with a length of 10 - 20 km and a width of 5 - 8 km. Its core is composed of the sediments of the lower sub-

formation of A Vuong formation. Its limbs are the sediments of the upper sub-formation of A Vuong formation. The dip angles of the limbs are gentle, 25 - 30°, the fold axis extends in NW-SE direction. The central part of this anticline has been penetrated by Dong Hoi granite massif.

#### *Dai Du Anticline*

Dai Du anticline is in an arc form, with even curvature, its back side facing Northward. The length of the anticline is about 20 - 25km, its width is 6 - 7km. It extends from Troc village, through Dai Du to Cha Cung. The core of the anticline is composed of sediments of Rao Chan formation ( $D_1$ ) the two limbs are the sediments of Ban Giang formation ( $D_{2e}$ ) and Muc Bai formation ( $D_{2g}$ ). The axis of the anticline is an arc form, the northern limb has a slope angle of 60 - 65°, the southern limb 70 - 75°, the axis plunges in the West direction to pass to Thac Dai - Marai syncline.

#### *Si Thuong anticline*

Si Thuong anticline has a length of 20km, a width of 1 - 5km, its NW end is enlarged and complicated, its SW end is diminished and more simple. The core of the anticline is composed of sedimentary rocks of Rao Chan formation ( $D_1$ ), its two limbs being the sediments of Ban Giang formation ( $D_{2e}$ ). The NW limb has a dip angle of 54 - 50°, its SW limb is cut by faults, has a dip angle varying from 55 - 60° to 70 - 80°. The axis of the anticline is in an arc form with its back facing SW, to form together with Dai Du anticline the Thac Dai - Marai syncline.

#### *Dong Phuong anticline*

Dong Phuong anticline extends for a length of 20 - 20km, with a width 2 - 4km. The core of the anticline is the sediments of Ban Giang formation ( $D_{2e}$ ), its limbs are the sediments of Muc Bai formation ( $D_{2g}$ ). The axis of the anticline extends in NW-SE. In the central part, its axis is bent due to the action of faults. The NE limb has a dip angle of 50 - 60°, the SE limb about 65 - 70°.

#### *Cao Mai anticline*

Cao Mai anticline has a length of 25 - 30km a width of 2 - 3km. The core of the anticline is the sediments aged Eifelian, the two limbs are sediments aged Givetian. The axis of the fold relatively gentle, extends in latitudinal direction.



The Southern limb has a dip angle of 60 - 70°, the Northern limb has a dip angle of 45 - 50°, further it takes part in Rao Nay syncline.

#### ***Cat Dang anticline***

Cat Dang anticline extends from La Trong to Cat Dang with a length from 15 - 20km, a width of 2 - 3km. The axis of the fold extends in NW-SE direction but is bent in Avi area. The core of the anticline is composed of the sedimentary rocks of Rao Chan formation ( $D_1rc$ ), its 2 limbs are the sediments of Muc Bai formation ( $D_2gmb$ ). Its NE limb has a dip angle of 50 - 55°, limb SW is strongly crumpled and folded, having a reverse attitude with dip angle 60 - 65°.

#### ***Rao Nay graben-like syncline***

The Rao Nay graben-like syncline extends for 70 - 100km, with a width of 3 - 5 km. The axis of the syncline is in an arc form, its back facing SW, plunging towards the SE then is covered by the Cenozoic sediments. The core of the syncline is the sediments aged Famennian, its limbs are the sediments aged Frasnian of Dong Tho formation and sediments aged Givetian of Muc Bai formation. The SW limb has a dip angle varying from 60 to 75°, the NE limb has a dip angle of 70° - 80°. Overlying with unconformity this syncline are the sediments of La Khe formation ( $C_1$ ), and Bac Son formation ( $C_2 - P_1$ ) with gentle attitude.

#### ***Quy Dat syncline***

Quy Dat syncline is in an arcuate elliptic form, with its back facing SW. The length of the syncline about 20 - 25km, its width is 3 - 4km. This syncline is located between Si Thuong anticline and Cao Mai anticline, on the NE of this syncline is Dong Phuong anticline. The core of this syncline is the sediments aged Famennian of Cat Dang formation, its limbs are the sediments of Dong Tho and Muc Bai formations. The axis of this syncline is in an arc form with its back facing SW, its NE limb has a dip angle of 60 - 65°, its SW limb 50 - 55°.

#### ***Phong Nha syncline***

Phong Nha syncline extends from Highway 20 through Bai Dinh to Thac Dai, extending beyond the study area. The core of the syncline are the sediments of Bac Son formation, their limbs are the sediments of Dong Tho formation ( $D_2gdt$ ) and Muc Bai formation ( $D_2gmb$ ). The axis of the syncline is in an arc form, with its back facing SW. Its limbs have a dip angle varying from 45° to 70°. The syncline is complicated by faults, creating block structures.

### *Thac Dai - Ma Rai syncline*

Thac Dai - Ma Rai syncline extends from Thac Dai to Ca Rai mountain, has a length of 15 - 20km and a width of 5 - 6km. The core of the syncline is composed of the sedimentary rocks of Bac Son formation ( $C_2 - P_{1bs}$ ), its limbs are the sediments of La Khe formation ( $C_{1lk}$ ). Its Western limb has a dip angle of 20 - 30°, its NE limb is cut by faults.

### *Trung Thuan syncline*

Trung Thuan syncline extends from Trung Thuan to Ong Na mountain, beyond the study area with a length of 45 - 50km and a width of 22 - 25km. The core of the syncline is the sediments of upper sub-formation of Dong Trau formation. Its limbs are the sediments of the lower sub-formation of Dong Trau formation. ( $T_{2adt}$ ). The two limbs of the syncline have a dip angle of 50 - 60°, its axis is slightly deviated to the North, its Eastern part is covered by the Quaternary sediments.

#### *5.1.2. Fault systems*

Faults are widely developed in the area, playing the important role in the formation and complication of the geologic structure of the area. Based on the morphology the following fault system can be differentiated: NW-SE trending fault system, NE - SW trending fault system, and sub-latitudinal faults.

##### *NW-SE trending fault system:*

The faults of this fault system are relatively popular in the study area. Playing the important role in this fault system is the Rao Nay deep-seated thrust fault. This fault extends from Kim Lu down to Ba Don with a length of 120km, serving as the boundary between Truong Son and Hoanh Son zones (according to J. Dovjikov - 1965). This fault has its down-thrown block on the NE side composed of Triassic rocks, thrust block composed of rocks aged Devonian, Carboniferous, Permian with a total vertical displacement is over 1000m. This fault has entailed a series of faults with the same trend, causing a wide broken, sheared and quartzified zone 2 - 3km wide and forming scaly structure in Dong Le - Ngoc Lam area. Related with these faults are the magmatic bodies which were intruded in the SW block in the Mesozoic period (Dong Le granitoid massif).

##### *NE - SW trending fault system*

This fault system is occurs in the SW of the study area, pertaining to Truong Son zone. The typical fault in this fault system is the Highway 20 normal fault developed from Ngan Son through Phong Nha to Ca Roong, extending over 60 -

80km called by J.Fromaget as "Hang Rao trench ". In the up-thrown block of this fault are exposed the metamorphic rocks of A Vuong formation. Its slipping face is inclined toward NW with an angle 70 - 75°. The fault was generated and was intensively active during Carboniferous and terminated at the beginning of Cretaceous. The total vertical displacement is 200 - 300m, the horizontal displacement is 800 - 1000m, the NE - SW trending faults usually cross and displace the NW-SE trending ones.

#### *Sub-latitudinal faults*

In general in the study area sub-latitudinal faults are of little popularity. Most considerable is the Trooc - Cat Dang arcuate normal fault which is 60 - 70 km long. The slipping face of this fault is inclined to SSW. The Trooc - Cat Dang fault appeared in Late Paleozoic and has been moderately active up to present. The total vertical displacement is over 700m. In relation with this fault there is a mineral water spring in Nghan cave.

### **5.2. The geological, geomorphologic diversity and evolution history of the Earth crust in Phong Nha-Ke Bang area**

The Phong Nha - Ke Bang area can be said to be a converging place of many diversity aspects of nature: geology, geomorphology, topography, climate, biology, ecology, landscape, environment, etc. This is because there still exist here evidences of geological events proving the active development history of the Earth crust throughout the last 500 Ma, from Ordovician period to present. The complicated tectonic activities of the Earth crust are the cause of all causes which built up and destroyed again the geological setting, forming evolutionary spiral to have a geological and geomorphologic setting as that of today. The multiform geologic structure and lithologic composition is a factor deciding the diversity of the topographic and geomorphic features and is also one of the factors deciding the hydrographic network, the groundwater systems, the climate and the physical geographic conditions, the diversity in biosphere, landscape and environment in this nature's wilderness full with mystery. Such cause and effect relationship is like a closed energy cycle, which is so harmonious and perfect to such an extent that no component can be separated from the whole system to be examined separately, but each of them must be considered in the unified and dialectical relationship - the evolutionary relationship.

### *5.2.1. Geologic and geomorphologic development history*

The evolution history of geological formations and ancient living world, that of geomorphologic and topographic features is closely linked with the development history of the Earth crust. Each stage of the Earth crust development is formulated by a characteristic structural type called structural plan..

Fromaget (1927) has referred to the Hercynian orogenic movements in Truong Son area. Dovjikov et al. (1965), while compiling the 1/500.000 geological map of the North of Vietnam also attributed the study area to the Late Hercynian orogenic movements belonging to North Vietnam structural region. In his tectonic scheme, the study area belongs mainly to the Truong Son facial-structural zone and partially to Hoanh Son zone. However, the present Phong Nha - Ke Bang area is the integrated result of six great stages in the development history of the Earth crust in the region:

1. Late-Ordovician - Silurian stage (463.9 - 430 Ma)
2. Middle - Late Devonian stage (386 - 362.5 Ma)
3. Carboniferous - Permian stage (362.5 - 245 Ma)
4. Triassic stage (241 - 66.4 Ma)
5. Cretaceous stage (97 - 66.4Ma)
6. Cenozoic: Neogene (23.7 - 1.6 Ma) and  
Quaternary stage (1.6 Ma to nay)

In the following will be resented successively all stages of the evolution history of the Earth crust in the Phong Nha - Ke Bang area, with important information arranged logically in cause-effect relationship: tectonic movements, Lithological and paleogeographic characteristics, sedimentary - paleontological formation, petrographic characteristics and magmatic activities, geomorphologic evolution, forming mechanism of relief and hydrographic systems, forming mechanism of various generations and types of Karstic caves.

*The stage of break-down and subsidence of continent from Middle Cambrian to Ordovician ( $\Theta_2 - O_1$ ). About 570 Ma in the territory of the study area the continental crust (consolidated crust) started its break down and subsidence lasting up to Ordovician, creating endogenous rift basins where terrigenous - carbonate sediments with a thickness of 1550m belonging to A Vuong formation*

were formed. Nowadays these sediments have been metamorphosed into marble, dolomite, mica schist and quartzite. The outcrop area of these sediments is very small, in the form of a residual area beyond the study area.

### ***1) Late Ordovician - Early Silurian stage***

The territory of Phong Nha - Ke Bang area was subsided again. The structural plan was broken down in the mechanism of forming the Long Dai flysch andesite volcanic arc basin. (Tran Van Tri, 1995). The basin has its axis in the bent form extending in NW-SE direction, developed in the following 4 periods as follows:

- Period 1, corresponding with the formation of Long Dai formation ( $O_3-S_1 ld$ ), the subsidence was started with the formation of quartz conglomerate, quartz sandstone belonging to the littoral facies, claystone and bituminous claystone belonging to the deep water facies of alternated red-ox environment. The original rocks were metamorphosed in the next stages to become quartz sericitic schists, quartzitic sandstone and bituminous shale which are alternated and have flysch structure, 1000 - 1500m thick.

- Period 2 ( $O_3-S_1 ld_2$ ): The sedimentary basin continued its subsidence alternated with island-form uplifted blocks of "Cocdilie" type, composed of poly-mineral conglomerate, quartz sandstone siltstone and claystone, which are now quartzitic sandstone and sericitic schist, 1050m thick, containing *Demirastrites convolutus*, *Oktavites spiralis*, *Monograptus halli*.

- Period 3 ( $O_3-S_1 ld_3$ ): Lithologic and paleontological composition is similar to that of the Middle member, but the grain size is less, the basin tended to subside deeper, the sediments are 660-700m thick.

- Period 4, corresponding with the formation of the Dai Giang formation ( $S_2-D_1 dg$ ). The sedimentary basin tended to rise up, characterized by silty sandstone and monomineral quartz sandstone of shallow sea and littoral facies with wave action.

The Ordovician - Silurian and Silurian - Lower Devonian sediments are exposed mainly in the SE of the study area (belonging to a part of Quang Ninh district and part of Bo Trach district) and a narrow island in the NW (Minh Hoa district) beyond the study area. Looking at the geostructural plan one can infer a unified linear Ordovician - Silurian - Lower Devonian sedimentary basin connecting the two above outcrops extending in NW-SE direction.

### ***2) Middle Devonian to Late Devonian stage***

This stage corresponds with Ban Giang formation ( $D_2$  e *bg*) Muc Bai formation ( $D_2$ g *mb*), Dong Tho formation ( $D_3$  fr *dt*) and Cat Dang formation ( $D_3$  fm *cd*).

The Devonian stage was also the stage when the development D-S type basins was terminated, where the sediments have typical rhythmic flysch structure. The Earth crust in the Phong Nha - Ke Bang area started to develop a new type of basin the "continental rift" type. The axis of the basin is an arc form extending in the NW-SE direction, not far away to the NE of the study area. Compared with the O-S sedimentary basin, the Devonian basin is more expanded in width and shallower in depth, expressed through, 5 sedimentary members (called 5 formations) from older to younger as follows:

- **Member 1:** Lower Devonian sediments (Rao Chan formation) - ( $D_1$  *rc*) consists of sandstone, siltstone, claystone and limestone of black color, containing bitumen, reflecting the depositional environment varying from littoral to relatively closed lagoon. The sedimentary basins are small in size, but they were developed into systems separated from each other by larger uplifted blocks O-S which played the role as the supply sources of material. The Rao Chan formation, although exposed outside the study area, should also be described here as it was the start of the second geological cycle in the Phong Nha - Ke Bang area.

- **Member 2:** Middle Devonian sediments consisting of Ban Giang formation and Muc Bai formations.

Ban Giang formation ( $D_2$  e *bg*) is composed of quartzitic sandstone, silty sandstone, in some places intercalated with siliceous rocks and shale 800-900 m thick, containing *Calceola sandalina*, *Desquamatia kurbesekiana*. This is the sediments of a new rhythm characterizing transgressive facies from the littoral zone to the shallow sea and deep sea facies. The basin was expanded, however to some extent it was differentiated to form semi-closed basins where black calcareous clay containing bitumen was deposited.

Muc Bai formation ( $D_2$  g *mb*) is composed of limestone, calcareous shale containing pockets of siliceous rocks and silty sandstone overlying with conformity the sediments Ban Giang formation, 600-700m thick, containing *Stringcephalus burtini*, *Emanuella*, *Takwanensis*, *E. volhynica*, *Desquamatia ventrycosa*, *Scoliopora denticulata*, cropping out in narrow bands in the NE and NW of the study area.

This sedimentary complex characterizes a type of clearly bottom differentiated basin. The platform-type limestone was formed in the terrace structure whereas the banded siliceous and thin-bedded limestone intercalated with shale were deposited in the deeper basins (troughs). Well sorted quartz sandstone is the characteristic of the littoral sand facies with wave action

**Member 3:** Upper Devonian sediments, composed of 2 formations: Dong Tho and Cat Dang.

- Dong Tho formation ( $d_3$  fr *dt*) is composed of sandstone, quartzitic sandstone, silty sandstone, siliceous schist and black bituminous shale 350-450m thick, containing fossil assemblage *Schizophoria ivanovi*. This is a section of the third transgression in Devonian from the littoral quartz sand facies to deep sea clay and siliceous facies of gulf type which expresses the tectonic subsidence phase of the basin in Late Devonian.

- The rock of Dong Tho formation are distributed in bands extending in NW -SE direction, overlying with conformity the Muc Bai formation and is overlain with conformity by Cat Dang formation. All of them follow the limbs of 3 synclines, which used to be three sedimentary basins having their axes passing through Rao Nay, Minh Hoa and Xom Quyen. This shows a differentiation into 3 secondary basins in Late Devonian, where Rao Nay basin is asymmetric.

- Cat Dang formation ( $D_3$  fm *cd*) is the youngest formation Upper Devonian, overlying with conformity the Dong Tho formation, cropping out along the core of the Xom Quynh syncline inside to the study area and the 2 remaining synclines are located outside the study area, however they have the same facial paragenetic distribution.

Cat Dang formation is composed of diverse carbonate sediments, where banded limestone and motley limestone account for a considerable amount. In some places are intercalated thin layers of siliceous limestone or siliceous shale. The thickness of this formation is 400-450m, it contains Stromatoporoidea fossil assemblage: *Stachyodes* aff. *costulata*, *S. lagowiensis* and *Conodonta* belonging to *rhenana*, *linguiformis*, *triangularis*, *crepida*, *marginifera*, *trachytera* zone and assemblage *gracilis* - *sigmoidalis* aged from Frasnian to the end of Famennian ( $D_3$  fr-fm).

The banded structure of the rocks, their complicated lithologic composition, with the presence of both massive limestone and siliceous limestone containing Conodonta characterizes the deep water environment, with clear bottom differentiation and with the presence of bottom currents. This proves a recurrent tectonic subsidence phase, very quickly creating various depositional environments when it goes in the direction perpendicular with the axis of the basin, i.e. the NE-SW direction.

### 3). *Carboniferous - Permian stage*

At the beginning of Carboniferous period the Earth crust in the Phong Nha - Ke Bang area started to change in a completely new mechanism. One tectonic phase with the predominantly uprising trend entailed three process which took place in the territory of the study area:

- Intrusive magmatic activities forming the Dong Hoi granite massif aged Early Carboniferous.
- Formation of a typical Carboniferous - Permian isometric basin of intracontinental platform type West of Dong Hoi and linear basins of residual types extending in NW-SE
- Appearance of extensive erosion and denudation areas aged Pre-Carboniferous distributed in the East, SE and NE of the Carboniferous - Permian Phong Nha - Ke Bang basin.
- *Appearance of intrusive magmatic activities:* Dong Hoi massif is located to the West of the town with the same name, covering about 300 km<sup>2</sup>. In the study area there is only about 1/4 of the outcropping area of the massif in the SW.

In petrographic composition the massif is composed of: quartz diorite, granodiorite, biotite granite, two-mica granite, aplite and pegmatite. Of these the melanocratic rocks predominate. The assimilation of the magma in the top is not complete, creating hybridized zones which are widespread all over the massif.

The Dong Hoi granitoid massif penetrated the sediments of Ordovician - Silurian belonging to Long Dai formation (O<sub>3</sub>-S *ld*) and created a zone of contact metamorphism 2-3 km wide. Near the contact are mica-staurolite schist which passes to felspar-biotite-quartz hornfelse, then to shale which has practically not metamorphosed.



The Dong Hoi massif was intruded during Early Carboniferous, creating a dome-like anticline with its core being the sediments of A Vuong formation.

- *Formation of Late Devonian - Carboniferous - Permian intra-continental basin.*

The Carboniferous - Permian basin was formed by the block movement mechanism, controlled by 3 large fault systems: NE-SW extending adjacent to Dong Hoi massif, NW-SE and W-E. These 3 systems have created 4 sedimentary basins: Phong Nha - Ke Bang basin in isometric form and 3 linear basins with axis extending in NW-SE direction in an extending arc form, with its back facing SW direction.

The tectonic circumstance has defined the carbonates formations characterizing three types of basins as follows:

- Transitional basin type aged Late Devonian - Early Carboniferous ( $D_3-C_1$ )
- Shallow isometric basin type (C-P)
- Shallow linear basin type (C-P).

The following described formations were formed in the above mentioned sedimentary basin types:

a) *Phong Nha formation ( $D_3-C_1$  pn)*

In ascending order the following three members can be differentiated:

- **Member 1:** Grey massive, thick-bedded limestone of platform type containing Tetracoralla, Tabulata, Brachiopoda, Foraminifera belonging to *Cystophrentis - Quasiendothyra* complex aged Famennian of Late Devonian. This member built up the entrance of Phong Nha cave Hang Toi cave. At the entrance of Hang Toi cave there is a big limestone boulder which contains densely compacted Tetracoralla fossils of genus *Cystophrentis*. Whereas the limestone at the entrance of Phong Nha cave contains large amount of Tabulata fossils of genus *Syringopora*, Tetracoralla of genera *Cystophrentis* sp., *Fedorowskia* and Foraminifera of genera: *Septatournayella*, *Septabrunsiina* sp., *Quasiendothyra*
- **Member 2:** Grey, thick and medium-bedded limestone, intercalated with calcareous shale containing many small Brachiopoda and Foraminifera of *Bisphaera* zone aged Tournaisian (C1): *Bisphaera malevkensis* *B. elegans*, *Endothyra* sp. and some forms of Gastropoda.

- **Member 3:** This is a member of terrigenous sediments intercalated with claystone and siliceous rock with thickness 30m. The siliceous schist is black, with flat, occasionally conchoidal fracture, brittle, easy to crush. This member contains Trilobita aged C1.

b) *La Khe formation (C<sub>1</sub> lk)* is composed of sandstone, silty sandstone, claystone, coaly shale containing bitumen, limestone, calcareous shale and siliceous rock 300-500m thick, distributed in the form of narrow bands in the massif as well as in the margin of Phong Nha - Ke Bang limestone massif. These sediments characterize the transgressive section from the littoral to deep sea facies. When the basin was at the maximum subsidence, the environment was of weakly alkaline and reducing character, rich in CO<sub>2</sub>, SiO<sub>2</sub> with extrusive origin, creating the development of siliceous algae, as raw material for formation of bitumen in the calcareous shale.

c) *Bac Son formation (C-P bs)* was established by Nguyen Van Liem (1979). This formation occupies nearly the whole quantity of Phong Nha - Ke Bang limestone, forming a huge "wilderness" from Phong Nha - Ke Bang to Middle Laos with a peculiar type of geologic structure: the continuity, homogeneity and isometry typical for the platform limestone in Vietnam.

In ascending order this formation consists of three members:

- Member 1: Black limestone, limestone containing Crinoidea stems, medium and thick-bedded siliceous limestone containing Foraminifera, Tetracoralla aged Lower Carboniferous Visean stage (C<sub>1</sub> v).

- Member 2: Grey, light grey, medium and thick-bedded, massive, oolitic limestone, containing Foraminifera fossils aged C<sub>1</sub>v - C<sub>2</sub>.

- Member 3: Light grey oolitic medium and thick-bedded limestone containing Foraminifera, corals aged Permian (P<sub>1,2</sub>). The thickness of Bac Son formation is 600-1,000m.

The section of the sediments reflects a sedimentary basin which became shallower and expanded in width. From the weak reducing environment in Early Carboniferous it passed to the oxidizing environment in Middle Carboniferous and Permian.

d) *Khe Giua formation (P<sub>2</sub> kg)*

This formation has a narrow isometric outcrop area, overlying sporadically the Phong Nha - Ke Bang limestone massif, 30-120m thick. It is mainly composed of light grey, black grey, thin to medium bedded limestone. In ascending order the following three members can be differentiated:

- Member 1: Light grey, ash grey limestone with breccia and siliceous pockets, containing large Foraminifera fossils: *Verbeckina verbecki*, *Parafusulina*.
- Member 2: Calcareous breccia, with cement being lime or siliceous lime
- Member 3: Grey, medium-bedded marl containing Fusulinida: *Nankinalla cf. orientalis*, *Lasiodiscus aff. teumuis*, *Pisolina cf. subspherica*.

Thus, the Khe Giua formation reflects a type of carbonate sediments of a residual basin which not only bears the inheriting character of the Carboniferous - Permian basin but also was affected by the block uplifting process, where the limestone of Bac Son formation was brecciated to pass to a new stage of development - the post Carboniferous - Permian orogenic stage.

#### 4). *Mesozoic orogenic stage*

1. During the Triassic - Jurassic stage the whole Phong Nha - Ke Bang area fell to the continental regime, where the Earth crust was subjected to the orogenic block uplift movements. In the North of the study area from Gianh river to Ca river the Earth crust was subsided forming a *marginal rift-type acidic volcanic - sedimentary basin*. The remaining part from Gianh river (Rao Nay fault) to Hai Van pass became a source of material supply to the surrounding seas.

2. In Cretaceous period, in the trend of orogenic uplift block movement there appeared again many pre-mountain, marginal and intracontinental basins (subsided block) of isometric, elliptic forms, half connected with the ocean in the East and in the West of Laos as well.

In the study area are recorded also two Cretaceous sedimentary basins belonging to Mu Gia formation (K mg) ở the SE and West of the Phong Nha - Ke Bang limestone massif, superimposing with unconformity on this limestone massif. The composition of the sediment complex in ascending order is as follows: monomineral, poly-mineral conglomerate, gravelite, coarse grain sandstone, intercalated with siltstone and claystone, weathered to become red brown, purple brown about 700m thick.

The sediments contain Bivalvia: *Plicatounio* sp., *Trigonioides* sp. similar to the fossils in Muong Pha Lan (Laos) aged Cretaceous. Thus, the sediments of Mu Gia formation is considered to be the youngest in the Phong Nha - Ke Bang outcrop area if the Quaternary sediments are excluded.

## 5). *Cenozoic stage*

### *a-Evolution of the Earth crust*

The Cenozoic stage is the stage of intensive tectonic activities as a turning point in the development history of Earth crust, with the formation of the East Sea, the inland mountains and the intra-mountain, pre-mountain and marginal (pull apart) basins and the basins on the continental shelf of Vietnam

The Cenozoic formations partially bear an inheriting character. But basically they involved the old geologic setting into a new tectonic mechanism to have the present topographic - geomorphologic picture.

The newly formed fault systems together with the reactivated old fault systems have transformed the old structural plan into the Cenozoic structural plan which continued changing up to present.

The continental crust was destroyed to form Dong Hoi intracontinental rift-type sedimentary basins, filled by a Cenozoic (Neogene and Quaternary) sedimentary complex with cyclic structure. Besides, the orogenic uplift movements of the area also occurred cyclically. These are two contrary movement directions as a necessary rule for the static balance of the Earth crust.

The present landforms in the Phong Nha - Ke Bang area are the effect of the Cenozoic tectonic movements due to the geomorphologic processes which have occurred throughout the last 65 million years and are expressed through the topographic level division. In the study area one can easily recognize 5 planation surfaces at various elevations as follows:

- The 1600 - 1400m topographic level is the relic of the highest and oldest planation surfaces. They are only developed on red color terrigenous sediments red aged Cretaceous of Mu Gia formation (K mg). This is the planation surface aged Paleogene which has been investigated and recognized throughout Indochina, corresponding with the first East sea spreading phase and the subsidence forming Eocene - Oligocene basins.

- The 1000 - 800m topographic level (in the West) and 700-600m (in the East) is the second topographic level, the evidence of planation in the second uplift cycle in Cenozoic. The surface of this topographic level is discovered owing to the remaining fragments of planation surfaces on top of the mountains composed of terrigenous rocks around the limestone massif and the top surface of the limestone mountains. The age of this level is determined as Miocene (23 to 5 Ma).

- The 600-400m and 300-200m level is the planation product of the uplift tectonic phase in Pliocene (5 to 1,6 Ma). This level corresponds with the Pliocene planation surface which is very popular and has been recognized by many researchers in Vietnam (Nguyen Can, Nguyen The Thon, Rezanov, 1969; Le Duc An, 1985; Nguyen The Thon, 1978, etc.). However, this surface has been only discovered at the margin of the limestone massif in the form of mountains composed of limestone intercalated with terrigenous rocks with relatively flat tops and round-top terrigenous mountains as well as ancient cliffs and ancient "suspended" caves at the corresponding elevation, with the indications of abrasion, dissolution of the ancient surface water currents.

- The planation surfaces with elevation from 100m downward in Vietnam in general and in Phong Nha - Ke Bang area in particular have been attributed to Quaternary (1,6 Ma to present).

By correlating with marine terraces, marine cliffs, river terraces investigated in Vietnam, it is possible to divide the planation surface levels and terrace generations in relation with various interglacial cycles in Quaternary as follows:

- 100-80m: corresponds with Gond - Mindel interglacial cycle, over 800 Ka (the end of Early Pleistocene),

- 80 - 60m: corresponds with Mindel - Riss interglacial cycle, over 300 Ka (Middle Pleistocene)

- 40 - 25 m and 25 - 15m: Riss - Wurmian interglacial cycle, over 70 Ka (beginning of Late Pleistocene)

- 15 - 6m: Corresponds with Flandrian transgression (occurring 18 - 4 Ka).

The above mentioned elevation levels are the evidences of the highly raised sea level action due to tectonic phases which occurred in each cycle (rhythm).

## Chapter 6

### MINERAL RESOURCES

Through research, geological surveys and mineral prospecting, many mineral occurrences have been found, comprising deposits, ore occurrences, mineral dispersion haloes, element dispersion haloes, mineral water, etc.... The mineral resources are divided into various types: metallic minerals, non-metallic minerals, fuel minerals, construction materials and other materials,

#### 6.1. METALLIC MINERALS

Although metallic minerals in the area have not large reserve, they are diverse, comprising: Iron, manganese, copper, lead, arsenic, gold, tin, tungsten, etc.

- **Ferrous metals:**
  - + Iron: is distributed in Khe Ngang, Thu Loc, Len A, Lang Ve. In general the reserves are small, with no economic value.. The largest ore occurrence is Thu Loc ore occurrence which is of deluvial genesis, occurring in the rocks of Long Dai formation, with a reserve of about 58660 tons, with grade of  $Fe_2O_3$  from 43,5% to 52,1%.
  - + Manganese: Occurs in the form of sediment, precipitation and dispersion haloes in Cat Dang, Kim Lu, Dong Van... Some deposits are of commercial prospect Dong Van manganese deposit, some others have not been investigated in detail. Dong Van deposit is of sedimentary-precipitation genesis. It occurs in the rocks of Cat Dang formation The grade of sedimentary content Mn is 3,02- 3,19%, that of precipitation Mn is 26,78-40,9%
  - + Vanadium: Occurs in the form of dispersion haloes, with no commercial value, being only the indication to prospect for native ore bodies or mineral assemblage in sulfide ore.
- **Color metals:**
  - + Copper lead: Mainly dispersion haloes, concentrated in Cat Dang, Song Nan, Xom Thon... areas, being the indications for prospecting of native ore or copper, lead bearing sulfide ores.
  - + Arsenic: The ore occurrence on top of Ngang pass, located in the area of quartzification and Pyritization zone, with hydrothermal genesis.
- **Precious metals:**

Gold has been found by panning. Gold dispersion haloes are mainly distributed in Ca Xen, Dong Cao, Co Poong La, areas and in the NW of the study area...The gold in the dispersion haloes is of no commercial value, and is only the indication for prospecting primary ore.

- **Rare metals:**

- + Tungsten: Is met in the form of random stones in Kim Lu and mineral dispersion haloes in Ba Tam. The grade of wonframite in the random stone ore in Kim Lu reaches 30%, in genesis they are related with hydrothermal quartz veins.
- + Mercury: Is distributed in Xuan Canh, Ba Don... in the form of mineral dispersion haloes. It occurs mainly on the rocks of Ban Giang ( $D_{2ebg}$ ), Muc Bai ( $D_{2gmb}$ ), Dong Trau formations ( $T_{2adt}$ ) and sediments of Quaternary system.

## 6.2. NON-METALLIC MINERALS

Well developed are optical, chemical, fertilizer and ceramic raw materials

- + Optical raw materials: Crystalline quartz has been found in Da Co in the form of random stone ore. The ore quality has not been evaluated in detail.
- + Chemical raw materials: Pyrite of hydrothermal genesis has been found, distributed in: Ba Loi, Dong Cay, Vuc Tran, Da Den... Besides, there is also pyrite in the form of heavy mineral dispersion haloes, met in the areas of Bong Nay, Rao Moc...
- + Fertilizers: Fertilizer raw materials rarely occur in the area, consisting mainly of phosphorite with small reserve, distributed in Khe Net, Minh Cam, Hang Chua..., accumulated in karst caves, with a total reserve of about 13300 tons. Phosphorite can be exploited for making fertilizers, serving the local industry.
- + Ceramic raw materials: Consisting mainly of quartz, kaolin, clay. Their prospectiveness has not been investigated in detail.

## 6.3. FUEL MINERALS

- + Peat: Has been found in Ba Don. Although the peat is of good quality, the reserve is small.
- + Oil shale: Ba Nuong deposit, located in the sediments of Muc Bai formation in Cay Da hamlet (Xom Nha), West of Quy Dat. With small reserve (60-70 tons), all has already been mined.

#### 6.4. CONSTRUCTION MATERIALS AND OTHER MATERIALS

- + Carbonate rocks: Distributed in many places in the area such as in Ha Trang Tang Hoa...Especially Ke Bang limestone massif occupies a large part of the area. The limestone present in Bac Son, La Khe, Cat Dang, Xom Nha... formations are of great potential, can be used for cement production, construction and as facing stone. Ha Trang deposit has a reserve of about 154300 thousand tons, Tang Hoa deposit occurs in the upper part of Cat Dang formation, 10-12km long, 200-300m wide, 150-200m thick, has been evaluated to be of great potential
- + Clay, kaolin: Are used for ceramic, brick, tiles, etc. Are well developed, with large potential. Clay distributed in Qui Dat, Ha Trang, Dien Loc...has large reserve form hundred thousands m<sup>3</sup> to tens of millions m<sup>3</sup>, in particular Dien Loc clay deposit has a reserve of about 45 million tons. The total clay reserve in the whole area is 85 million tons. Kaolin and quartz have not been investigated in detail. In general they are prospective and need more investigation.
- + Sand: is used for construction and glass production. Is well developed, but has not investigated in detail. Ba Don glass sand deposit has relatively pure sand quality and large reserve (not yet exactly determined). Building sand is widely developed in Paleozoic, Mesozoic sediments, however it has not been investigated in details
- + Mineral water: 2 sources have been found: No Bo and Dong Nghen. They are located closed to the faults, the mineral water has a temperature from 43 - 66°C, the TDS is over 0,48 - 14,28 g/l, pH = 6 - 6,5. The mineral waters here are of value both in terms of medical treatment and as energy source, but their potential has not been evaluated.

In general, the mineral resources of the study area are relatively rich, some are of commercial potential. They were formed from 2 genetic types, one related with the sedimentary genesis and one with hydrothermal genesis.



## Chapter 7

# CHARACTERISTICS AND EVOLUTION OF GEOMORPHOLOGY AND TOPOGRAPHY IN RELATION WITH NEOTECTONIC MOVEMENTS

### 7.1. GENERAL

The limestone mountain massif is located in the center of the area, is of relatively isometric form, about 30km wide and extends for over 60 km in sub-longitudinal direction. With the objective to investigate karst and caves for protection of the natural heritage, we find out that it is necessary to set the limit of the area by using the water divides of the rivers and streams flowing towards the limestone massif or the discharge zone of the area. With such awareness, the Ke Bang - Phong Nha area is limited in the North by the low mountain range with latitudinal trend from Nui Bo - Nui To to the East of U Bo mountain (North of Troc river). In the East the limit of the area is the West Dong Hoi dome-like mountain massif composed of intrusive rocks, the hill series and the coastal plain. The medium height Co Ta Roun - Co Choc mountain series separates this mountain massif from the Khe Ngang massif in the South. In the West, the Ke Nang limestone massif extends beyond the border, connected with Ma Ha Xai massif of the Lao People' Democratic republic.

Although in the central part, the limestone massif is of isometric form and not much differentiated, in general the Phong Nha - Ke Bang area has a differentiation in the direction of lowering from South to North and from West to East. The extreme South of the area is a medium mountain range with an elevation 1200 - 1600m, with gently undulated peak, extending in sub-latitudinal direction the West and NE - SW direction in the East. This is the catchment area for the limestone massif in the North. From South to North, the limestone mountain massif has a relatively uniform elevation, about 700 -900m, In the Northern margin, the low mountain range has an elevation decreasing 400 - 600m to 200 - 300 m towards Rao Nay valley (Fig. 7.1). From West to East, the Ke Bang limestone massif is exactly the water divide between the East and the West of Truong Son. The Vietnam-Laos border area consist of nearly equal limestone peaks with height of 800 - 1000m. In the area of Mu Gia pass exist also some mountain peaks 1200 - 1600m high, composed of red sandstone of Mu Gia

formation. From West to East, the limestone terrain is lower down to 600 - 700m and in the Eastern margin it passes to the levels of 400 - 500m and 200 - 300m. The topographic levels below 100m are composed of non-karst rocks popular in the East of the area.

Composing the Phong Nha - Ke Bang area are mainly the carbonate rocks aged from Upper Devonian to Permian, comprising Phong Nha ( $D_3-C_1pn$ ), La Khe ( $C_1lk$ ), Bac Son (C-P *bs*) and Khe Giua formations ( $P_2kg$ ), of which the Bac Son formation is most widely distributed, constituting the main area of the limestone massif. Taking part in the limestone massif catchment area for the limestone massif are also sandstone, siltstone, sericitic schist... of Long Dai ( $C_3-Sld$ ), Ban Giang ( $D_2bg$ ) formations and the red molasse sediments of Mu Gia formation ( $Kmg$ )...

The Pre-Cenozoic rocks in the area are strongly broken due to the faults with mainly NE - SW, NW-SE and sub-longitudinal trends and less commonly sub-latitudinal trend. These fault systems play an important role in the process of karstification to form superficial and underground karst features. Besides the valleys which are relatively clearly oriented along faults, close negative landforms in the limestone massif are also concentrated along the broken zones. Neotectonic movements with the generally uprising trend alternated with stable periods have promoted the karstification processes and other relief forming processes.

Of those factors taking part in the promotion of the karst process, mention should be made about the climatic factor. Phong Nha - Ke Bang area is located in a humid tropical zone with mean annual rainfall zone from 1800 - 2200mm and the annual mean temperature reaches 23 - 24°C. More over the rainy season here is concentrated from August to January, i.e. in the in the cool and cold period, so the dissolving capacity of the water is intensified.

With favorable conditions in terms of lithological composition, structure, texture tectonics and other factors, the karstification process in the Ke Bang limestone massif is intensively development, creating the diversity in the landforms as well as other natural landscapes..

## **7.2. CHARACTERISTICS OF LANDFORM TYPES**

### **7.2.1. Non-karst landforms**

Non-karst landforms are distributed around the Phong Nha - Ke Bang limestone massif, consisting of the following types:

- Medium-low dome-block mountain massif on granite distributed in the East of Phong Nha.

- Medium denudation-structural mountain massif on red terrigenous sedimentary rocks aged Cretaceous: comprise the mountain ranges in the area of Mu Gia pass and the Southern extreme of the massif. These are highest mountain ranges in the area (1200-1600m), playing the role as a water catchment for the limestone massif.

- Low block-denudation mountain range on terrigenous sedimentary rocks: These mountains are distributed mainly in the North of the area on the sedimentary rocks of Ban Giang suite ( $D_2bg$ ) with gently undulating water divide extending in sub-latitudinal direction (Photo 7. 1). In the West and SW are low mountains with gentle slopes composed of metamorphic rocks of Long Dai continent (Photo 7.2).

In Phong Nha - Ke Bang area, all of the above landform types are the catchment area supplying water for the karstification process and clastic materials (sand, gravel, cobble, pebble,...) which are deposited in the caves at present and were in the past. The extremely abundant water source from this large area also created many favorable conditions for the development of the living world in the caves in particular and in the karst area in general.

### **7.2.2. Karst landforms**

Karst topography is the most characteristic feature of the Phong Nha - Ke Bang massif. First, it occupies 2/3 of the heritage area. At the same time it is an largest the limestone massif in Vietnam which is relatively intact and, and its extends further qua Hin Namno of the Lao PDR. This limestone massif has a thickness of over 1000m, mainly composed of limestone aged Carboniferous - Permian, with high purity, with massive or thick-bedded structure. This is the condition ensuring that the karst evolution process to occur completely: From the stage with many small karst dolines to cone karst, then tower type and finally karst plain. The limestone formations in Phong Nha - Ke Bang area are in many aspects similar to the limestone in Ha Long bay, Bac Son, Ha Giang and South China. But these areas are located in the regions with tectonic regime, climate and

relationship with the non-karst landforms in the surroundings not similar to those of the study area. In Hà Long bay, the limestone massif is located at the margin of the continent adjacent to the sea. In Bac Son, Ha Giang, in general, the limestone massifs are distributed in the mountain areas, far from the sea and are higher than the non-karst landforms in the surroundings, whereas in Phong Nha - Ke Bang area the topography of the limestone massif is lower than that of the surroundings. The climate in Phong Nha - Ke Bang area is hotter and more humid than other areas (Table 7.2).

**Table 7.1: Annual mean temperature and humidity in some places with limestone in Vietnam and South China**

Climate factors	Vietnam				China	
	<i>Dong Hoi</i>	<i>Hon Gai</i>	<i>Lang Son</i>	<i>Son La</i>	<i>Guizhou</i>	<i>Guangxi</i>
Temperature (o°C)	24.9	22.9	21.0	21.3	15.3	21.0
Rainfall (mm)	2112	1994	1419	1400	1200	1990

The above reasons have made the evolution of the karst landforms in Phong Nha - Ke Bang area not completely similar to other areas, although this evolution occurs with the same mechanism of dissolution (by both surface water and groundwater) and mechanical destruction (slump and collapse on slopes and in caves). Due to this mechanism, many types of karst land forms have been created both on the surface and underground. Based on the topographic characteristics and the degree of karstification, the karst landforms of Phong Nha - Ke Bang massif into the following types :

- Medium block mountain massifs with conical peaks and high concentration of close negative landforms

This landform type occupies the main area of the limestone massif. So far there is still not much information on the landforms as well as their natural characteristics. The karst process of the limestone mountain massif is in the intensive stage. In the karst massif there are practically no more flat peak surface of a few m<sup>2</sup>, everywhere are seen only sharp karst peaks, steep slopes, karst dolines and shafts. The water flows in the limestone massif are mainly underground flows.

The diversity in the lithologic composition and geological structure, has led to the diversity in topography inside this karst massif. Besides the popularity of the karst landforms with sharp peaks, in the massif are distributed also low hill and mountain ranges with the water divides relatively gentle as they are developed on the non karst rocks of Khe formation ( $C_1lk$ ).

- Low residual karst mountain massif with conical peak steep slopes and extensive valleys

This type of landform is developed at the margin of the limestone massif, distributed in Phong Nha area, along Highway 20, Minh Hoa area, etc. They are characterized by small mountain massifs surrounded by extensive valleys, the slopes of the mountains create vertical cliffs on these valleys. Closed depressions are relatively common in this type of landform, they have large dimension, with a depth only about 100 m, and on their bottom are accumulated unconsolidated deposits. Due to the above characteristics, within this type of landform are often discovered many karst caves.

### **Types of karst landforms**

#### *a. Surface karst landforms*

Different from other limestone areas in Vietnam (Hà Giang, Cao Bang, Bac Son, Ha Long, Ninh Binh, Son La,...) the cone shape and tower shape karst landforms on the surface of Phong Nha - Ke Bang massif are not typical. But if one goes from the periphery to the center of the limestone massif, one can see a transition from the tower-shape karst to cone shape karst on the surface of this intensively dissected limestone plateau. As it has not been investigated in detail, the ratio between the height and the width (the diameter) of the base of karst cones and towers. The karst landforms distributed on the peaks and slopes of mountain massifs creating a ragged topography.

Closed negative types of landforms are another characteristic feature for the karst area. They are an important indicator to evaluate the degree of karstification. According to Vu Do (1980), the distribution density of closed negative landforms of the Phong Nha - Ke Bang massif is 3 - 6/km<sup>2</sup>, against that of North Son massif of 2 - 5/km<sup>2</sup> that of Dong Van - Moc Chau area of 0,5 - 3/ km<sup>2</sup>. The depth of karst dolines decreases from 200 - 300m in West to below 100m in the East where the bottom areas of these dolines vary in a reverse direction. The closed depressions in the East of the massif having bottom area of a few hundred m<sup>2</sup> to over 1km<sup>2</sup>

with the surrounding topography relatively ragged would be the places where the rich natural heritages can be well preserved.

In the Phong Nha - Ke Bang karst massif relatively common is the valley landform type formed by the leaching and solution of carbonate rocks. These valleys usually developed along tectonic faults and are involved in the process of connecting karst doline due to the collapse of underground cavities. The valley extends over a few hundred meters to over 5 km, creating ragged canyon topography, with bottom with very little or even no alluvial materials (which are usually distributed on the central part of the massif). (Photo 7.2). In the meantime, in the marginal areas, the bottoms of the valleys are expanded and filled by a relatively thick layer of alluvium (Photo 7.3, 7.4) and called border poljes. (Fig. 7.2). On these poljes usually there are rivers and streams. These rivers and streams are the agents bring water from the non-karst areas into the limestone area. At the locations close to the limestone massif usually appears deep pits filled with water (Photo 7.5). Such features can be observed clearly in Khe Gat, Cha Noi, in from to En caves.

There are also depressions surrounded by limestone massifs with relatively large areas such as in the Phong Nha area. Here, as the river brings constantly a considerable amount of unconsolidated materials, a relatively thick alluvium has quickly covered on the eroded limestone surface (Photo 7.6).

#### *b.Characteristics of karst caves in Phong Nha-Ke Bang area(Fig. 7.3)*

The Phong Nha - Ke Bang karst area has a relatively high rainfall. Besides, it receives as large amount of water from the non-karst areas, there are nearly surface flow in the area of the limestone massif. This evidences that the underground streams along the cave system in the area are intensively developed. So far, after 10 years, there have been 5 cooperation projects in cave exploration between the Faculty of Geography and Geology of the Hanoi University (before) and the Faculty of Geography, Hanoi Natural Science College and the UK Royal Speleological Association. The cave system in the Phong Nha - Ke Bang limestone massif have been discovered and surveyed with a total length of 80km. Practically all caves have rivers flowing in them, therefore Howard L. called them as "River caves". The river caves here can be divided into 3 systems: the Phong Nha cave system (from Khe Ry, En caves through Thung, Cha Ang caves and to Phong Nha cave with a total length of about 40 km); Vom cave system (from Ruc Ca Roong cave to Vom cave, with a total length of about

30km) and Ruc Mon cave system. Of these the Vom and Phong Nha cave systems are in Bo Trach district and all of them debauch to Son river, whereas Ruc Mon is located in Minh Hoa district.

The Phong Nha cave system originates from the Southern limit of the Ke Bang limestone massif. The main entrance of this system is Khe Ry and En caves, occurring at the elevation about 300 m above the sea level. The cave entrances are in general extensive and high. En cave has two entrances. The low entrance is the place with water flowing in, 15 m high and 7 m wide., the other entrance is at the elevation 50 m above the water current, is 70 m high and 100 m wide. The exit of this cave is 170 m wide and its height is estimated to be about 100 m. The cave entrances on this side are the places where in flow the streams which, originate from the high elevation area (elevation reaching 1,500 - 1,600 m a.s.l) developed on the non-karst rocks. Therefore, immediately at the cave entrance one can see coarse clastic sediments (cobbles - pebbles). The Khe Ry, En, Thung caves form the upstream part of Phong Nha cave and are distributed in a dendritic form. The common direction of these caves is NE - SW. The sections of these river caves may be developed along the fractures appearing in the limestone massif.

The Vom cave system is also a modern river cave, which has a considerable extent in the Phong Nha - Ke Bang massif. This system starts from Ruc Ca Roong cave which is an elevation of about 360 m above the sea level. The whole this system has the common direction from South to North, developed along a main fault in the area. The Ruc Ca Roong river flows towards the downstream, now hidden in the caves, now reappears again in the narrow and deep valley sections to finally debauch into Chay river in the entrance of Vom cave (Photo 7.8; 7.9). Both of these two river caves merge with each other to debauch into Son river, and then to Gianh river to finally debauch to the sea which is about 50 km away.

The above characteristics show that both of these cave systems have their entrances and exits which are the water level in the current rivers and streams.

This can be considered a river cave system with largest extent in the Asia ever discovered so far.

In morphology, most of caves are high, wide, in the caves there are many branches and extensive rooms. Therefore most of caves have relatively complicated, for example Duat, Tiên caves....The cross sections of the modern river caves are of relatively isometric form and the caves are classified to the

phreatic type (which is a type of cave classified according to the relationship with the regional groundwater level) (Photo 7.10) and has been developed through many cycles. The multi-cyclicality of the caves is also expressed in the cave levels as well as the water levels at the cave entrance. So far at least 4 entrance levels have been discovered (according to the relative height): The 0m level is the present river and stream level; the  $20\pm 5$ m level, the  $40\pm 10$ m level and the  $90\pm 10$ m levels. All of these 4 entrance levels were certified in Over cave belonging to Vom cave system (Bo Trach district) with the concrete heights as follows: 0,0m; 24m; 43m and 93m.

In the caves there are many speleothems forming stone troughs, stalagmites and stalactites, stone columns, stone laces, stone flowers with beautiful colors and shapes. The bottoms of En, Khe Ry, Dai Cao, caves there are distributed clastic deposits such as cobbles, sand cemented with lime.

Through the resemantation above, the caves in the Phong Nha - Ke Bang limestone massif can be distinguished into two types: active caves and fossil caves.

- Active caves are the river cave system which has been mentioned above are at the lowest cave level in relation with the groundwater water level (the present basic regional erosion level).

- Fossil caves in turn are divided into:

+ Old phreatic caves that now have been freed from the present groundwater level. In these caves there are many stalagmites and stalactites such as Tien cave, (Cao Mai) cave, Tien cave, Dry Phong Nha cave, etc. The caves of this type mainly occur on high levels. At some entrances of this type of caves at the high levels relics (such as bones, teeth of animals, snail shells, fragments of crockery, etc), have been discovered, which shows that ancient that these caves have been populated by ancient people.

+ Old karstic mountain foot caves, being the horizontal caves, formed when the fooms of the limestone massifs were submerged in water in the Phong Nha - Ke Bang area. Practically no speleothems are found in these caves. These caves are met on the second cave level. Typical are Hang Chay (here during the war it was used to cater a soap factory, therefore it is also called Xa Phong cave), the Brewery cave (the true name unknown) (Photo 7.11; 7.12).

### **7.3. GEOMORPHOLOGIC EVOLUTION IN PHONG NHA - KE BANG AREA**



To create a diversity of the landforms and the magnificence of the karst landscapes, Mother Nature has spent a long period of time with its particular rules and has left behind typical relics: the horizontal surfaces (planation surfaces) river terraces, marine terraces...), cave levels, sediment layers in basins their ages. Before restoring the geomorphologic evolution these relics must be reviewed.

### ***7.3.1. Relicts of the topographic evolution process***

As referred to in the above parts, the topography of the study area has a clear step character. The existence of 5 planation surfaces within the mountain area has been determined. The 1400 - 1600m topographic level is the relic of the highest and oldest planation surfaces in the area. They only develop on the red terrigenous sediments of Mu Gia formation (*Kmg*). This is the Indochina planation surface aged Paleocene which has been recorded in many literatures. Although no wide residual fragment of this surface are preserved, the nearly equal peaks of 800 - 1000m in the West and 600 - 700m in the East are themselves relics of an intensive planation process which exposed on the surface the Ke Bang limestone massif. The age of this surface has been determined to be of Miocene. The planation surfaces of 400 - 600m, 200 - 300m aged Pliocene are distributed at the margin of the karst massif and the pediments of 80 - 100m aged Early Pleistocene occur in the transitional area between the mountains and the coastal plain. The planation surfaces on the mountains in the West of Quang Binh are correlated with the rhythmic sediments containing palynological remains aged Mio - Pliocene of Dong Hoi formation.

On the coastal plain the existence of river and marine terraces has been determined with their number and heights correlated with cave levels as mentioned above. The first cave level is closely link with the modern erosion base, the 4 - 6m is correlated with the high flood plains of rivers and streams, the 10 - 15m level corresponds with the first terrace aged the end of Late Pleistocene, the 20 - 40m level corresponds with the second terrace aged the beginning of Late Pleistocene and the 40 - 60 m corresponds with the third terrace aged Middle Pleistocene.

### ***7.3.2. The geomorphologic evolution of the area***

After the process of accumulation of the red sediments of Mu Gia formation in Cretaceous, the Phong Nha - Ke Bang area was raised up and the main process was denudation. The "rhythmicity" of the neotectoni movements in combination

with the periodicity of the world ocean level fluctuation have led to the diversity of the topographic and karst levels.

The intensive planation activities in the whole territory during Oligocene has led to the formation of an extensive peneplain, which now still reserved in residual forms on the peaks of 1200-1600m. The neotectonic movements of the area which might have occurred at the end of Paleogene- beginning of Miocene have led to the intensive dissection of the peneplain surface. The initial stage of the karst processes which are still preserved today may have been Middle - Late Miocene, when the denudation and planation process had removed a considerable amount of covering formations aged Cretaceous and exposed the carbonate formations which had been overlain by the red color formations (it is either not excluded that below this cover there existed a karst landscape which have not discovered so far. Periods of intensive tectonic activities alternating with relatively calm periods in Pliocene has contributed to the formation of planation surfaces which are at present the relics of peaks with elevation 400 - 600m and 200 - 300m in the marginal part of the limestone massif (Fig. 7.4, Photo 7.13).

In the Quaternary period, the transgressive and regressive cycles occurring at the end of Early Pleistocene, Middle Pleistocene, Late Pleistocene, Middle Holocene combined with neotectonic uplift movements have created cave levels which are now distributed on various elevations. Noteworthy is that at the Eastern margin of Phong Nha limestone massif the karstification process which occurred during the regressive period at the end of Middle Pleistocene have created a relatively extensive marginal karst plain, however, a large part of this surface has been covered by the mixed alluvial-marine sediments of the transgressive period at the end of Late Pleistocene (Photo 7.14; 7.15; 7.16). How is this relationship in the Phong Nha - Ke Bang area needs further investigation for clarification.

#### **7.4. CONCLUSION**

From the presentation above one can see that the Phong Nha - Ke bang limestone massif is one of the large karst massifs not yet intensively dissected in the SE Asia region. Here various cave levels have been discovered at various elevations. This proves that the Phong Nha - Ke Bang limestone massif has had a very long geomorphologic evolution history which has undergone many stages. This is also proved by the multi-phase structure of the caves. At present, karst process is intensively occurring in the favorable conditions in terms of lithology, tectonics,

climate, which have created a diversity in landforms and natural landscapes. Therefore the detailed investigations to come will let us know in more detail the significance of the karst geomorphologic processes in the condition of hot and humid tropical climate. This is not only of regional significance, but also of great international significance to answer the question: Why in the Phong Nha - Ke Bang limestone massif there is no typical cone-shape and tower-shape karst features as in China or in the North of Vietnam and other areas.

Although there are already some initial results in karst geomorphology in Phong Nha- Ke Bang area, due to the large extent of the limestone massif and the diversity of the karst topography both the surface and in caves which are mainly long river caves and due to the raggedness of the area, there may be many unknown locations. The above results are only those obtained in the easily accessible locations. This emphasizes more the importance of the Phong Nha - Kê Bàng limestone massif for our knowledge about the karst areas worldwide. On the other hand, also due to this reason the conservation of the diversity of the nature including geodiversity and biodiversity is still quite good. Therefore the conservation of karst landscapes in this area will bring more scientific and practical significance.

## **7.5. SOME REMARKS AND COMPARISON WITH OTHER KARST AREAS WORLDWIDE**

So far many karst areas world wide have been recognized by UNESCO as world natural heritages, including the Ha Long bay in Vietnam. It can be said that all of these heritage areas have their peculiar features and these features are practically not similar. However, practically all world natural heritages with karst landforms are located in the temperate zone, with more concentration in Europe and North America such as the Pirin national park in Bulgaria, the Plitvice lake national park in Croatia, Skocjan caves in Slovenia, Dales - Yorkshire national park in the UK, the Aggtelek and Slovak cave areas located in the border area between Hungary and Slovak, the Carlsbad cave national park and Mammoth cave national park in USA, the Tasman wilderness in Australia etc. All of these areas in their development history have been subjected to great impacts of glaciations, especially the glaciation cycles during the Quaternary period. The imprints of these glaciation periods are still expressed rather clearly in the superficial karst

landforms: the gentle appearance of limestone massifs, outlines of karrens, many lakes and relatively deep and steeply sloped uvalas. On the other hand, as most of them occur on ancient continents and far ways from the modern dynamic belt (the boundary between lithosphere plates) the carbonate formations in this area have gently dipping or nearly horizontal attitude and overlie with clearly angular unconformity the other formations. Besides, they are in the area with higher topographic elevation than the surroundings. Therefore in this area there are many beautiful waterfalls. Also for this reason, the caves here have considerable depth. Among these national parks recognized as world natural heritages, the cave area of the Aggtelek and Slovak karst massifs are considered to be typical temperate zone karst systems.

The Phong Nha - Ke Bang area is quite different from the above heritages. These differences are decided by two factors: the geological structure and the climate. The Phong Nha - Ke Bang area is located in the Alpine orogenic belt, a young mountain belt intensively developed in Cenozoic. Therefore the limestone massif here is rather strongly deformed due to faults and fractures. Besides, the Phong Nha - Ke Bang limestone massif is located in the region of tropical monsoon climate. Therefore the karst phenomena in this area are not similar to those in the temperate zones both in the intensity of the karst process and in the landforms it creates (on the surface as well as underground). In this aspect the Phong Nha - Ke Bang area has many common characteristics with the tropical karst areas.

In the tropical zone in general and in Asia and SE Asia in particular, some national parks have also been recognized by UNESCO as world natural heritages, such as Gunung Mulu national park in Sarawak of Malaysia, Lorents national park in West Irian of Indonesia etc., and many other karst areas in SE Asia have been investigated rather in detail.

The Gunung Mulu national park is located in Sarawak, a province of Malaysia in Borneo island. Present in this national park is a coralline limestone accumulated within the time period from Middle Eocene the end of Early Miocene with a very considerable area.

Such a circumstance is also described in Baliem river in Lorents national park, West Irian, Indonesia or other areas of Papua New Guinea - Both of these areas are on New Guinea island and part of New Britain island. These areas also have humid equatorial climate with both annual mean temperature and rainfall being

high. The limestone here are also aged from Oligocene to Miocene with a thickness over 1000m. In West Irian, Baliem can also be considered as one of large underground rivers in the world, with an average flow of about 100 m<sup>3</sup>/s and up to about 400 m<sup>3</sup>/s during the rainy season and is at the bottom of a shaft (a karst doline) as deep as 200m. In this underground river there is also a room with a volume of about 45.000m<sup>3</sup>. In New Britain island of Papua New Guinea there is a swift river with a length of near 4km. The superficial karst landforms in this area are covered by thick tropical forests. The openings of large karst dolines can be observed from a helicopter.

Another karst area in Indonesia is located in the East of Java island is Gunung Sewu area, with cone-shape landforms, the base diameter is as much as 4 times greater than the height. Besides, here there are also up to 17 caves, groups into different systems, where the Lweng Jaran system is the longest in Indonesia, with a total length of over 18 km.

Lets turn back to other areas in SE Asia. Most of AE Asia countries are located on the continental part with limestone, of which more considerable are Laos, Thailand and Vietnam. As for Laos in particular, there still not many results of karst and cave investigation. On the other hand, limestone is concentrated only in the Middle Lao region, where there is a connection with the Phong Nha - Ke bang limestone massif of Vietnam. In Thailand, limestone is also present in some national parks, such as Trung Salaeng. Most of limestone here is aged Permian, similar to many places of Vietnam and China. However, limestone outcrop area in Thailand is not much. Besides, Thailand has tropical climate, the karst formations here are very developed. On the surface the limestone areas are all covered by the tropical forests and there are developed rather many tower -shape karst features. However, most of limestone area here is divided by streams into separate blocks. As the cave system here is also very developed, including the active caves (such as Tham Nam Lang - river cave of foreigners - with a length of near 3000m).

Although in Thailand there are many caves, they are distributed in many different areas. Therefore the total length of caves in an area is not large, although there are many beautiful scenes in thick caves such as Tham Nam Lang cave (in Mae Hong Son area, North of Chiang Mai). Probably this area is the one with largest total length of caves in Thailand (about 40 km, as of 1992). Whereas in Vietnam, the Ha Long world natural heritage recognized by UNESCO in 1994 is itself a

rather special area. According to the way the geomorphologists call it, Ha Long is one of the typical coastal karst areas in the world. Therefore T. Waltham has considered that the limestone landscapes in Ha Long bay are of international significance and of great importance for the geomorphologic science, as all cone-shape and tower-shape karst landforms ancient and active caves are present here. Besides, the researches on karst and caves in the NE of Vietnam, although still not in detail, have shown the uniformity in age of the limestone here, as well as in Phong Nha - Ke Bang area, and the cone-shape and tower-shape karst landforms are very common, the caves are many in number but are all short.

From the presentation above, one can see that the Phong Nha - Ke Bang limestone massif in comparison with other world natural heritages which have been recognized by UNESCO, as well as other karst areas, has its particular characteristics which are practically not repeated in other areas. They reflect some certain aspects of the geodiversity and biodiversity which bear the tropical character and Vietnamese specific features.

- The limestone has very old age from Devonian to Permian
- The karst caves are peculiar “river caves” formed in a very old times (Oligocene), 36 Ma, creating 7 levels corresponding with 7 topographic levels (planation surfaces) due to the uplift tectonic phase: Oligocene, Miocene, Pliocene, Early Pleistocene, Late Pleistocene, Early- Middle Holocene (Table 5.1)
- The Phong Nha - Ke Bang area has both common characteristics with the above mentioned area and its specific features. In terms of area, the Phong Nha - Ke bang limestone massif has largest area in Vietnam. If the limestone area in Laos is also included, this area can be considered as largest limestone area of SE Asia.
- The limestone has massive and thick-bedded structure (with the thickness of the limestone layer reaching over 1000m), with very old age (from Devonian to Permian), distributed in the area with tropical climate with the widespread of ever green wide-leaf forests. In topography the limestone massif is lower than the surrounding areas composed of non-karst rocks. These conditions have made the Phong Nha - Ke Bang karst massif become more diverse and complicated, wider, older, and more prominent in many aspects in comparison with other areas in SE Asia.

## CONCLUSION

1. The Phong Nha - Ke Bang area and its surroundings has a long geological development history

- A Vuong formation ( $\epsilon_{av}$ ) is characterized by carbonate sediments alternated with terrigenous ones, formed in the deep sea environment and have been metamorphosed..

- Long Dai formation ( $O_3 - S_1 ld$ ) is composed of metamorphic sedimentary rocks: biotite-sillimanite gneiss, two-mica quartz schist, quartzitic sandstone, shale containing Graptolite of deep sea facies.

- Rao Chan formation ( $D_{1rc}$ ) is composed mainly of sericitic shale calcareous shale of black grey color, containing bitumen, quartzitic sandstone and black massive limestone containing corals. The sedimentary basin was expanded and become shallower than in the Ordovician-Silurian periods. However in horizontal direction the bottom of the basin is clearly differentiated.

- Ban Giang formation ( $D_{2c}bg$ ) is composed of quartzitic sandstone, black shale siliceous shale in pocket form, belonging to the deep sea facies. The basin is narrow, deep, in a linear form.

- Muc Bai formation ( $D_{2g} mb$ ) is composed mainly of limestone, calcareous shale of black color containing bitumen, intercalated with mudstone, in some places with siliceous pockets. The sandstone contains pockets turbidite limestone formed on the steep continental slope, showing a type of deep basin with differentiated bottom.

- Dong Tho ( $D_{2g} - D_{3fr} dt$ ) is composed of quartz sandstone, siltstone and shale containing bitumen, of black color, belonging to calm close sea facies, with predominantly reducing environment.

- Cat Dang formation ( $D_3 cd$ ) is mainly of carbonate composition: Banded and motley limestone, intercalated with siliceous limestone, containing Conodonta fossils belonging to deep water facies with bottom currents.

Phong Nha formation ( $D_3 - C_1 pn$ ) is composed of 3 members:

Member I: Grey massive limestone

Member 2: Grey, medium-bedded limestone

Member 3: Terrigenous rock intercalated with siliceous rock

- La Khe formation ( $C_1 lk$ ) is composed of limestone, marl intercalated with siliceous rocks, calcareous shale containing organic matter, with black color, containing Foraminifera and Brachiopoda belonging to not very deep marine facies, in narrow linear basins on continental shelf.

- Bac Son formation ( $C -Pbs$ ) is composed of black limestone (Lower member) containing Crinoidea stems, Conodonta, belonging to deep water facies, passing upward into light color limestone containing Foraminifera, shallow sea Coralla, (platform type).

- Khe Giua formation ( $P_2 kg$ ) has small amount of black grey thin-bedded limestone containing large size Foraminefera.

- Mu Gia formation ( $K_2 mg$ ) is composed of quartz conglomerate, calcareous shale and silty sandstone of red brown color.

- Cenozoic Sediments, formed in intra-mountain basins pre-mountain marginal rifts, corresponding with the period of intensive uplift tectonic movements. This is also a historic landmark initiating a period of forming the peculiar limestone karst caves and river caves in Phong Nha - Ke Bang corresponding with abrasion terraces, cave bottom levels and water level marks with various elevation on the limestone cliff.

- In Quaternary period very typical sedimentary entities and landscapes were formed: coastal sand levees with various ages from Sen Thuy to Ba Don, lagoons (Bau Tro lagoon and dry lagoons South of Dong Hoi) and plains such as Le - Ninh due to the incomplete filling of wide inland lagoons.

2. The landforms in Phong Nha - Ke Bang area consists of two basic types:

- Non karst landforms: Dome-like mountain and hills formed by intrusive and terrigenous rocks.

- Karst landforms: Cone-shape landforms including the close negative landforms with steep slope, with development of karst dolines and shafts, residual limestone landforms, with pointed-peaked tower shape and small cone shape, elevated above the Quaternary karst plain and underground karst landforms.



**Appendix 3a**

**DESCRIPTION CAVE OF  
PHONG NHA - KE BANG NATIONAL PARK**

## **Appendix 3a**

### **DESCRIPTION OF PHONG NHA CAVE SYSTEMS**

#### **Background**

Phong Nha Cave has known in Vietnam for long time as the best cave landscape. Before the World War II, the Phong Nha Cave was organized to visit. There is a tourist house on the bank of Son river, 100m far from the Cave entrance. Tourist may go to the cave entrance by boat along the Son river for about 6km.

Up to 1990 Phong Nha Cave was only known with underground stream running out to Chay river. It was assumed that many unknown caves below the tropical dense wet evergreen forest on the spacious limestone.

After 1990 many investigations of British Caves Research Association (B.C.R.A) was made in Phong Nha. Some of caves have been found out and declared in Phong Nha.

#### **I. The Position of Phong Nha Cave System in the Vietnam' s Cave System**

There is 1.150.000 ha of total limestone area in Vietnam, distributing in provinces: Cao Bang, Lang Son, Thai Nguyen, Quang Ninh, Ha Giang, Son La, Hoa Binh, Ninh Binh, Thanh Hoa, Nghe An, Quang Binh and Kien Giang. Many caves were surveyed and assessed in these provinces. Some of them have opened for visitors as: Pac Bo (Cao Bang), Dong Puong, Dong Tham Khit, Dong Na Phong... (Ba Be), Dong Tam Thanh (Lang Son), Dau Go, Bo Nau (Ha Long), Dong Hoa Lu, Bich Dong (Ninh Binh), Dong Nguoi Xua, Dang Cave, Thanh Minh Cave (Cuc Phuong), Hon Chong Cave, Chua Hang (Kien Giang)..... Each cave has its own beauty. If we compare some characteristics of cave such as:

- The abundance and density of caves in each area

- The vertical range

- The length

- The length of the rivers flowing inside the caves

- The Complex structure

- The Width of tropical primary forest covering surface around the caves

Phong Nha Cave system is the best one in the Vietnam' cave systems in the limestone areas.

#### **II. Assessment of Phong Nha Cave system**

According to Nguyen Quang My (Vietnam National University), the length of the Phong Nha Cave System has surveyed 64,385m (information up to April 1997).

Based on this data, the Vom Cave is the longest cave in Vietnam. This is listed by International Speleological Union (ISU) as one of the Asian longest caves.

The caves are very complicated structure with many tributaries and inlets of inside rivers. Each tributary or inlet is splitted into many chambers with different size varies from 10 to 50m wide, 10 to 80m vertical range.

#### List of cave system in Phong Nha area

Order	Name of cave	Commune	District	Length of caves (m)	Vertical range (m)
<b>Phong Nha cave system</b>				<b>33,758</b>	
1	Phong Nha Cave	Son Trach	Bo trach	7,729	83
2	Hang Toi	Son Trach	Bo trach	5,258	80
3	Hang E	Thuong Trach	Bo trach	736	-
4	Hang Cha An	Thuong Trach	Bo trach	667	15
5	Hang Thung	Thuong Trach	Bo trach	3,351	133
6	Hang En	Thuong Trach	Bo trach	1,645	49
7	Hang Khe Tien	Thuong Trach	Bo trach	520	- 15
8	Hang Khe Ry	Thuong Trach	Bo trach	13,817	120(+58-62)
9	Hang Khe Thi	Thuong Trach	Bo trach	35	- 20
<b>Vom cave system</b>				<b>30,627</b>	
10	Hang Vom	Thuong Trach	Bo trach	15,050	145
11	Hang Da Cao	Thuong Trach	Bo trach	1,645	28
12	Hang Duat (Maze cave)	Thuong Trach	Bo trach	3,927	45
13	Hang Pitch	Thuong Trach	Bo trach	1,500	60

14	Hang Ho	Thuong Trach	Bo trach	1,616	+ 46
15	Hang Over	Thuong Trach	Bo trach	3,244	103(+93-10)
16	Hang Pygmy	Thuong Trach	Bo trach	845	- 94
17	Hang Ruc Caroong	Thuong Trach	Bo trach	2,800	45

### III. General description of Phong Nha Caves

#### A. Phong Nha Cave system

##### 1. Phong Nha Cave

Length: 7729

Vertical range: +78m -5m

Explored by British Speleological, 1990,1992

Phong Nha Cave is only one of cave systems used for tourist destination. The tourism has been presented two phases: phase 1 from 190-1930 to 1945 and phase 2 from 1990 up to now.

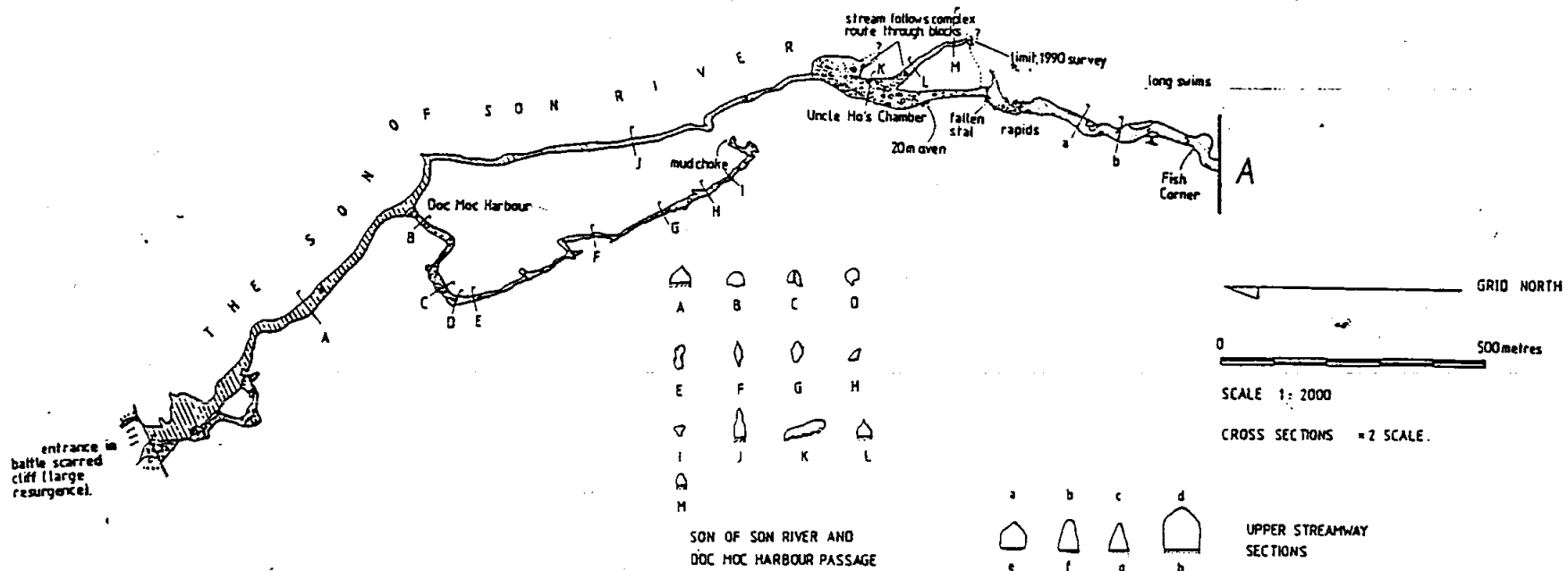
Under the Mac dynasty in XVI century, the author of "O Chau Can Luc" book has written that the Phong Nha Cave could be more beautiful than the Dao Nguyen Cave (Heaven's Cave) which is the folk legendary history. He was the first author written about the wild of vegetation of this area 500 year ago. That is the best article of literature aspect up to now.

In phase of 1920-1930 the Governor-general palace started organizing for visitors to visit the Phong Nha Cave. There was a tourist office (Tourist colonial en Indochine) that was led by Philippe Eberhard a head of General delegation (Le Delege General). Some folder paper was published to promote the Phong Nha tourist and inform the cost of services: boat, acetylene lamp, guide etc. At that time, there was a guess house near the outside entrance.

Phong Nha Cave was described by D. Limbert in Vietnam Cave 1990 & 1992 as:

"... In the near future visitors to Vietnam will be taken to visit this amazing cave. I am sure it will become one of the great tourist caves of the world...."

From its war scarred entrance Phong Nha Cave is usually explored by boat. This 1.6 kilometre paddle is a great relaxing start to this magnificent river cave. Passing through the large and beautiful Uncle Ho's Chamber with many fine formations you meet the river again. A huge sporting river passage is followed



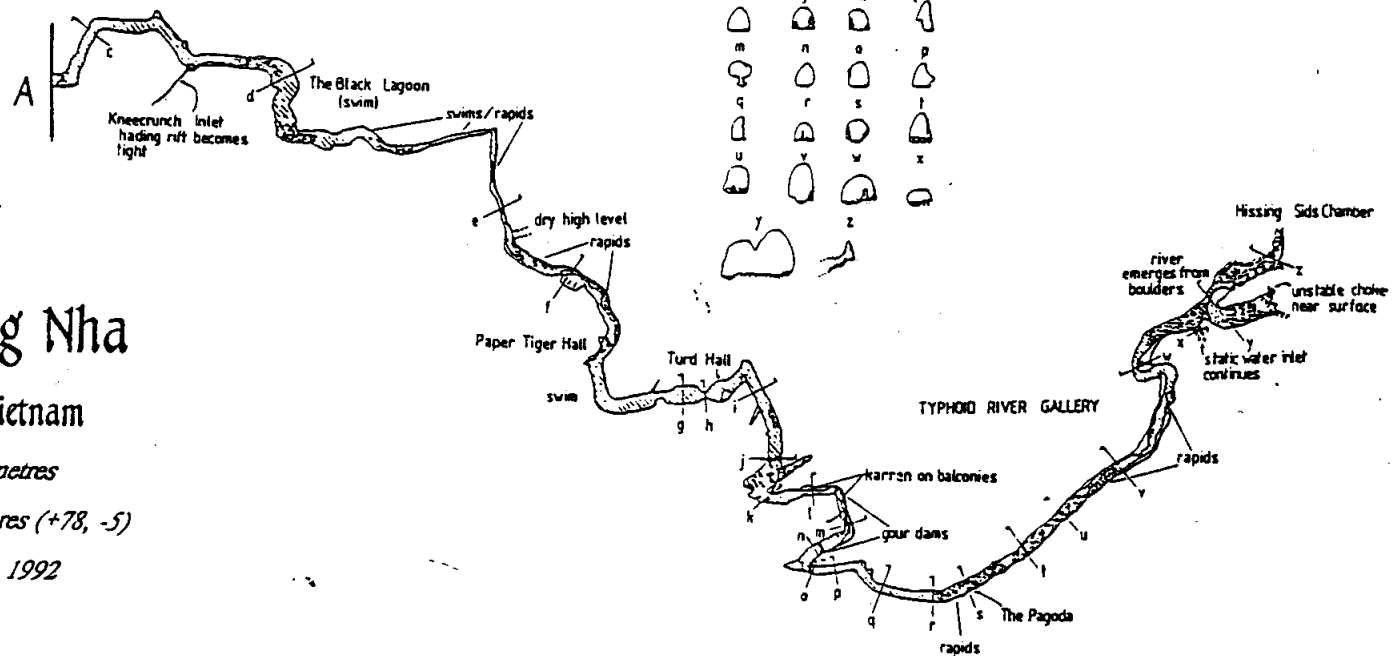
# Hang Phong Nha

Quang Binh, Vietnam

Length 7 729 metres

Vertical Range 83 metres (+78, -5)

Explored 1990 & 1992



with many rapids. The next 6 kilometres is tremendous river passage with swims, wades and a number of rapids intermingled with gravel and sandy banks.

.... Phong Nha is a spectacular river cave. The first 1.5km can be covered by the Doc Mocs (sampan), or when totally necessary by the rubber dinghy! Apart from dry oxbows and a side passage, there are no other dry passages in the main streamway and the only alternative would be to swim the whole 1.5km. 700m into the cave a large sandbank is found on the right. Disembarking here, we followed steeply ascending phreatic tube which was 10m in diameter. The top of the ramp led into the total of 1.5km of well decorated phreatic passage. The locals had explored this for five hundred metres where they were stopped by a climb that we rigged. This 6m drop and several short climbs were descended to more passage and eventually a stalagmite choke.

Continuing along the main river a large boulder fall is encountered, which blocks the river at 1.5km. Leaving the boat we climbed over and between the house-size boulders, (again the locals had been this far), and entered the huge chamber surveying round the right hand wall we dropped down the other side of the choke and into a stream again. From the chamber, which is at least 90m wide there are several ways off. From the top of the slope a drop down over boulders required a rope, so it was not pushed. The third route leads back into the upstream continuation by a different route to the surveyed passage. From the boulder choke the surveyed route leads after 300m or swims to the junction of the other passage of main river.

As time was running out, a quick push at the main streamway was made to assess the requirements for a return visit. A small rapid is reached immediately but this is soon passed. The flow of the water is generally quite strong, making swimming fairly hard work but not impossible. The next section can be passed quite easily on the side for a couple of hundred metres. It is then possible to lead the water and traverse the rocky left hand side for about 100m. Here you can follow the superb dry sandy oxbow or continue in the stream. The oxbow is 8-10m wide and 8m high for about 100m. A long section of swimming follows with no easy means of traversing the walls. In a couple of places large blocks have dropped into the streamway creating rapids where the stream is forced into narrow channels. These are the only tricky bits hard work going up, but fast coming back downstream! The passage was left wide open at the first convenient point to get out of the river. There was an estimate of 1 km unsurveyed...."

## 2. *Hang Toi (Dark cave)*

Length: 5258

Vertical range: 83

Explored by British Speleological, 1990, 1992, 1993

From the entrance of the Phong Nha Cave, returning its main river passage to the T-junction of river, that is the Son river. Continuing about 2km up along the Chay river, you meet the Hang Toi on the left hand. The fine river water passage that

seems to be no polluted with very clean and green coloured water. The Hang Toi is located near the guard station of the Phong Nha Nature Reserve. There are the high vertical rocky walls on the both sides of the river. Some herds of leaf monkey usually arrives to sleep over night on the rocky walls 2 or 3days.

Hang Toi described by H. Limbert in Vietnam Cave Report 1990:

"... Wetsuits are definite advantage due to the extensive swimming. We intend to have more dinghies on our return to ease surveying and photography.

... Taking the motor boat further upstream on the Son river, a second inlet on the left is met. This is the Chay river. After about 1km up, this inlet the river enters a gorge. On the left a large cave entrance is seen. This is the Hang Toi or Dark Cave. The entrance is 20x30m dimensions. Several small lakes are passed involving short swims. There are many side passages (only 2 surveyed), and after 800m the foot of an immense boulder slope is reached. The boulder slope is 50m high and leads into a chamber 500m in circumference. Straight ahead in this chamber leads down the boulder slope for a short way in a large passage involving clambering over massive blocks reach a junction with the stream. Turning right in the chamber leads down the boulders to a balcony overlooking the streamway. A phreatic passage here 20m in diameter with massive stalagmite bosses leads to an easy but exposed 25m climb down to the stream.

The river passage is huge, in places more than 50m wide. Initially the stream meanders through gravel banks then follows 200m of boulders and sharp solution pockets. Eventually easy working passage with a gravel and mud floor is reached.

The next obstacle is a series of lakes which have to be swum. The first, also the longest, is 120m. These lakes are separated by small boulder piles. Beyond the lakes 500m of large passage leads to the upstream entrance. Throughout this section there is great deal of flood debris, fish and insects. The draught is also in credibly strong. The stream is followed for a short way on the surface before jungle became too dense. This entrance and the resurgence entrance had also been shelled. On our third trip into Hang Toi we were other concerned to find water flowing into the entrance and enlarging the lakes somewhat. It was at this point that we realized that the Son river which flows directly to the sea was also tidal and the level had risen 1m. Due to the very low water levels in Hang Toi it had temporarily become a sink!..."

### 3. *Hang E (E Cave)*

Length: 736

Vertical range: 0

Grid - Ref: 653.0E 1940.1N

Explored by British Speleological, 1994

# HANG E (THE DRAIN.)

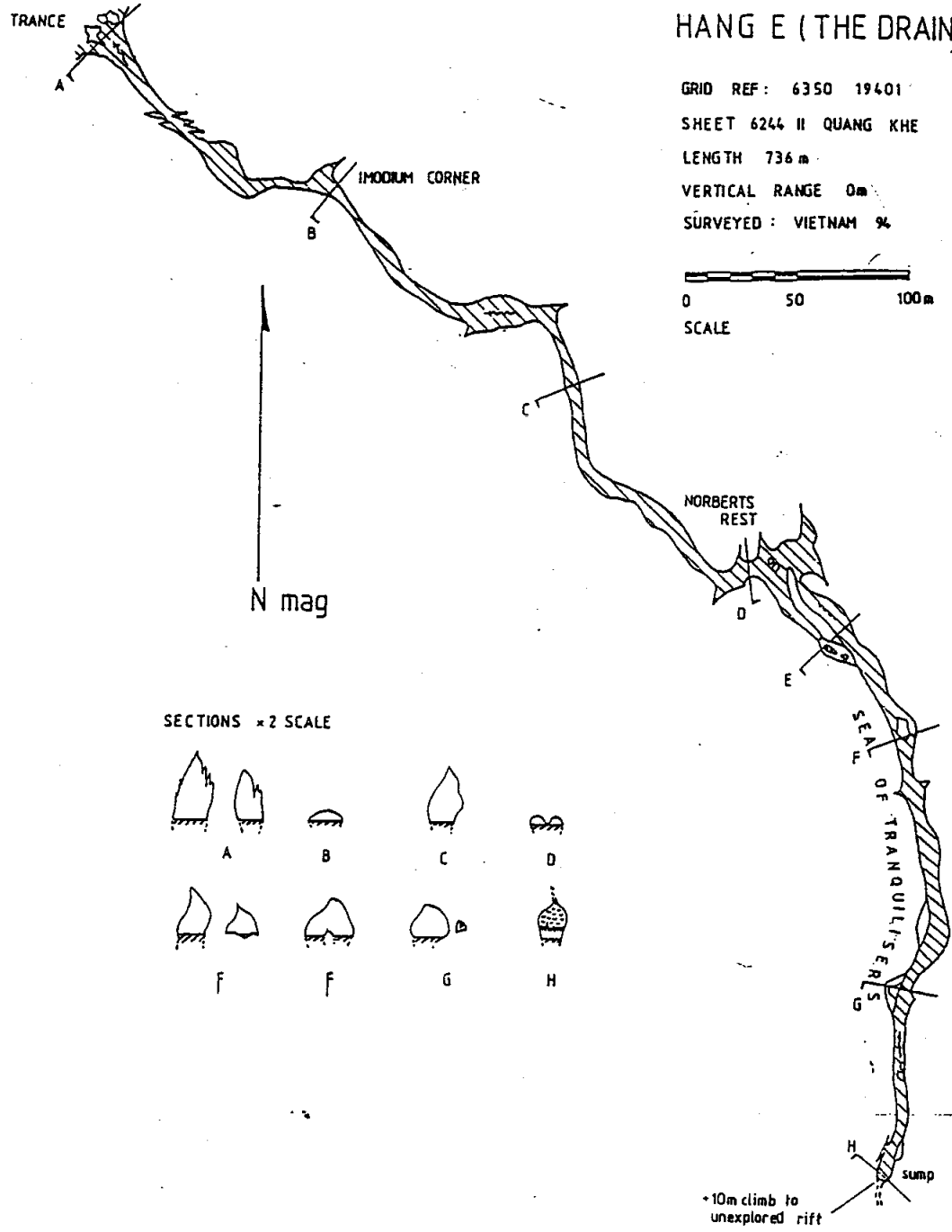
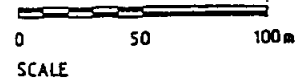
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SHEET 6244 II QUANG KHE

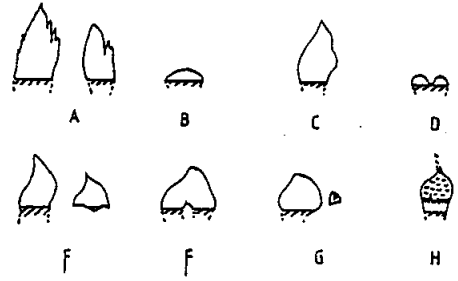
LENGTH 736 m

VERTICAL RANGE 0m

SURVEYED: VIETNAM 94



SECTIONS x 2 SCALE





Hang E is located in the East of Phong Nha Cave. There are two ways leading to the Hang Toi. The first one could be continued from the Hang Toi. The second one could be started from the National road number 20 (Ho Chi Minh Trail).

Continuing from the Hang Toi to walk up to the Eo Gio that is wind blowing passage. This site is interesting for short break on the traveling way. Passing the Eo Gio to Chay river again, you have to pass that one for some 100m and turn left the path to road number 20. Coming to a narrow valley, that is the location of the Hang E entrance.

Hang E was described by D, Limbert in Vietnam Cave Report, 1994 as:

"... To the East of Phong Nha are two caves Hang E and Hang Toi believed to have been formed by a flood overflow of the water forming hang Phong Nha...

... Initially easy passage with short swims and several side passages leads 800m into the cave, to an immense boulder slope. This is 50m high and leads in to an impressive chamber 500m in circumference. Climbing down out of the chamber the river passage is regained. Dimensions are much large here, in places the passage is 50m wide.

A series of lakes is reached the largest a 120m swim. After 500m of large passage the exit is reached. At the exit the number of old bombs were found.

1992 a side passage was surveyed from the large chamber (the Dragon) for 700m before rejoining the main passage. Other leads were checked with no result. Due to limited time a hasty reconnaissance was made to locate the upstream continuation. This was found after about 800m of jungle bashing, and involved a long swim, the end was not reached.

In 1994 a team set out to push this next section, or Hang E as it was named. Hang E was found to be 736m long, all of which required swimming with only an occasional rest spot. The cave finally sumped with a small rift visible 10m or more above the sump, but impossible to climb into...."

#### 4. *Hang Cha An (Cha An Cave)*

Length: 667

Vertical range: 15

Explored by British Speleological, 1994

Hang Cha An could be reached by going along the National Road number 20 for 16km. Returning on the left side we walk along the river to the entrance of Hang Cha An. The cave is large and flat that can be used for camping. In the war time, this cave was used for storing foods and ammunitions.

A. Jarrant described Hang Cha An in Vietnam Cave Report, 1994 as:

"... At a point 16km from Son Trach, We discovered Hang Cha An. Upstream of the final choke in Phong Nha, the river flows over the surface for about 1km until

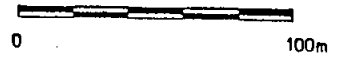
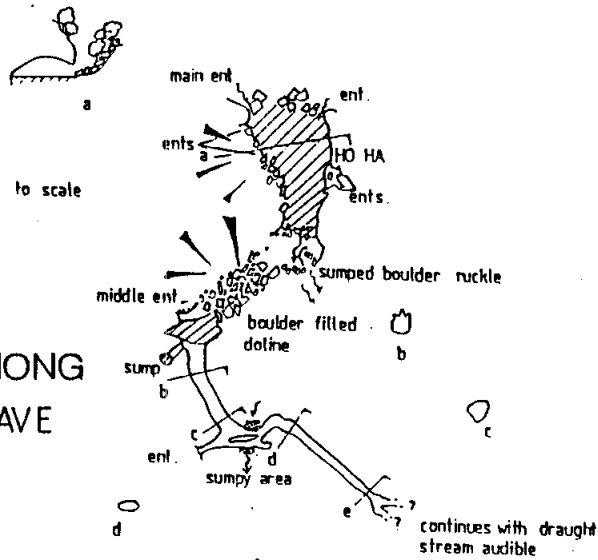
# CHA ANG RIVER CAVES

HO CHI MINH TRAIL  
QUANG BINH PROVINCE  
VIETNAM.

BCRA GRADE 5b

## HUNG THONG UPPER CAVE

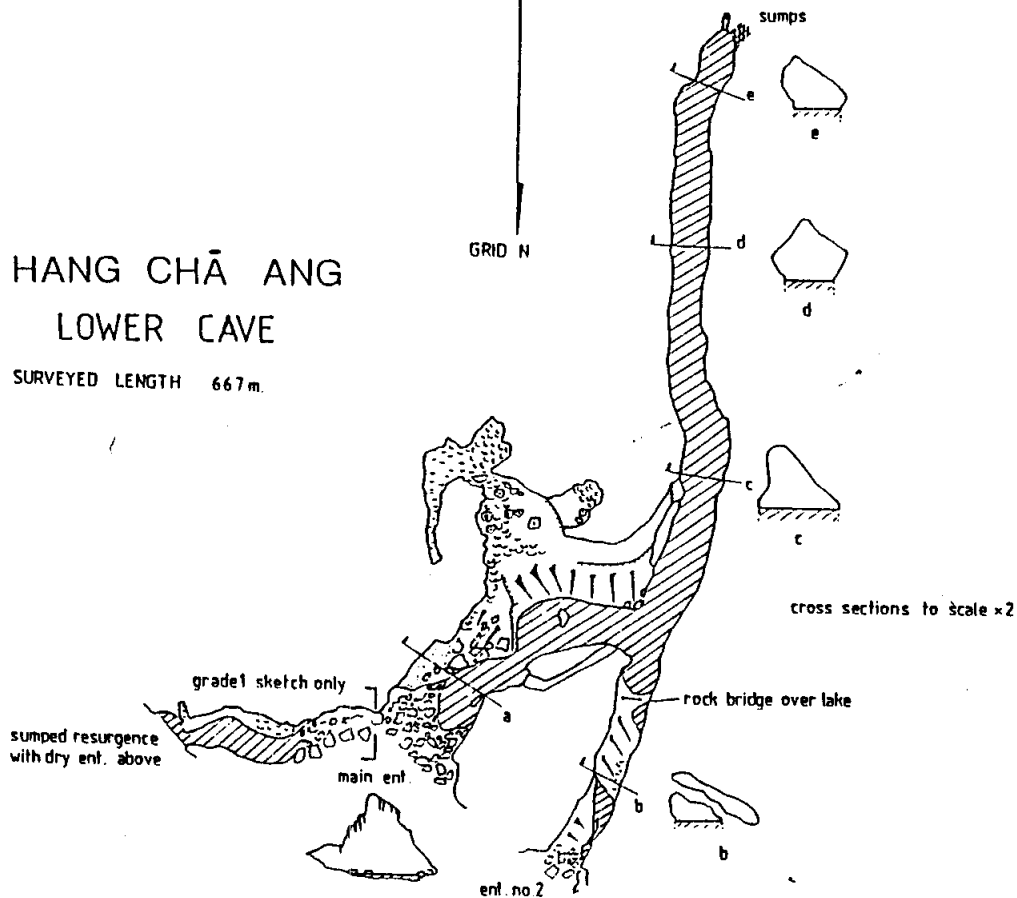
LENGTH 193 m



SCALE 1 : 1000

## HANG CHA ANG LOWER CAVE

SURVEYED LENGTH 667 m



the entrance is reached. The cave was surveyed for nearly 700m to a sump. The passage is initially a 15m x 15m streamway but lowers towards the end to 5m high, before the sump is reached.

... The only way yet to next section of the Phong Nha system is to walk overland on Ho Chi Minh Trail. They follow a small path through the jungle to next short section of cave. Hang Cha An is 667m long. The passage is mainly swimming ending in a sump.

... The Hung Thong valley was reached after a desperate struggle through leech infested, jungle covered lapioz on our second attempt. Here the Cha An river entered a large cave mouth. Carl and Tony explored 100m of partly collapsed cave here before leaving from one of the numerous entrances and finding a second accessible part of the system. The passages here were more solid and again about 100m was explored and surveyed before the presence of a large black snake curtailed our activities. There is potential here for a lot more cave but any connection with Hang Cha An will almost certainly be underwater as there is an obvious active phreatic series throughout this system...."

#### 5. *Hang Thung (Thung Cave)*

Length: 3351

Vertical range: 133

Explored by British Speleological, 1994

Hang Thung is described by R. Skorupka in Vietnam Cave Report, 1994 as:

"... From Hang Cha An a three hours walk brings you to the continuation of main river passage. Hang Thung displays a spectacular change in character to the other sections of cave. Parts of the cave include huge river passages, with excellent gours and impressive formations but this cave not only has a 20m pitch, but some sections are extremely narrow (1m). With the majority of Phong Nha river in the passage this made for extremely careful caving, avoiding a powerful water. Hang Thung was 3.5km long but again ended in a sump with over 10km known to be main sink.

The Entrance is located at the head of a large collapse doline. At the lowest point, a deep pool leads away under collapsed blocks. A route can be forced with the water to re-emerge about 100m downstream in the doline.

50m above and to the right, two draughting entrances unite after 30m in a downward sloping overflow. This enlarges dramatically to a massive (60+) wide chamber, containing several static lakes. One of these is crossed by a 30m swim to a slope over flowstone ending in a 9m climb up. Above, a smaller passage floored by fine gours is followed to where daylight can be seen. A short swim needed to cross a big gour to the continuing rift. This passes below a 25m shaft (daylight) to a short slope down to a 16m pitch. (Rebelay at 4m). This fine second shorter collapse is crossed above and a third is passed by swimming below a boulder. A section of elliptical passage sloping down from the right follows, with

easy going on a clean arched rock floor to the right of the river. A dribble inlet enters down a flowstone slope on the right.

Another big collapse follows, with the sound of roaring water ahead. Up a slope to the right here leads to brilliant gours stal and a devious rout to a balcony 30m above the river in a passage 1m wide. The best rout is to climb about 3m above the water and squeeze through boulders back down to the stream. A short arched duck follows into fast following canal

50m forward the stream roars down a canyon about 1km wide. Progress is made by pulling along the walls until a very turbulent section is passed by a precarious traverse 2m above the water. A fall here would be very serious. Around a bend the entire river falls from a 2m high cascade into a spray filled chamber. Fortunately a rift short cuts this section with an upwards 10m climb to a spacious lake chamber, the water falling away on the right hand side.

A further swim leads to a series of rapids and a point where the passage is split by a high rock island, the river flowing on either side. To the right, a swim against the current leads to where it is possible to climb up onto the island. This allows a traverse on one wall with rapids below, to another big lake chamber more rapids leads to a large stal "portcullis" with a passage above. This is about 1750m into the cave..."

## 6. *Hang En (En Cave)*

Length: 1,645

Vertical range: 78.6

Explored by British Speleological, 1994

Hang En is Located at the "Nuoc Lan" (sink stream point) of Rao Thuong stream. The way to the Hang En is through many deep streams and dense jungle areas. The neighbouring area of cave is very quiet with many footprints of the tigers, bears, gours. There are also many massive trees with large buttress of 5-6m high.

Hang En with large entrance, initially large clean gravel bank which can be used for camping. In the Autumn, there are many interesting swifts flying above rocky cliff.

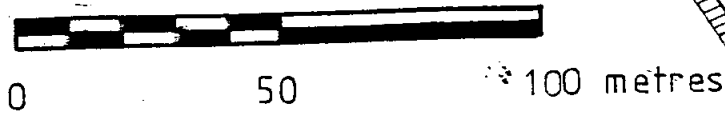
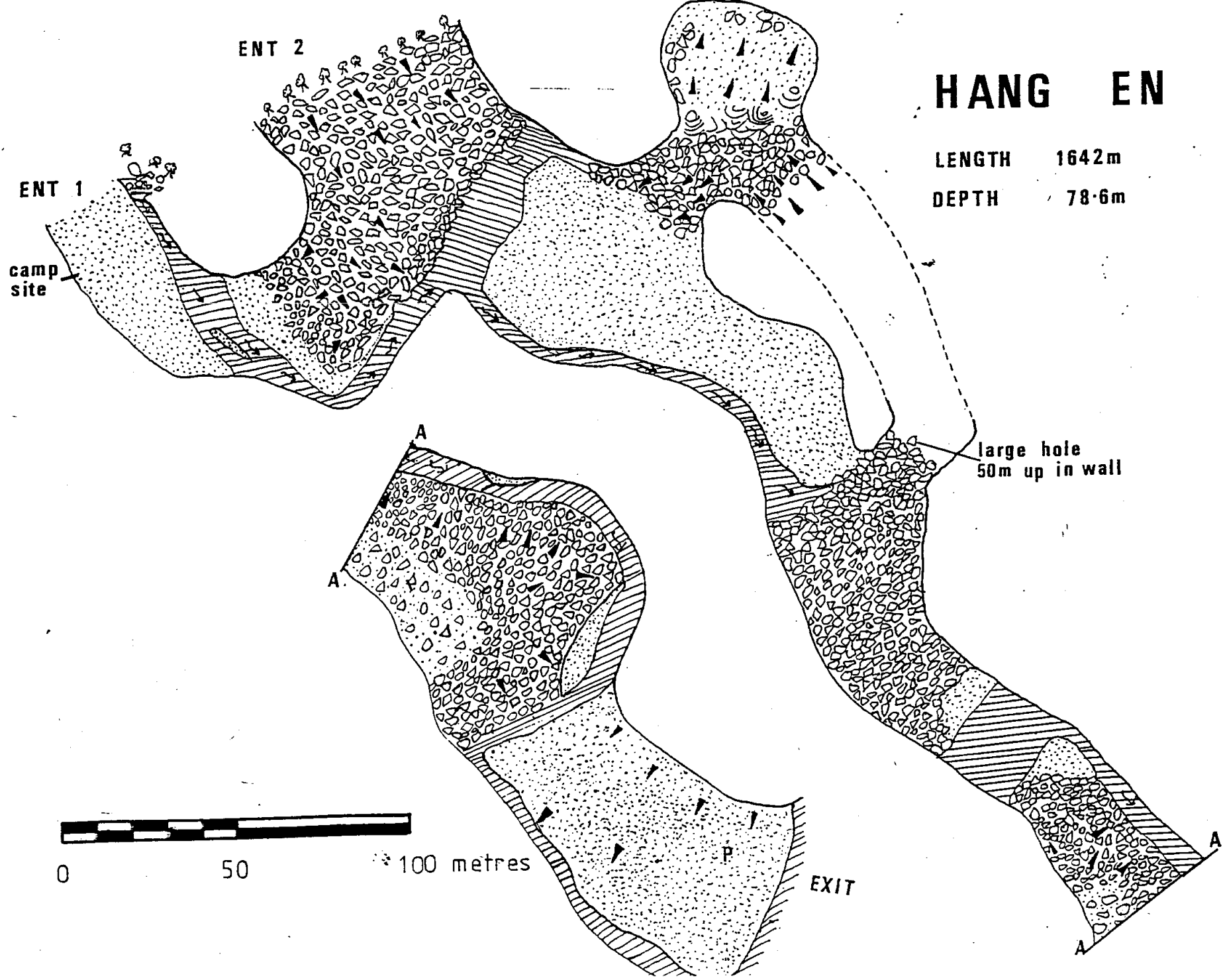
Hang En was described by Dandy Bradshaw in Vietnam Cave Report 1994 as:

"... The walk to the cave is however not an easy one. It takes 123 hours if all goes well and you don't lose path. The last 4 hours of the walk involves wading along a river. Leeches are abundant in this area, so leech proof gaiters, salt bags, and cigarettes are useful accessories to this otherwise beautiful approach march. The walk was completed over 2 days, our campsite being hastily constructed by our guide in the middle of the jungle. Our guide also brought along for a trip an old rifle to guard against the large nasty creatures in the jungle. Luckily nothing came to visit us during our stay but tigers and other large cats do exist in this area of Vietnam.

# HANG EN

LENGTH 1642m

DEPTH 78.6m



At last the cave was finally reached and we were not disappointed. A river enters the cave by the smaller of the two entrances 15m high and 70m wide, with the river at this point 5m wide. Camp was made on the shingle beach at cave entrance.

The river meanders for 300m in low wide bedding, before following the right hand wall into the large chamber with the main entrance visible on the left. The main entrance is a climb 50m a boulder to an entrance 70m high and 100m wide.

At the base of the boulder slope is a wide pool which is crossed to sandy beach, with the river flowing on the right hand side. A large side passage here leads up a 45 degree angle for 50m then dropping down the other side for a similar depth into a dry passage with no obvious way on. At the top of the climb a large passage can be seen going off which connects with a main passage later in the cave.

The main river passage continues as before in a low wide passage, this terminates after 200m at a large boulder collapse where daylight can be seen from another entrance. The water goes through boulder collapse and then follows the left hand wall of the passage for 400m. The passage here is 50m wide and high, and partly filled with large boulders to a height of 30m. High on the left hand wall a large passage can be seen which has been previously described. Hang En at this point is really enormous, with width as the passage being measured at up to 170m and the height estimated at 100m.

Hang En was surveyed for 1645m which was disappointing knowing the enormous potential to the next known section of the Phong Nha system (>10km). So on exiting Hang En the river was followed downstream for 1.5km in enclosed valley. The river finally sinks in a massive tree and boulder choke. We spent a number of hours in this area in the hope of a continuation to the Phong Nha system. However no way on was found."

#### **7. *Hang Khe Tien (Khe Tien Cave)***

Length: 520

Vertical range: -15

Hang Khe Tien is located at the end of Tien stream (river) in the South of the Phong Nha Heritage. On the surface around the cave, there is a large area of primary tropical evergreen forest with many massive old trees. This cave has not been surveyed yet.

#### **8. *Hang Khe Ry (Khe Ry Cave)***

Length: 13,817m

Vertical range: 120 (+48m -62m)

Grid - Ref: 635.42 E 1922.84N

Explored by British Speleological, 1997

Hang Khe Ry is located in the end of the Khe Ry stream. This stream is be starting from the 1300m a.s.l. The water enters the cave very strongly. Arounding surface of the cave has a large and quiet area of primary forest. The cave could be reached by going along the National Road number 20 to the Ban village, and then you need the local people helping as the guide to the cave.

Martin Holroyd described the Hang Khe Ry in Vietnam Cave Report 1997 as:

"... Nothing was known about this area other than what was known on our maps. Several river valleys terminated at the geological contact with the limestone massif. Ban village was chosen as a starting point.

... The only entrance we found here was in the cliff and housed colony of bats.

... The watershed flows into the various caves at the contact cliffline, then flows into and through the Khe Ry system to connect with Hang En and eventually resurge at perhaps Phong Nha cave, Hang Toi cave.

... It is interesting that all the stream sinks are at an elevation of between 286 and 296m. Their course under the massif takes them under peaks almost 1000m high and past depressions between 150m and 250m before surfacing in the Hang En depression at about 110. The large depressions in the massif could produce multi-levelled fossil passage as cave development progresses further north towards the resurgence. This is a relatively large block of Karst with no surface drainage.

Following the now stream bed a further 200m an impressive entrance was found. This was indicated to be Hang Khe Ry.... The passages consist of a series of wide meanders with several deeps, static pools. After approximately 800m a wet T-junction was reached. Along the entrance passage there are several ways on to either side. After 600m from the entrance, a passage off to the left is found. This has been explored to over a kilometer. After the T-junction the nature of the cave changes. Up to the junction there were been some decoration to the sides of the passage and in the gours to the right and left. The junction is where the cave becomes more active. The stream is believed to originate in the most easterly sink (sink 1). Upstream follows a wide passage with cobbled floors and a shallow stream, the passage averages approximately 40m in width with the occasional swim being required. Along the left hand wall impressive flowstone and gour pool formation were found.

The main stream continued for an other 400m to a deep canal. On pushing this canal it was soon found to open out into a large circular chamber approximately 60m in diameter with a low ached ceiling. The water was very deep throughout and in no places could bottom be touched. The sides of the chamber were sheer and with no handholds. The impression was of being inside a large flooded church. The water was definitely welling up from beneath out feet. It was correctly reasoned to be an upstream sump. We deduct that this contained water from the original sink 1.

The passage necessitated stooping in places and also contained fetid pools which smelt strongly of bat shit.

Some of the upstream sections are very near the surface with several collapse chambers exhibiting signs of bat habitation and even war debris. This area is obviously close to the edge of the limestone and is also noted for its immaturity and lack of significant decoration.

The total upstream distance surveyed was in the order of 3 km, with the potential for further diving extensions.

The downstream passage begins with a wide deep canal requiring a swim of approximately 100m. Beyond the river meanders through a cobbled flow in a massive passage, in many sections the river widens and deepens and involves either swimming or wading to cross.

Although not an inlet some confusion can occur at pseudo inlet, the passage being split by very large boulders and calcite formations. The flow to the right and dry route over the boulders to the left can be followed, rejoining the stream further down.

Approximately 2km downstream the passage changes direction abruptly with an inlet entering on the left ("up the junction") which closed down after 100m. A fantastic section of passage is followed downstream with the river cascading over the solid rock floor, before ending when passage swings back NE.

Three inlets enter from the right, the first ending in a sump after only a very short distance, with the second starting as a small narrow passage before entering the large stream section which can be followed for over a kilometre finally ending in a sump, believed to connect with the sink 3 on the surface. The third inlet is a large boulder filled passage which links in with the second inlet in a large boulder filled hall..."

#### 9. *Hang Khe Thi (Khe Thi Cave)*

Length: 25m

Vertical range: -15m

Grid - Ref: 636.1E 19272.0 N

This cave has known very little information. The underground stream is followed to the Phong Nha system.

#### B. **Vom cave system**

The main sink for the Vom system lies South of the Vom cave about 4.4km along the National Road number 20. The river flows North passing the remote village of Bacxin and sinks into Ruc Ca Roong. In the dry season, this sink is the main feeder of the system and presents the main source of the Hang Vom water. Little is known of the other stream which must make a major contribution in the wet season.



Ruc Ca Roong ends in a sump after 2.8km. The river resurges and the next section of cave is the Hang Pygmy. In the dry season little or no water is seen in this 850m section of huge passage. However obvious signs of flood debris indicate that during the wet season this too is an active sink

The main underground river is rejoined in the next section of cave - Hang Ho. From here it can be followed downstream through the majority of its length via Hang Dai Cao, and Hang Duat to the Hang Vom resurgence. The only section of cave not explored is the upstream river passage in Hang Ho which may lead to a further 2km of passage.

Thus the total length of the Hang Vom system is now 31.4km. Although the whole system has never been traversed in a single trip, it should be possible to complete a traverse without the use of ropes, but the route finding is in places very complex.

The Hang Vom is a truly remarkable and due to the remoteness should remain in pristine condition for many years.

#### 10. *Hang Vom (Vom Cave)*

Length: 115,050m

Vertical range: 145

Grid - Ref: 630.4E 1937.0N

Explored by British Speleological, 1992, 1994, 1997

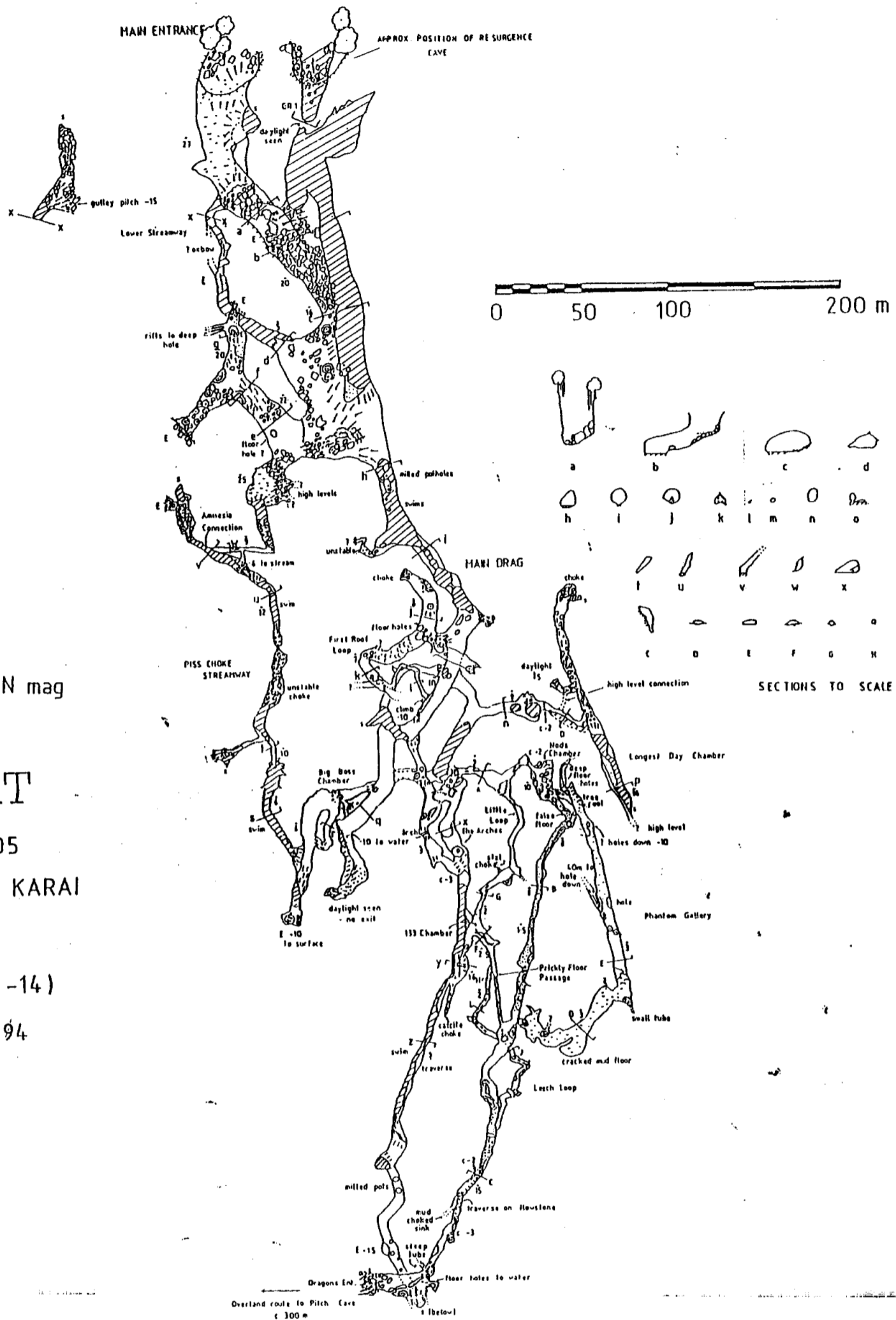
Hang Vom was described by D. Limbert as:

"... Large part of the route to Hang Vom is through dense jungle and without the determined efforts of our guides the entrance would not be located.

The arched entrance 50m high and 100m wide was filled with immense lake and this set the style of Hang Vom. Through out the cave there are many swims over 100m long, the longest being the Hall of Bright. At 1.6 km from the entrance *the Daylight Beckons* is reached. This is a daylight shaft about 200m high. On the left here is the longest side passage and also longest section of dry passage. *Into the Great Wide Open* starts steeply uphill over immense dry gours with huge stal columns. 5 kilometres of passage leads to an entrance at the base of the cliff. Due to the dense jungle it was impossible to make out surface features, but the survey confirms this to be separate valley.

The main streamway continues in style with swims, boulder piles, rapids and fine formations, passing another major side passage *The pretentious Inlet*, the cave emerges after about 6 kilometres of streamway.

Only 100m separates this exit from the next entrance. This leads almost immediately into the *Hall of Bright Cavings* 350m of swimming in a 10m wide rift. At the *Gates of Delerius* the passage regains its former immense proportions



# HANG DUAT

GRID REF. 6255 19305

SHEET 6243 IV BAN KARAI

LENGTH 3927 m

V. RANGE 45m (+31, -14)

SURVEYED: VIETNAM 94

DRAWN: R SKORUPKA

with one wall generally out of sight. After about 2 kilometres this section of cave ends at *Panthers Entrance*.

Both the *Pretentious Inlet* and *The Great Wide Open* were used as camps to enable the cave to be pushed to this point. The surface stream was followed for 1km, swimming and wading, and through a rock arch 50m high 100m long. The next section of passage was located after a surface lake leading to tree entrances the largest being 80m high and 50m wide.

This cave, Hang Vom, is without doubt one of the great river caves in the World. It was explored for 14km in 1992 with many parts of the cave being over 50m high and 50m wide. It is a two hour boat journey up the Son river and one of its tributaries, the Chay river, then overland, first on the Ho Chi Minh Trail.

With 14 km of passage surveyed, Hang Vom was major find of the expedition in statistical terms. It was also quite simply the most amazing only of us had ever had the privilege to explore. Future potential for extension of the system is excellent and the continuation must currently rate as one of the World's great leads. Hang Vom was the cave we hardly dared to dream of, but now it will fuel more dreams as the English winter begins to bite and thoughts turn to Vietnam and what lies in store un 1994."

#### 11. *Hang Dai Cao (Dai Cao Cave)*

Length: 1,607m

Vertical range: 120 (+48m, -62m)

Grid - Ref: 624.3E 1930.5N

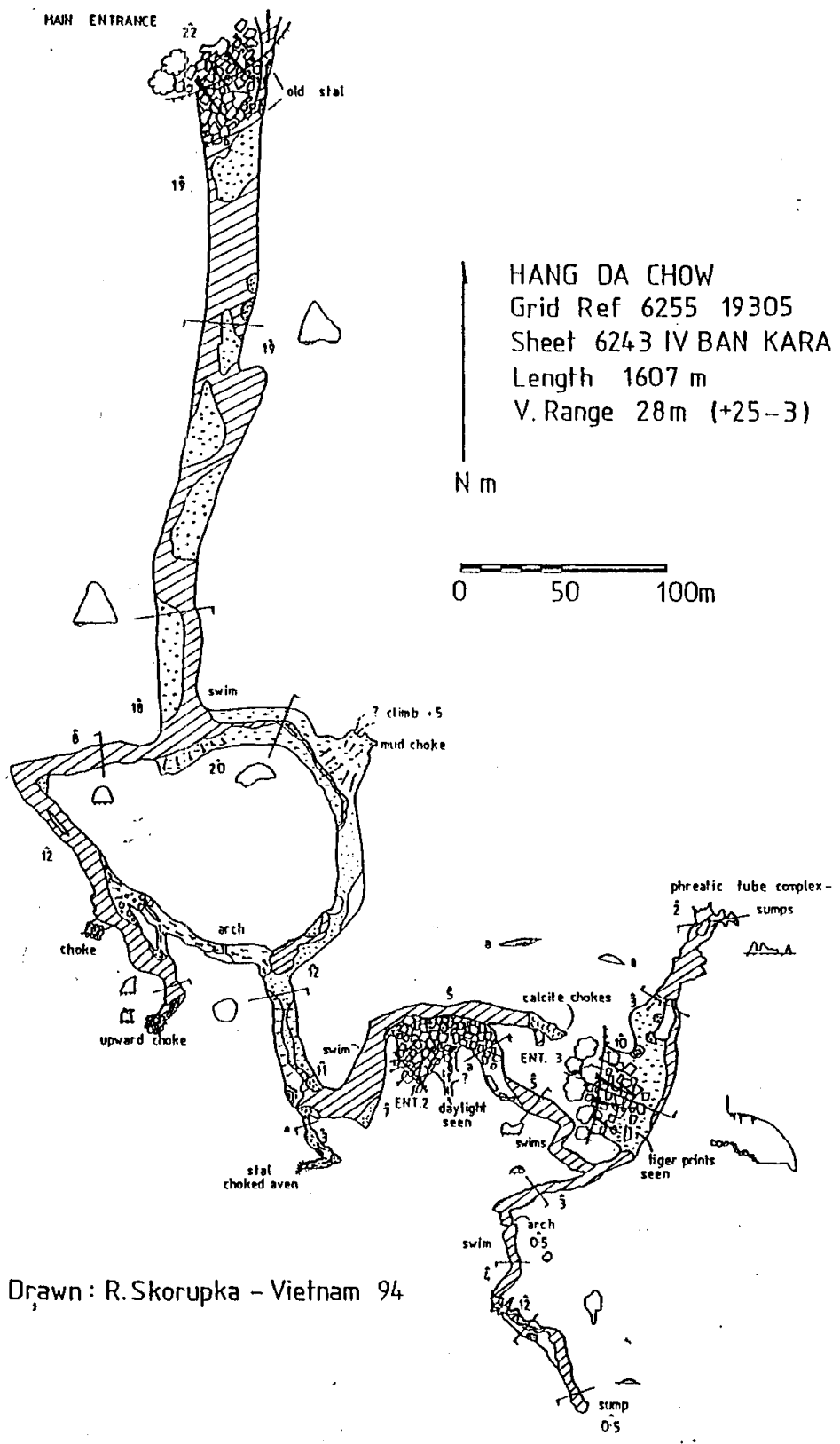
Explored by British Speleological, 1994

From the Hang Vom, we could be not to be the Hang Dai Cao by the underground way or the way from the Hang Vom entrance, because around the Hang Vom that is dense jungle with the high rocky walls. The way to the Hang Dai Cao that could be gone along the National Road number 20. Turning on the right from the kilometre 24 on the Road number 20, that is the path to the Co Khu area. The Dai Cao cave lies among the Jungle of Co Khu area. Local people knowledge can be use as the guides for the way to Hang Dai Cao.

Deborah Limbert described the Hang Dai Cao in the Vietnam Cave Report 1994 as:

"*Hang Dai Cao* and *Maze Cave* are separate caves, although the water unites on the surface. The entrances are located about 2 kilometres south of the last section of *Hang Vom*. *Hang Dai Cao* was explored for 1.6km with 2 further entrances.

The final trip into Hang Vom had shown that it was no practical to try and extend the cave via the underground route, We located a guide who knew a route through the jungle to Hang Dai Cao, to the next section of cave in the Hang Vom system.



Drawn : R. Skorupka - Vietnam 94

To get there we walked up to Ho Chi Minh Trail to kilometre 24. Taking a small footpath to the right just after a well used bivvy site, we entered the jungle. The path is fairly obvious in most places, but crosses several streams where it is necessary to know the way. There are a couple of steep hills, but after three hours in the jungle you reach Hang Dai Cao. The locals have a bivvy site next to the entrance, but we chose to camp in the cave as it was free of leeches and mosquitoes.

Hang Dai Cao contains a small stream, which just inside the entrance lead into several shallow pools. After 500m of 20m wide passage a T-junction is met and the first swim. Swimming first to the left hand branch, we emerged onto very soft sand and gravel. A good section of walking passage followed with a shingle floor and a small stream for 400m.

A passage on the left soon choked but a flowstone climb to a small passage could not be scaled. Another swim was reached. A steep muddy slope on the right led over a flowstone climb to a choke. Swimming across the pool we saw a glimmer of daylight and emerged on some boulders at the foot of an entrance ramp. The passage appeared to continue but soon choked. Further round another swim led into another section of passage. This relatively small passage (3m) was all swimming and joint controlled with many sharp bends. After another 100m a junction was reached. To the left led via a short climb into a very large entrance. The sand banks showed many large paw prints. Carefully crossing the entrance and looking out for tigers, we entered the inevitable swim, which sadly sumped after 50m.

Reversing our tracks we returned to the main T-junction near the original entrance. Taking the right hand junction the passage continued for 220m all swimming. A side passage on the right led up into a choke of enormous limestone blocks. The main passage continued for 50m before ending at the draughting choke.

Returning we checked out the only remaining lead. A climb up led via a short section of passage to the left hand branch which we had explored first. The total length of Hang Dai Cao was 1.6 kilometres..."

## 12. *Hang Duat (Maze Cave)*

Length: 3,927m

Vertical range: 45m (+31m, -14m)

Grid - Ref: 625.5E 1930.5N

Explored by British Speleological, 1994

This cave was described by D. Limbert and R. Skoruoka in Vietnam Cave Report, 1994 as:

"*Maze Cave* was surveyed for 4 kilometres and proved to be very complex. Development was on several levels and a further nine entrances were found.

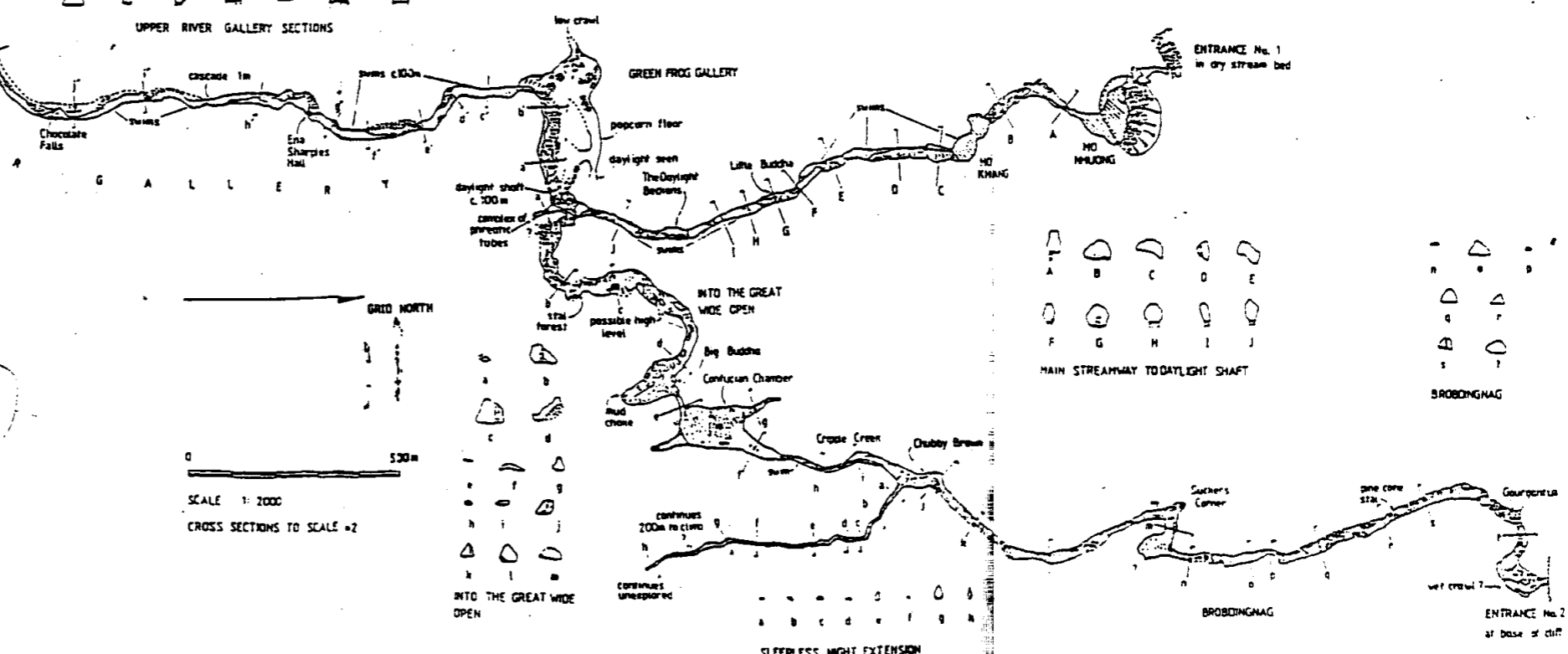
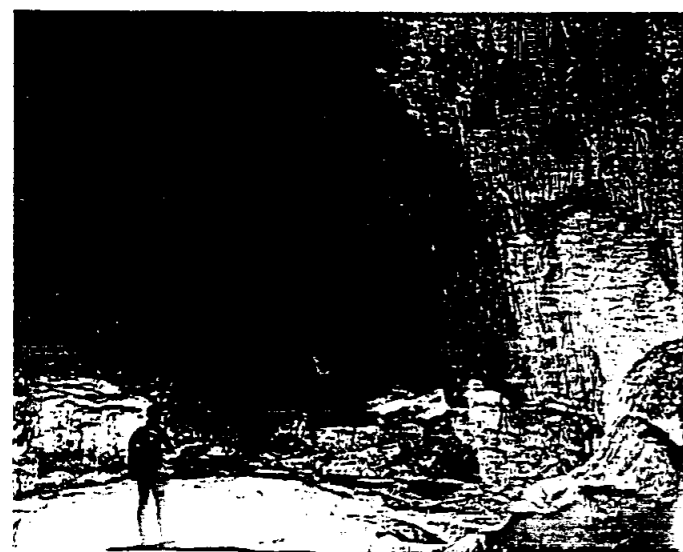
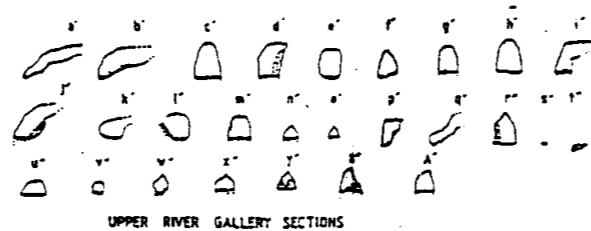
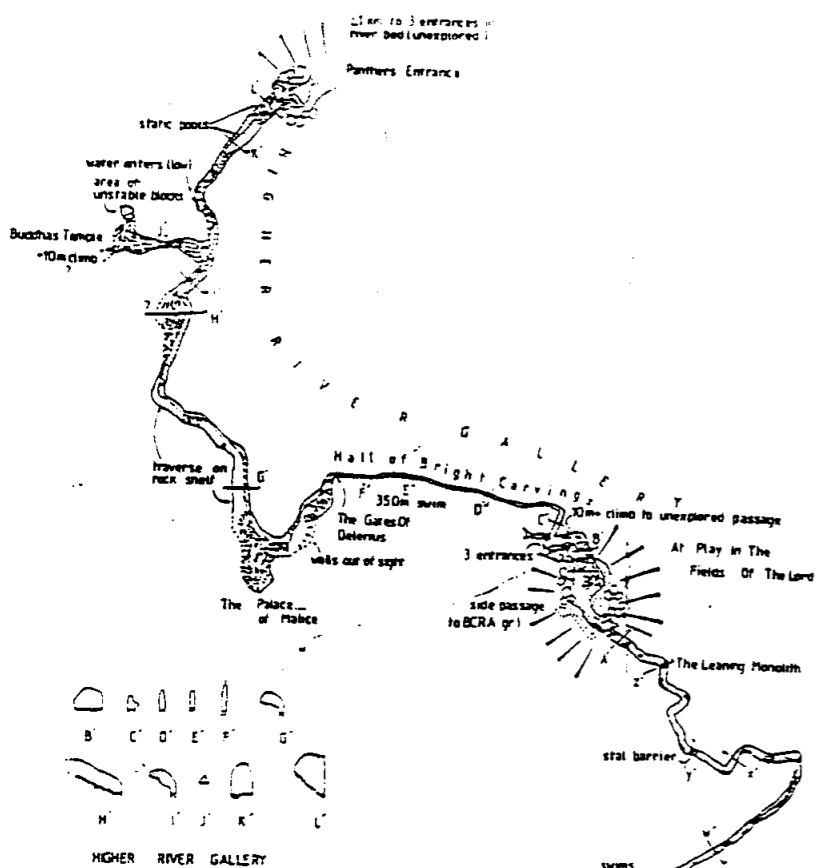
# Hang Vom

Quang Binh Province, Vietnam

Surveyed Length 13 969 metres

Vertical Range 131 metres (+125, -6)

Explored 1992



There was very little swimming in *Maze Cave*, and this cave was very well decorated.

On exiting *Maze Cave* a short walk up a dry stream bed led to *Hang Ho*. The draught to this cave could be felt over 200m away. It was explored for over 800m in large impressive passageway. Before exiting again via a tight loose squeeze. This cave was unusual in that it required the use of vertical equipment to descend a 300m drop into the main stream passage.

The Complex nature of these caves is in direct contrast to the single passage simplicity of the first 15 km of *Hang Vom*. Also very little passage with the original dimensions of *Hang Vom* was seen. It is possible that the water which formed the lower section of *Hang Vom* comes from several different sources in this area. There is a lot more work to be done before the full hydrology of this system is understood.

Continuing further round the rock face a short (100m) section of large cave passage was reached. There was a sump pool on the left and sand banks along the right hand wall. The exit was over a dried gour slope. We emerged an area of slippery boulders, with deep holes in between. Down to the right could be seen the passage and the sound of running water could be heard, but it was impossible to get down to the water without a rope.. Continuing across the boulders the team was rewarded by another immense entrance....

... Climbing up a steep ramp the passage split and revealed two new entrances. Returning to the chamber, it was possible to regain the main streamway via a series of gour dams.

The main passage continued with the bare polished black limestone floor and walls. Some large fossils were noted in this area....

Swimming across the pool, we continued on a dry section, and almost immediately two passages we noted on the right. These two tubes united quickly and continued to a swim. This swim connected with the main streamway again. Just before this connection was a very complex area.

From the next pool which could be traversed around three passages led off. Straight ahead was presumed to be the continuation of the main passage, with two separate side passages on the left. Taking the first on the left, the smooth polished phreatic tube led to a couple of pool and calcite barrier. Over top of the calcite a small passage led quickly into a much large dry passage going left and right. To the right was followed for about 75m to a dead end. To the left continued over boulders for 150m to an eventual choke, the lower area of the choke being sumped. Back at the start of the choke a steep upward slope over boulders and calcite led to a small entrance in the roof.

Back at the main streamway the second side passage revealed a slightly lower streamway than the main passage. Initially quite small with pools to wade it soon opened up to a large stream passage. Passing under an obvious high level route an

enormous rock arch crossed the passage. The Arches Passage was followed upstream for 275m, some walk in passage and some swimming. At the end of the passage sumped, but daylight could be seen high above with no easy way to climb up. There are many connections to the Arches Passageway from the high level series we explored later (Noddy's Series).

A short way back from the end of the main passage a steeply ascending tube was followed. After 30m it emerged in the floor of a large chamber with one or two stal columns. To the right a short section of large passage overlooked the main way. A smaller tube connected to the same point. A passage running parallel to the main passage led to another entrance in the same area as the end of the main passage.

Continuing away from the entrance, this small passage (2-5m wide) was followed for 200m to an area of collapse. The passage was generally wet, swimming and wading, with a couple of section of fast flowing stream. Passing through the boulder a further section of wet passage was reached. Negotiating a short section of low airspace, the passage enlarged and daylight was seen.

Exiting, a ledge on the right was followed for a short way to a bouldery area. A couple of possible entrances were checked, but both sumped immediately

Returning to the area of breakdown, a passage in the roof connected with the first side passage explored, from the main entrance.

In the main streamway, two high level passages had been noted near the large boulder. The one on the right was the connection to high level chamber just described, An easy climb up on the left took us into the high level series overlooking the Arches passage. On the right a sandy floored passage led to a climb down onto the arch itself and down to the lower streamway. Straight ahead and to the left several holes in the floor connected to the lower route.

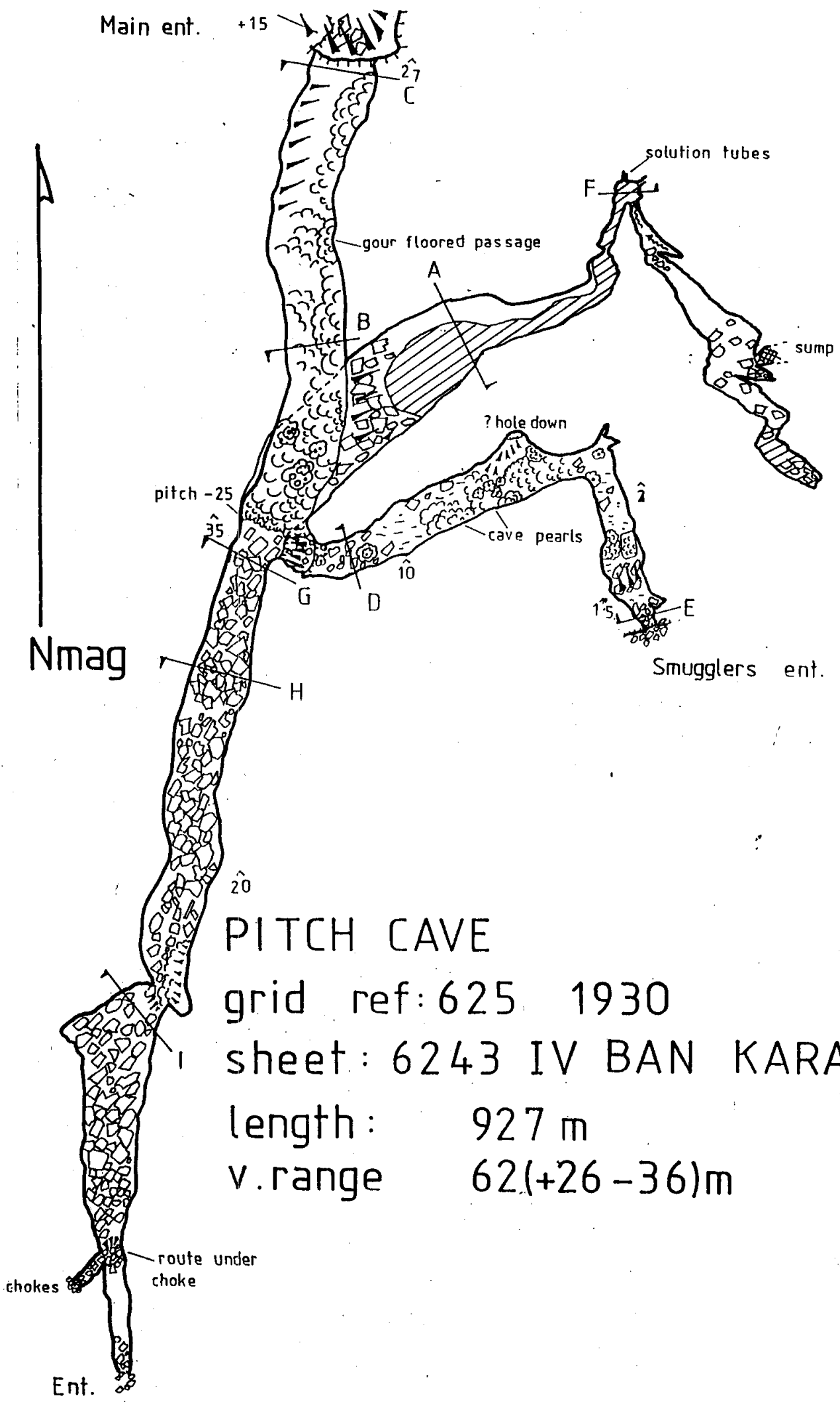
Traversing around a couple of holes, a tube on the left led to into an extensive section of dry passage, Noddy's series. A steep mud slope and a short climb up led into a small well decorated passage. Climbing down, the section to the right was explored for 450m. The left hand section was not explored due to the lack of time.

The passage continued generally tall and narrow (15mx5m) with a dried mud floor and extensive formations

Behind one section of flows, the " Expanding Alcove' passage was followed for 220 through a short low crawl and around same loose holes in the floor to a choke.

Dropping down a short climb the main way changed to clean washed rock and fewer formations. A passage and several holes in the floor were noted. After 175m another entrance was reached. A lower entrance was noted which obviously connected with the holes in the floor at the entrance.





PITCH CAVE

grid ref: 625 1930

sheet: 6243 IV BAN KARAI

length: 927 m

v. range 62(+26 -36)m

Returning to the side passage, the holes in the floor were found to interconnect and led into a lower section of small passages. The side passage was followed for 75m to the tree ways junction. Straight on led to a high level connection with the Arches, to the right led back to the start of Noddy' Series and to the left led to the area of tubes entered via the holes in the floor. The majority of the leads noted were checked off, but during the exploration, it was obvious that each lead invariably led to along section of passage, some connecting back via very obscure routes. There are probably many more passage to be explored which we did not notice or think to be significant..."

### 13. *Hang Ca (Pitch Cave)*

Length: 1,075m

Vertical range: 62m (+26 - 36)m

Grid - Ref: 625.0E 1930.0N

Explored by British Speleological, 1994

This cave was described by M. Robson in the Vietnam Cave Report, 1994 as:

"... After success of Maze Cave at the uppermost section of the Hang Vom system, the final caving trip of the expedition was to continue exploration of the caves discovered in this area.

We camp again in Hang Dai Cao and to reach the new caves involved a two hour caving trip through Maze Cave. After exiting the Maze Cave we followed a dry stream bed up to the impressive entrance of Pitch Cave. An enormous draught could be felt from 200m way. The river entrance was sumped but a steep climb up led to the 200m x 10m entrance of Pitch Cave.

This soon enlarge passing giant gours and columns for 150m to a huge void. A delicate traverse to the left entered a well decorated passage which led for 150m to another entrance deep in the jungle. Back at the Pitch a fine 25m drop led into a large passage 15m wide and 25m high.

Downstream of the Pitch continued for 200m through a large boulder filled passage followed by traversing around the sides of a large lake for 150m. The way on was found through a fine 3m long arch with 0.5 of airspace. Emerging from the tunnel into a small lake the cave character changed completely. The direction of the cave changed by 270 degrees and doubled back on itself. The cave continued as a streamway littered with boulders and was followed for 75 m until the way on was blocked by large submerged bounders.

Upstream of the Pitch a fine well decorated passage was followed for 400m with the dimension decreasing slightly. At this point the large passage deteriorated and started to break down. Progress was made by traversing the left wall for 100m where a short climb of 10m through loose boulders leads to the tight entrance (Flag entrance). The entrance emerged a closed doline.

### 14. *Hang Ho (Tiger Cave)*



## HANG HO

BO TRACH DISTRICT  
QUANG BINH PROVINCE  
VIETNAM

Grid Ref: 625.5E 1928.6N  
Sheet: 6243 IV BAN KARAI  
Surveyed Length: 1,616m  
Vertical Range: +46m  
B.C.R.A. Grade: 4b

Explored & Surveyed by  
"VIETNAM 94 & 97" Expeditions

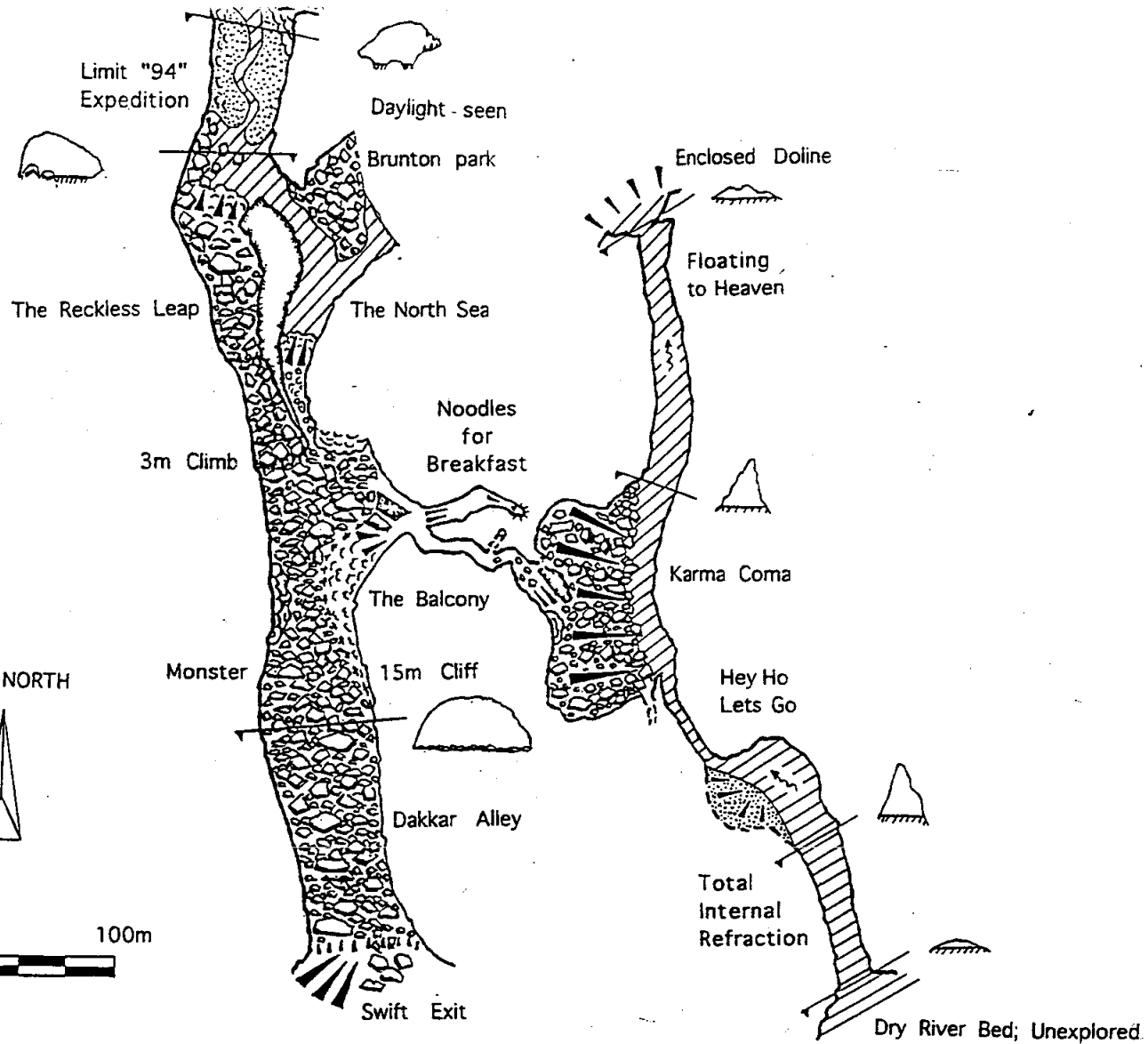
Survey Team:

P. Callister  
M. Holroyd  
H. Limbert  
A. Mackie

Drawn:

R. Greenslade (94)  
M. Holroyd  
D. Limbert  
P. MacNab

MAG NORTH



Length: 1,616m

Vertical range: 46m

Grid - Ref: 625.5E 1928.6N

Explored by British Speleological, 1994, 1997

Hang Ho is located in the upstream of Hang Vom system. It is surveyed by a large number of cave explorer as: P. Lallisten, M. Holroyed, H. Limbert, A. Mackie, R. Greenslade, D. Limbert, P. Macnab from 13 to 19/3/1997. And Andy Mackie has been written:

"... It was obvious that to continue surveying in Hang Ho, and to explore Hang Over we would need to camp further into the system and the entrance to Hang Ho was chosen as there is a reasonably smooth beach and a plentiful water supply. The next day was therefore spent trying to find a route to bypass Hang Duat, to avoid having to transport equipment through the swims. Partial success in the form of an overland route to the entrance was achieved but no route between the two valleys could be located. On our return to the jungle after a break in Son Trach we had no problems in following the correct route and arrived at Hang Duat for an overnight camp. Having got through Hang Duat and into Pitch Cave we decided to try to find a route through the jungle from Smugglers Entrance to Hang Ho, avoiding the need to descend the Pitch. The jungle proved to be no worse than the route taken previously and therefore this was probably a slightly easier option overall.

Having made camp in the entrance to Hang Ho we again set off into the cave to continue surveying. we followed the streamway expecting it to lead to the large passage where surveying was finished previously. A short way along the streamway the passage entered into the large chamber, a scramble up boulders to the left of the stream led to a choked daylight shaft that couldn't be investigated. Returning to the water the stream was found to sump, the only way on being a climb through a boulder choke on the right hand side of the stream that led back to the large dry passage. Returning to the end of the earlier survey we made our way down to the stream and began to follow the water downstream. Swimming down stream we eventually arrived at one of the most beautiful entrance encountered in Vietnam..."

#### 15. *Hang Vuot (Over Cave)*

Length: 3,244m

Vertical range: 103m (+98 -10)m

Grid - Ref: 625.80E 1928.10N

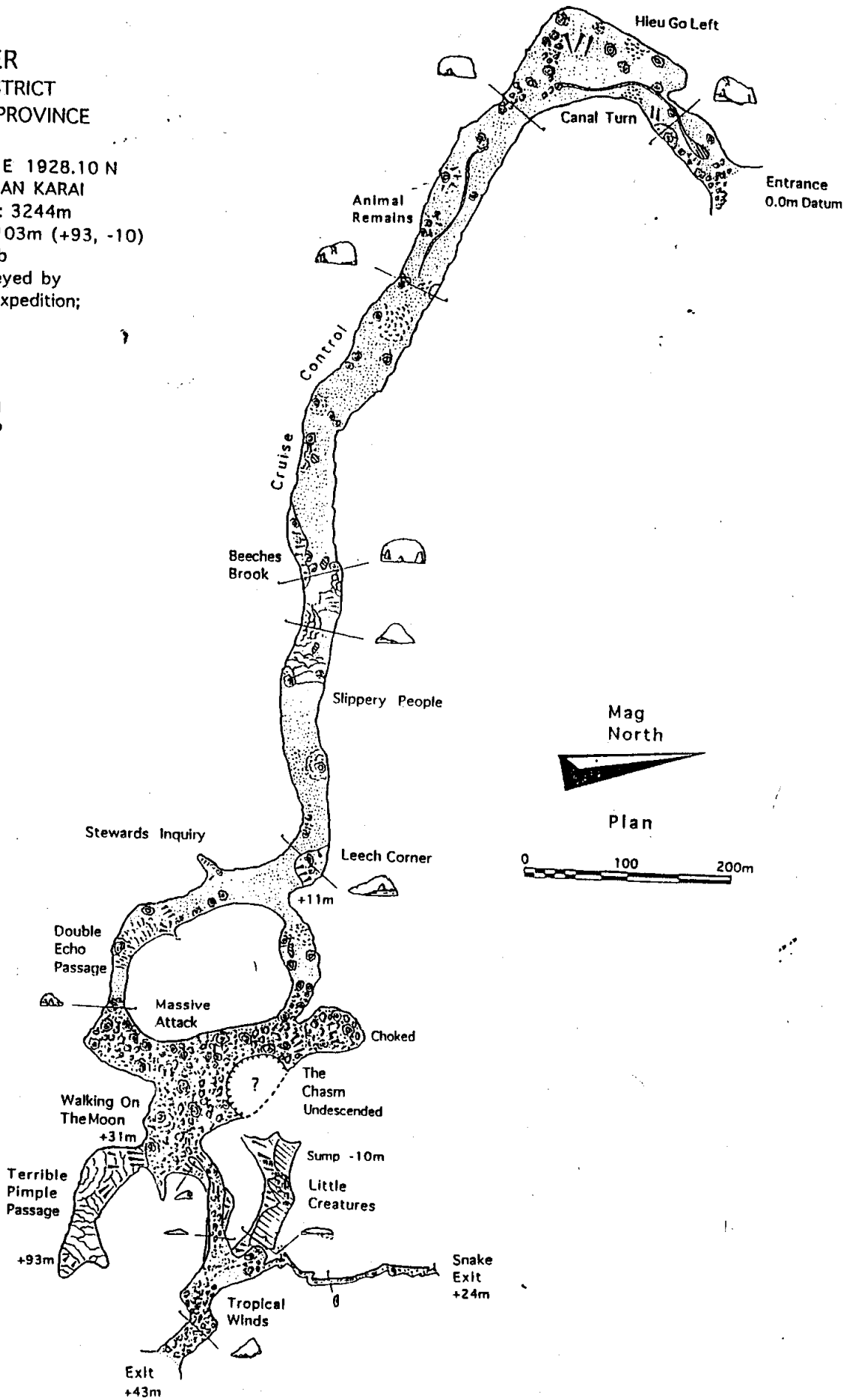
Explored by British Speleological, 1994, 1997

Hang Over is located in the upstream of Hang Vom cave system. This is described by H. Limbert, Martin Holroyd and Andy Mackie:

**HANG OVER**  
**BO TRACH DISTRICT**  
**QUANG BINH PROVINCE**  
**VIETNAM**

Grid Ref: 625.80 E 1928.10 N  
 Sheet: 6243 IV BAN KARAI  
 Surveyed Length: 3244m  
 Vertical Range: 103m (+93, -10)  
 B.C.R.A. Grade: 4b  
 Explored & Surveyed by  
 "VIETNAM 97" Expedition;

P. Callister  
 Hieu  
 M. Holroyd  
 H. Limbert  
 A. Mackie  
 Drawn by M. Holroyd  
 Drafted by P. MacNab



"...Hang Over is a more 100m from the large exit of Hang Ho. Although smaller, the entrance of Hang Over is impressive. A mud-rimmed lake has plenty of evidence of animals using it as a water hole. Beyond this are large stalagmite bosses, well within the daylight zone, are covered in lichen and bathed in a haze of warm tropical air.

The main passage continues large between 30 and 50 wide. However, it soon loses its westwards direction and trends southeasterly in line with the known caves in this area. The main passage, "Cruise control" continues for 900m. The going is generally easy though with some slippery mud floors interspersed by impressive calcite bosses, flowstone and a large section of dried gourds. The remains of a water buffalo of similar bovine were found, or was it a mammoth?

At "Leech Corner", where we still seemed to be carrying a few of these repulsive creatures, the passage turns south then splits into three. The right hand passage was found on the second day to end in a mud choke after a few metres. Straight on was on going but we surveyed to the left and passing over sharp calcite entered, what appeared from our echoing shouts to be, a very large chamber. A clamber up flowstone took us to a balcony above a sheer drop in to darkness. Rocks thrown from here were taking a significant amount of time to land and we estimated the pitch at 25m plus.

"Massive Attack" was indeed massive. A width measurement later revealed it to be 125m wide at one point. Much of the chamber was well decorated with towering columns and stalls forming the walls and gourd, bosses and flowstone between. To the left of the chasm the balcony petered out whilst to the right it widened and flattened out into "Walking on the Moon" leading to "Hieu's Corner" and a number of ways on. A smaller passage soon led to a calcite choke though a steep climb up a flowstone wall (even hairier descent!) entered "Terrible Pimple Passage" after Hieu's distressing ailment on his bum! This passage also ended in a calcite choke.

To the left at Hieu's corner the way on dropped steeply down a slippery mud slope in to a mud chute. Up and over a ridge, with difficulty, led to another chute with a pool at the base entered through a low arch. Here two pools were bounded on one side by steep mud slopes, of which we had just traversed and on the other by a rock wall implying a sump. This was a dark and forbidding part of the cave inhabited by ugly grasshopper-like cave insects.

On the left hand, east wall of Massive Attack another way on was found. This also dropped down over boulders but a strong warm draught could be left -The Laos Winds? A 20m wide passage past odd whale back

formations and narrow stalagmites led to a low T-junction. The main draught went right but a lesser flow of air was followed in to an odd complex of small passages twisted passage where a climb was bypassed into a chamber. A small rift could be seen to lead to daylight through boulders but an exit was deemed unnecessary when trying to find a way out I turned to find myself looking at a snake only a hand span in front of my face. "Snake Passage" was named and I attempted to put my nerves back together.

Following the main draught right at the T-junction and a boulder entrance was found leading into a steep sided doline and another possible entrance on the opposite side. On returning from the exit the size of massive attack caused some confusion. In an unfeasible short time we found ourselves back at Leech Corner. Without realising we had come back a new way and had in fact discovered that the large ongoing passage straight on from Leech Corner was also connected to Massive Attack.

#### 16. *Hang Pygmy (Pygmy Cave)*

Length: 845m

Vertical range: -94m

Grid - Ref: 627.05E 1927.30N

Explored by British Speleological, 1997

Hang Pygmy is located in the upstream of the Hang Vom cave system. Before 1990 and in the wartime, people of Arem ethnic group lived in this cave. There are many evidence of their life that are still remaining in this cave. The cave is describe by UK Cave in 1977, but they are not certainly the first people lived in this interesting cave.

"This cave is across the doline from the exit of Hang Over. A steep climb up through the jungle, past an old oil drum used for water collection, leads to a phenomenally large rock arch entrance. This 90m wide arch drops steeply down debris slopes to the back wall some 100m away. A massive debris slope is funneled down to the left whilst the way on curves round to the right and southwards past a high bank of flowstone and fossil gour pools. Perched upon this is the remnant of a derelict bamboo village - "The Bronx"! At least four ruined structures and some remains of a material and wickerwork are evidence that the cave was once inhabited, maybe Ruc Ca Roong people (literally 'cave dwellers') a minority hill tribe in this part of Vietnam. In a series of calcite curtain enclosed chambers next to The Bronx was another water collecting oil drum, evidence that it can't have been that long ago since the village was abandoned.

**HANG PYGMY  
BO TRACH DISTRICT  
QUANG BINH PROVINCE  
VIETNAM**

Grid Ref: 627.05 E 1927.30 N

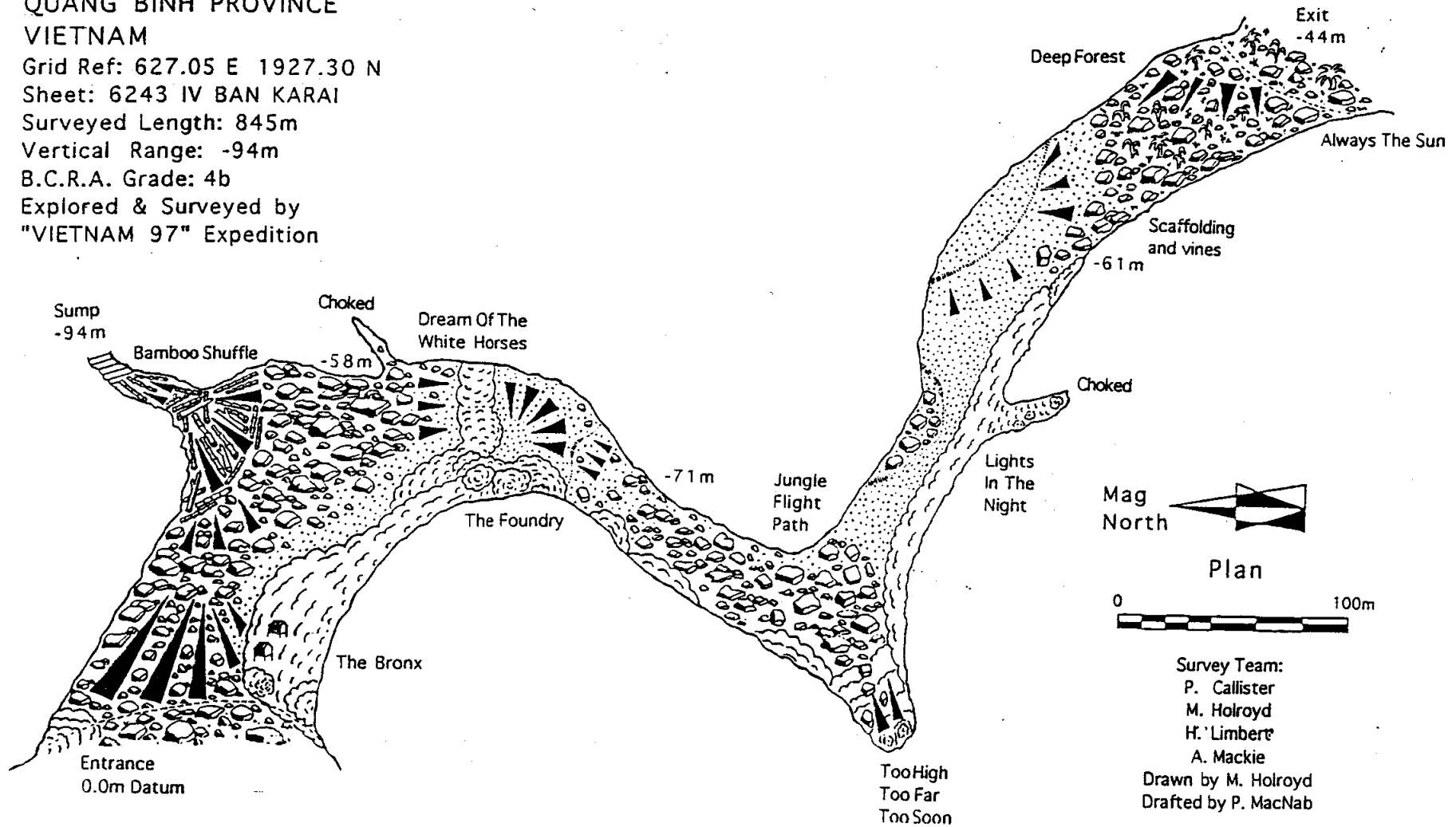
Sheet: 6243 IV BAN KARAI

Surveyed Length: 845m

Vertical Range: -94m

B.C.R.A. Grade: 4b

Explored & Surveyed by  
"VIETNAM 97" Expedition





The way on was surveyed in large passage to the edge of drop over a deep abyss. Already light could be seen coming in from another entrance over the other side of the abyss even though we were still in the light from the large rock arch. A short crawl to the right of the drop led to a narrow ledge leading precariously along one wall above the fearful void. This ledge was actually a path and well used. However, it appeared to end so we backtracked and picked a careful route down steep flowstone to the floor of the abyss. On the return we in fact found a dubious looking wire hand line down a boss which gave access to the ledge.

Climbing out of the Foundry the passage soared some 100m high and 40m wide as "Jungle Fling Path" curved around to the left and another massive entrance came into view some 300m distant. A massive slope to the right into the corner of the passage could be climbed to a series of false walls. Some of the alcoves were blackened by fire showing at one time that a large fire had been lit here maybe to light up the passage below. One easier accessible alcove nearer to the exit had been used as a recent bivouac and contained Vietnamese graffiti dating from 1964 to the 1990's..."

### **17. *Hang Ruc Ca Roong (Ruc Ca Roong Cave)***

Length: 2,800m

Vertical range: 45m

Grid - Ref: 628.0E 1927.0N

Explored by British Speleological, 1992

Hang Ruc Ca Roong is located in the South of the Phong Nha Nature Reserve. Turning right at the kilometre 29 on the Road number 20, the way goes to the new village that is Ban 39 (Ban Arem). This village was established in 1992 including almost the Arem people a minority hill tribe in this part of Vietnam. Before 1992, the Arem people inhabited scatter in the provisional houses or the caves in the jungle.

Ruc that means sink water, and Hang Ruc Ca Roong means the Ruc Cave at the Ca Roong stream.

This cave was described by D. Nodding in Vietnam Cave Report 1994 as:

"... We learn that the village name is Ca-Roong, the same name as the cave and is to become our home for the next 2 days.

... After the through cave we crossed the depression and climbed over a shoulder into a second depression, which lead to a large entrance. Hear we started surveying. The initial few survey legs were in the water and then along a dry oxbow which unfortunately did not last and its back into the

water. Although several entrances or daylight shafts are swum past, the cave is basically a single stream passage. More swimming, another oxbow and more swimming. It's 500m from the entrance before a sand and gravel floor is reached. The cave continues following sandbanks and boulders with occasional swims in between. The passage is up to 20m wide and generally about 13-17m high. There are occasions when rock columns split the passage or the river takes two routes but these all join up again.

A section follows for 100m or so which traverses over blocks with the river on the left-hand side. Due to the nature of the passage and lack of time the right hand wall was not checked out or seen.

After about 1300m of surveying we came across a pool without an outlet. With shocked faces we tried to guess where we had lost the main water, since we now had a boulder ramp leading off into the blackness. This resulted in a passage 30m wide and 15m high going up and over for about 300m before refining the river, which entered from a sump on the right hand side. A nice place to stop with 1650m surveyed.

On our way out of the cave we swam upstream from the cave entrance we started at, eventually reaching a final entrance below the through cave. Although there are several entrances they are all part of the same cave.

Our far point was reached 1.5 hours after leaving the surface and a few sweets eaten before setting off swimming once again. After 40m another sandbank is found with the river on the left. This continues for 50m before a stagnant methane pool is encountered. At the far end of the pool another joint is encountered that totally turns the cave and our feelings. Very little flow and a sump seem to be approaching fast, with the roof coming down to about 10m. Still it was another 360m before we could finally turn around. We felt that with no draught there was little chance of finding a by-pass and also since the sump pool is 360m long and 20m wide, finding where to dive would be quite difficult.

On our return we surveyed the other upstream passage we had missed the day before, across the depression and the through cave. This is all part of the same cave system..."

951 Rev  
5/7/2000  
# 3

UNITED NATIONS  
EDUCATION SCIENTIFIC CULTURAL ORGANIZATION

Date received:  
Identification No:

CONVENTION CONCERNING THE PROTECTION  
OF THE WORLD CULTURAL AND NATURAL HERITAGE

(APPENDIX)  
PART 2

WORLD HERITAGE LIST  
NOMINATION FORM

**THE PHONG NHA-KE BANG  
NATIONAL PARK  
VIETNAM**

## CONTENTS: PART II

### Appendix 2a

- List of threatened plant and Animal species at Phong Nha - Ke Bang National Park
  - List of Plant
  - List of Mammal
  - List of Birds
  - List of Reptiles and Amphibians

### Appendix 3a

- List of plant and animal species at Phong Nha - Ke Bang National Park
  - List of Plant species at Phong Nha - Ke Bang National Park
  - List of Mammal species at Phong Nha - Ke Bang National Park
  - List of Birds species at Phong Nha - Ke Bang National Park
  - List of Reptiles and Amphibians at Phong Nha - Ke Bang National Park
- A Preliminary assessment of the conservation importance and conservation priorities of the Phong Nha - Ke Bang proposed National Park - Quang Binh Province - Vietnam  
(Fauna & Flora International - Indochina Programme. R.J. Timmins-Do Tuoc-Trinh Viet Cuong, D.K. Hendrichsen)
- Results of the complex zoological botanical expedition to the Ke Bang area (Final Report: Vietnam Russian tropical centre world wide fund for nature action grant)
- Results of survey on mammal fauna in Phong Nha - Ke Bang area - Quang Binh - Vietnam (Fauna and Flora International - Indochina office Hanoi - Institute of Ecology and Biological resources)

### Appendix 4b

Copies of state decisions and documents concerning the property

### Appendix 4i

Statistics of Hotels, guest houses and visitors in Quang Binh Province

**Appendix 2a**

**LIST OF THREATENED PALNT AND ANIMAL  
AT PHONG NHA KE BANG NATIONAL PARK**

## Appendix 2a.

### LIST OF THREATENED PLANT AND ANIMAL SPECIES AT PHONG NHA-KE BANG NATIONAL PARK

#### 1. List of plant

No.	Scientific name	Vietnamese name	RDB of Vietnam	Red list of IUCN	Morphology
1.	<i>Acer oblongum</i>	Thích thuôn		E	Gỗ lớn
2.	<i>Annamocarya sinensis</i>	Chò dãi	V	R	Gỗ lớn
3.	<i>Anoectochilus setaceus</i>	Lan kim tuyến	E		Cây thảo
4.	<i>Aquilaria crassna</i>	Trầm	E		Gỗ lớn
5.	<i>Ardisia silvestris</i>	Lá khôi	V		Dây leo
6.	<i>Breynia grandiflora</i>	Dẻ lớn		R	
7.	<i>Burretiodendron tonkinensis</i>	Nghiến	V	V	Gỗ lớn
8.	<i>Calamus dioicus</i>	Mây tít		R	Dây leo
9.	<i>Calamus platyacanthus</i>	Song mật	V		Dây leo
10.	<i>Calamus poilanei</i>	Song bột	K	V	Dây leo
11.	<i>Callophyllum calaba</i>	Công tía		V	Gỗ lớn
12.	<i>Callophyllum touranenense</i>	Công chai	R	R	Gỗ lớn
13.	<i>Cephalotaxus hainanensis</i>	Phỉ lược	R	V	Gỗ T bình
14.	<i>Chenopodium ambrosioides</i>	Dầu giun		I	Dây leo
15.	<i>Chukrasia tabularis</i>	Lát	K		Gỗ lớn
16.	<i>Cyanotis burmanniana</i>	Thài lài bích trai		R	Dây trườn
17.	<i>Cinnamomum mairei</i>	Re mai		E	Gỗ
18.	<i>Cosciniium fenestratum</i>	Vàng đắng	V	E	Dây leo
19.	<i>Cycas balansae</i>	Tuế núi đá	V		Cây bụi
20.	<i>Dacrydium pierrei</i>	Hoàng đàn giả	K		Gỗ lớn
21.	<i>Dalbergia cochinchinensis</i>	Cắm lai nam	V		Gỗ lớn
22.	<i>Dalbergia tonkiensis</i>	Sưa	V	V	Gỗ lớn
23.	<i>Dendrobium amabile</i>	Hoàng thảo	R		Cây thảo
24.	<i>Drynaria fortunei</i>	Cốt toái bổ	T		Bì sinh
25.	<i>Dialium cochinchinensis</i>	Xoay	V		Gỗ lớn

No.	Scientific name	Vietnamese name	RDB of Vietnam	Red list of IUCN	Morphology
26.	<i>Eodia simplicifolia</i>	Ba gạc đơn		R	Gỗ nhỏ
27.	<i>Fokienia hodginsii</i>	Pơ mu	K	R	Gỗ lớn
28.	<i>Garcinia fagraeoides</i>	Trai	R		Gỗ lớn
29.	<i>Helicia grandifolia</i>	Mạ sưa lá lớn	R		Gỗ T bình
30.	<i>Hopea hainanesis</i>	Sao hải nam	K	E	Gỗ lớn
31.	<i>Hopea pierrei</i>	Kiến kiến	K		Gỗ lớn
32.	<i>Hypericum japonicum</i>	Ban		I	Gỗ nhỏ
33.	<i>Illicium parviflorum</i>	Hồi núi		E	Gỗ nhỏ
34.	<i>Livistona chinensis</i>	Lá nón		R	Bụi
35.	<i>Madhuca hainanensis</i>	Sến hải nam		V	Gỗ lớn
36.	<i>Madhuca pasquieri</i>	Sến mật	T	E	Gỗ lớn
37.	<i>Manglietia rufibarbata</i>	Giổi xanh		E	Gỗ lớn
38.	<i>Markhamia stipulata</i>	Đinh	V		Gỗ lớn
39.	<i>Melientha suavis</i>	Sắng	K		Gỗ nhỏ
40.	<i>Morinda officinalis</i>	Ba kích	K		Dây leo
41.	<i>Nagegia fleuryi</i>	Kim giao	V	V	Gỗ lớn
42.	<i>Parashorea chinensis</i>	Chò chỉ	R	R	Gỗ lớn
43.	<i>Platanus kerri</i>	Chò nước	T		Gỗ lớn
44.	<i>Podocarpus neriifolius</i>	Thông tre	R		Gỗ T bình
45.	<i>Pterocarpus macrocarpus</i>	Giáng hương	V		Gỗ lớn
46.	<i>Rauwolfia verticillata</i>	Ba gạc	V		Cây bụi
47.	<i>Schoutenia hypoleuca</i>	Sơn tần	V		Gỗ lớn
48.	<i>Sindora tonkinensis</i>	Gụ	V		Gỗ lớn
49.	<i>Smilax glabra</i>	Thổ phục linh	T		Dây leo
50.	<i>Tarrietia javanica</i>	Huỳnh	V		Gỗ lớn
51.	<i>Zenia insignis</i>	Muồng lá đỏ	R		Gỗ nhỏ
<b>Total</b>			<b>38</b>	<b>25</b>	

**Legend:**

E: Endangered

T: Threatened

V: Vulnerable

R: Rare

I: Indeterminate

K: Insufficiently known

## 2. List of mammal

No.	Scientific name	English name	RDB of Vietnam	Red list of IUCN
1.	<i>Cynocephalus variegatus</i>		R	
2.	<i>Cynopterus brachyotis</i>	Lesser Short-nosed Fruit Bat	R	
3.	<i>Myotis siligorensis</i>	Small-toothed Whiskered Bat	R	
4.	<i>Ia io</i>	Great Evening Bat	R	LR
5.	<i>Nycticebus coucang</i>	Slow Loris	R	
6.	<i>Nycticebus pygmaeus</i>	Pygmy Loris	R	VU
7.	<i>Macaca mulatta</i>	Rhesus Macaque		LR
8.	<i>Macaca arctoides</i>	Stump-tailed Macaque	R	VU
9.	<i>Macaca assamensis</i>	Assam Macaque	R	VU
10.	<i>Macaca nemestrina</i>	Pig-tailed Macaque	R	VU
11.	<i>Trachypithecus francoisi hatinhensis</i>	Ha Tinh Leaf-eating Monkey	R	VU
12.	<i>Trachypithecus francoisi ebenus</i>		K	VU
13.	<i>Pygathrix nemaeus nemaeus</i>		E	EN
14.	<i>Hylobates concolor leucogenis</i>		E	DD
15.	<i>Hylobates concolor siki</i>			EN
16.	<i>Cuon alpinus</i>	Asian Wild Dog	E	VU
17.	<i>Helarctos malayanus</i>	Malayan Sun Bear	E	DD
18.	<i>Selenarctos thibetanus</i>	Asiatic Black Bear	E	VU
19.	<i>Aonyx cinerea</i>	Small-clawed Otter	V	LR
20.	<i>Lutra lutra</i>	Common Otter	T	
21.	<i>Lutra perspicilata</i>	Smooth-coated Otter	V	VU
22.	<i>Melogale personata</i>	Burmese Ferret-badger	R	
23.	<i>Arctictis binturong</i>	Binturong	V	
24.	<i>Arctogalidia trivirgata</i>		R	
25.	<i>Viverra zibetha</i>	Large Spotted Civet	E	
26.	<i>Chrotogale owstoni</i>		R	VU
27.	<i>Felis marmorata</i>	Marbled Cat		DD
28.	<i>Felis temminckii</i>	Clouded Leopard	R	



29.	<i>Neofelis nebulosa</i>	Leopard	E	VU
30.	<i>Panthera pardus</i>		E	
31.	<i>Panthera tigris</i>	Tiger	E	EN
32.	<i>Elephas maximus</i>	Elephant	V	EN
33.	<i>Sus bucculentus</i>		K	
34.	<i>Tragulus javanicus</i>	Lesser Mouse Deer	V	
35.	<i>Megamunticus vuquangensis</i>	Giant munjac	R	
36.	<i>Bos gaurus</i>	Gaus	E	
37.	<i>Capricornis sumatraensis</i>	Serow	V	VU
38.	<i>Pseudoryx nghetinhensis</i>		E	EN
39.	<i>Manis javanica</i>	Malayan Pangoln		LR
40.	<i>Hylopetes alboniger</i>		R	
41.	<i>Petaurista petaurista</i>	Giant Flying Squirrel	R	
<b>Total</b>			<b>37</b>	<b>24</b>

**Legend:**

***Red Data Book of Vietnam:***

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

K: Insufficiently Known

***IUCN Red List Threatened Animals:***

EN: Endangered

VU: Vulnerable

LR: Lower Risk

CR: Critically Endangered

DD: Data deficient

### 3. List of bird

No.	Scientific name	English name	RBD of Vietnam	Red list of IUCN
1	<i>Icthyophaga humilis</i>	Lesser Fishing Eagle		LR
2	<i>Aceros nipalensis</i>	Rufous-necked Hornbill		VU
3	<i>Aceros undulatus</i>	Wreathed Hornbill	T	
4	<i>Alcippe rufogularis</i>	Rufous-throated Fulvetta		LR
5	<i>Berenicornis comatus</i>	Long-crested Hornbill	E	
6	<i>Buceros bicornis</i>	Great Indian Hornbill	T	
7	<i>Carpococcyx renauldi</i>	Coral-billed Ground Cuckoo	T	LR
8	<i>Cissa hypoleuca</i>	Eastern Green Magpie		LR
9	<i>Jabouilleia danjoui</i>	Danjou's Babbler	T	VU
10	<i>Lophura diardi</i>	Siamese Fireback Pheasant	T	VU
11	<i>Lophura edwardsi</i>	Edward's Pheasant		CR
12	<i>Lophura hatinhensis</i>	Vietnamese Pheasant	E	EN
13	<i>Lophura imperialis</i>	Imperial Pheasant	E	CR
14	<i>Lophura nycthemera berliozii</i>	Silver Pheasant	E	
15	<i>Macronous kelleyi</i>	Grey-faced Tit-Babbler		LR
16	<i>Magaceryle lugubris</i>	Greater Pied Kingfisher	T	
17	<i>Niltava davidi</i>	Fukien Niltava		LR
18	<i>Pavo muticus</i>	Green Peafowl		VU
19	<i>Picus rabieri</i>	Red-collared Woodpecker		VU
20	<i>Pitta cyanea</i>	Blue Pitta	R	
21	<i>Pitta elliotii</i>	Elliot's Pitta	T	LR
22	<i>Pitta soror</i>	Blue-backed Pitta		LR
23	<i>Ptilolaemus tickelli</i>	Tickell's Hornbill		LR
24	<i>Rheinartia ocellata</i>	Crested Argus	T	VU
25	<i>Stachyris herberti</i>	Sooty Tree Babbler		VU
26	<i>Strix leptogrammica</i>	Brown Wood Owl	R	
27	<i>Urocissa whiteheadi</i>	White-winged Magpie		LR
<b>Total</b>			<b>15</b>	<b>20</b>

**Legend:**

**Red Data Book of Vietnam:**

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

**IUCN Red List Threatened Animals:**

EN: Endangered

VU: Vulnerable

LR: Lower Risk

CR: Critically Endangered

#### 4. List of reptiles and amphibians

No.	Scientific name	Vietnamese name	RDB of Vietnam	Red list of IUCN
1	<i>Acanthosaura lepidogaster</i>	Ô rô vảy	T	
2	<i>Bombina maxima</i>	Cóc tía	R	
3	<i>Bufo galeatus</i>	Cóc rùng	R	
4	<i>Bungarus fasciatus</i>	Rắn cạp nong	T	
5	<i>Cistolemmys galbinifrons</i>	Rùa hộp trán vàng	V	
6	<i>Cuora trifasciata</i>	Rùa hộp ba vạch	V	EN
7	<i>Gekko gekko</i>	Tắc kè	T	
8	<i>Indotestudo elongata</i>	Rùa núi vàng	V	VU
9	<i>Manouria impressa</i>	Rùa núi viền	V	VU
10	<i>Naja naja</i>	Rắn hổ mang	T	
11	<i>Ophiophagus hannah</i>	Rắn hổ chúa	E	
12	<i>Palea steindachneri</i>	Ba ba gai		LR
13	<i>Physignathus cocincinus</i>	Rồng đất	T	
14	<i>Platysternum megacephalum</i>	Rùa đầu to	R	
15	<i>Ptyas korros</i>	Rắn ráo thường	T	
16	<i>Ptyas mucosus</i>	Rắn ráo trâu	V	
17	<i>Python molurus</i>	Trăn đất	V	LR
18	<i>Rana andersoni</i>	Chàng An đéc sơn	T	
19	<i>Sacalia quadriocellata</i>	Rùa bốn mắt		VU
20	<i>Varanus salvator</i>	Kì đà hoa	V	
<b>Total</b>			<b>18</b>	<b>6</b>

#### Legend:

#### **Red Data Book of Vietnam:**

E: Endangered

V: Vulnerable

R: Rare

T: Threatened

#### **IUCN Red List Threatened Animals:**

EN: Endangered

VU: Vulnerable

LR: Lower Risk

CR: Critically Endangered

**Appendix 3a**

**LIST OF PLANT SPECIES AT PHONG NHA-KE BANG  
NATIONAL PARK**

PTERIDOPHYTA - QUYẾT THỰC VẬT

No.	Scientific name	Vietnamese name	Source
	1- ADIANTACEAE (K.Presl.) Ching	HỌ TÓC THẦN VỆ NỮ	
1	<i>Adiantum caudatum</i> L.	Tóc thần vệ nữ	
2	<i>A. sp.</i>		VR
3	<i>Coniogramme sp.</i>		VR
	2- ANGIOPTERIDACEAE Fée ex Bommer	HỌ MÓNG NGỰA	
4	<i>Angiopteris cochinchinensis</i> De Vriese	Móng ngựa	RAS, VR
	3- ASPLENIACEAE	HỌ CÁN XỈ	
5	<i>Asplenium nidus</i>		VR
6	<i>A. tenerum</i>		VR
	4- BLECHNACEAE Ching ex Copel.	HỌ RÁNG DỪA	RAS
7	<i>Blechnum orientalis</i> L.	Ráng dừa	RAS
8	<i>Woodwardia sp.</i>		VR
	5- CYATHEACEAE Kaulf.	HỌ DƯƠNG XỈ MỘC	
9	<i>Cyathea contaminans</i> (Wall.) Copel.	Dương xỉ tọa bần	RAS
10	<i>C. glabra</i> (Bl.) Copel.	Dương xỉ mộc	RAS
	6- DENNSTAEDTIACEAE Ching ex Pic. - Ser	HỌ ĐĂNG TIẾT	
11	<i>Microlepis marginata</i> (Houtt.) C. Chr.	Ráng vi lân bìa	RAS
	7 - DICKSONIACEAE Hook. ex Bower	HỌ LÔNG CU LY	
12	<i>Cibotium barometz</i> (Milld.) J. Smith	Lông cu ly- làm thuốc	RAS
	9- DRYOPTERIDACEAE		
13	<i>Rumohra diffracta</i>		VR
14	<i>Cyclosorus sp.</i>		VR
	9- GLEICHENIACEAE (R.Br.) K.Presl	HỌ TUẾ	

No.	Scientific name	Vietnamese name	Source
15	<i>Dicranopteris linearis</i> (Burm.) Andrew	Tế, Guột - đan lát	RAS
	10- HYMENOPHYLACEAE Link	HỌ DƯƠNG XỈ MÀNH	
16	<i>Hymenophyllum</i> sp.		VR
17	<i>Vandenboschia auriculatum</i> (Bl.) Copel	Ráng dăng	RAS
	11-LEPIDOPTERIDACEAE	HỌ TAI CHUỘT	
18	<i>Lemmaphyllum microphyllum</i> Presl.	Tai chuột	RAS
	12. LINDSAEACEAE Chung ex Pic.-Ser.	HỌ LIÊN SƠN	
19	<i>Lindsaea</i> sp	Dương xỉ ngô công	RAS
	13- LYCOPODIACEAE Beauv ex Mirb.	HỌ THÔNG ĐẤT	
20	<i>Lycopodium cernuum</i> L.	Thông đất	RAS
21	<i>L. squarrosum</i>		VR
	14. LYGODIACEAE K. Presl.	HỌ BÔNG BONG	
22	<i>Lygodium auriculatum</i>		VR
23	<i>L. conforme</i> C. Chr.	Bông bong	RAS
24	<i>L. flexuosum</i> (L.) Sw.	Bông bong - thuốc	RAS
25	<i>L. japonicum</i> (Thunb.) Sw.	Bông bong - Thuốc	RAS
26	<i>L. microphyllum</i>		VR
	15-MARSILEACEAE Mirbel	HỌ RAU BỢ	
27	<i>Marsilea minuta</i> L.	Rau bợ	RAS
	16- POLYPODIACEAE Bercht. et J.Prel	HỌ RAU RÁNG	
28	<i>Colysis longisora</i>		VR
29	<i>Drynaria bonii</i> Chriet	Tắc kè đá	RAS
30	<i>Phymatodes</i> sp.		VR
31	<i>Polypodium argutum</i>		VR
32	<i>Pyrrosia</i> sp.		VR
	17- PSILOTACEAE		
33	<i>Psilotum nudum</i>		VR
	18. PTERIDACEAE H. Reichenb.	HỌ CHÂN XỈ	
34	<i>Histiopteris incisa</i>		VR
35	<i>Pteridium aquilinum</i>		VR
36	<i>Pteris eretica</i> L.	Chân xỉ hy lạp	RAS

No.	Scientific name	Vietnamese name	Source
37	<i>P. ensiformis. Burm.</i>	Seo gà - thuốc	RAS
38	<i>P. linearis Poir.</i>	Chân xỉ	RAS
39	<i>P. semipinnata L.</i>	Ráng lửa	RAS
	19- SELAGINELLACEAE WILLK	HỌ QUYẾN BÁ	
40	<i>Selaginella dolichoclada (Besv.) Baker</i>	Quyến bá nhánh dài	RAS
	20- VITARIACEAE		
41	<i>Vitaria sp.</i>		VR

### GYMNOSPERMAE - THỰC VẬT HẠT TRẦN

No.	Scientific name	Vietnamese name	Source
	1- CEPHALOTAXACEAE	HỌ ĐÌNH TÙNG	SỬ DỤNG
1	<i>Cephalotaxus drupacea Sieb et Zucc</i>	Phỉ lược - gỗ	RAS
	2- CUPRESSACEAE Bartl.	HỌ HOÀNG ĐÀN	
2	<i>Fokienia hodginssi (Dunn) Henry et Thomas</i>	Phơ mu- gỗ, tinh dầu	RAS
	3- CYCADACEAE	HỌ THIÊN TUẾ	
3	<i>Cycas balancae</i>	Thiên tuế núi đá- cảnh	RAS
	4- GNETACEAE Lindl.	HỌ GẮM	
4	<i>Gnetum montanum var. megalocarpum Mgf.</i>	Gắm-ăn hạt	RAS
5	<i>G. Macrostachyum Hook f.</i>	Gắm chùm to	RAS
	5- PODOCARPACEAE Endl.	HỌ KIM GIAO	
6	<i>Dacrydium pierrei Hickel</i>	Hoàng đàn giả- gỗ tốt	RAS
7	<i>Podocarpus fleuryi Hickel (Nageia fleuryi)</i>	Kim giao- gỗ tốt	RAS
8	<i>Podocarpus imbicatus (BL.) de Laubent</i>	Thông nạng- gỗ tốt	RAS
9	<i>Podocarpus neriifolius D. Don</i>	Thông tre - gỗ tốt	RAS
10	<i>P. wallichianus (Presl.) de Laubenf</i>	Kim giao- gỗ tốt	RAS

MAGNOLIOPHYTA - MAGNOLIÓPIDA - THỰC VẬT HAI LÁ MẦM  
(ANGIOSPERMAE-DICOTYLEDONES)

No.	Scientific name	Vietnamese name	Source
	1- ACANTHACEAE Juss.	HỌ Ô RÔ	
1	<i>Asistaria gangetica</i> (L.) T. Anders.		RAS
2	<i>Justicia</i> sp.		VR
3	<i>Neuracanthus tetragonostachyus</i> Nees in Wall.		RAS
4	<i>Pghlogacanthus yunnanensis</i> R. Ben		RAS
5	<i>Pseudoranthemum palatiferum</i> Radlk.		RAS
6	<i>Stropbilanthes</i> sp.		VR.
7	<i>Thunbergia geoffrayi</i> Benth	Dây bông báo	RAS
8	<i>T. laurifolia</i> Lind	Các đàng	RAS
	2 - ACERACEAE Juss.	HỌ THÍCH	
9	<i>Acer campbellii</i> Hook et Thoms ex Hiern var <i>campbellii</i>	Thích tùng	RAS
10	<i>A. calcaratum</i>		VR
11	<i>A. decandrum</i> Merro	Thích to nhị	RAS, VR
12	<i>A. laurinum</i> Hassk	Thích lá re	RAS
13	<i>A. laevigatum</i> Wall	Thích lá đơn	RAS
14	<i>A. oblongum</i> Wall ex DC.	Thích thun	RAS
	3- AIZOACEAE Rudol.	HỌ A PHIÊN,	
15	<i>Glinus oppositifolius</i> (L.) DC.	Rau đắng đất- thuốc	RAS
	4- ALANGIACEAE DC.	HỌ THÔI CHANH	
16	<i>Alangium kurzii</i> Craib	Thôi ba	RAS
17	<i>A. sp.</i>	Thôi ba bụi	RAS
	5- AMARANTHACEAE Juss.	HỌ RAU DỀN	
18	<i>Amaranthus spinosus</i> L.	Dền gai- ăn , Thuốc	RAS
19	<i>A. tricolor</i> L.	Rau dền - Rau	RAS
20	<i>Cyathula prostrata</i> (L.) Bl.	Cỏ cước dài - Thuốc	RAS
	6-ANACARDIACEAE Lindl.	HỌ ĐÀO LỘN HỘT	
21	<i>Allospondias lakonensis</i> (Pierre) Stapf.	Dầu gia xoan-Gỗ, ăn quả, bóng mát	RAS

No.	Scientific name	Vietnamese name	Source
22	<i>Buchanania arborescens</i> (Bl.) Bl	Chây sung	RAS
23	<i>B. lucida</i> Bl	Sung	RAS
24	<i>B. sp.</i>		RAS
25	<i>Dracontomelum duperreanum</i> Pierre	Sấu	RAS
26	<i>Mangifera foetida</i>		VR
27	<i>Semecarpus anacardiopsis</i> Evr. et Tard.	Sung	RAS
28	<i>S. annameusis</i> Tard.	Sung nam	RAS
29	<i>S. perniciosus</i> Evr. et Tard.		RAS
30	<i>Taxicodendron succedanea</i> (L.) Mold..	Sơn rừng - Gỗ nhỏ	RAS
	7- ANCISTROCLADACEAE Walpers.	HỌ TRUNG QUÂN	
31	<i>Ancistrocladus cochinchinensis</i>		VR
32	<i>A. tectorius</i> (Lour.) Merr..	Dây trung quân	RAS
	8-ANNONACEAE Juss.	HỌ NA	
33	<i>Alphonsea boniana</i> Fin. et Gagnep.	An phong	RAS
34	<i>A. monogyna</i> Merr. et Chun		RAS
35	<i>Annona muricata</i> L.	Mãng cầu xiêm-Ăn quả, thuốc	RAS
36	<i>A. squamosa</i> L.	Na-Ăn quả, Thuốc trừ sâu	RAS
37	<i>Artabotrys</i> sp.		VR
38	<i>Dasymaschalon</i> sp.		VR
39	<i>Desmos chinensis</i>		VR
40	<i>D. cochinchinensis</i> Lour.	Hoa dẻ lông đen-Thuốc	RAS
41	<i>D. dinhensis</i> (Fin. et gayn.) Merr	Dù dẻ	RAS
42	<i>Fissistigma</i> sp.		VR
43	<i>Goniothalamus</i> sp.		VR
44	<i>Miliusa</i> sp.	Song môi	RAS
45	<i>M. calcarea</i> Dich	Na hồng	RAS
46	<i>M. elongata</i> Craib.	Mại liễu dài	RAS
47	<i>M. velutina</i> Hook. f et th.	Mại liễu	RAS
48	<i>Mitrephora thorelii</i>		VR
49	<i>Polyanthia ceraoides</i> (Roxb.) Benth. et Hook	Nhọc	RAS



No.	Scientific name	Vietnamese name	Source
50	<i>P.corticosa (Pierre) Fin. et gagn.</i>	Nhọc	RAS
51	<i>P. jucunda (Pierre) Fin. et gagno</i>		RAS
52	<i>P. laui Merr.</i>		RAS
53	<i>Xylopia pierrei Hance</i>	Diên trắng	RAS
54	<i>Uvaria cordata (Dun.) Wall ex Alstan</i>	Giấy dất mè	RAS
55	<i>U. grandiflora Roxb.</i>	Giấy dất	RAS
	9- APIACEAE Juss.	HỌ HOA TÁN	
56	<i>Centella asiatica (L.) Urb.</i>	Rau má-Gia vị, Thuốc	RAS
57	<i>Eryngium foetidum L.</i>	Mùi tàu-Gia vị, Thuốc	RAS
58	<i>Hydrocotyle nepalnsis Hook.</i>	Rau má núi	RAS
	10-APOCYNACEAE Juss.	HỌ TRÚC ĐÀO	
59	<i>Alstonia mairei Levl.</i>	Sữa lá nhỏ	RAS
60	<i>A. scholaris (L.) R.Br.</i>	Sữa-Gỗ xấu, Thuốc	RAS
61	<i>Bousingonia mekongensis Pierre</i>	Dây bù liêu	RAS
62	<i>Melodinus locii Ly</i>	Dom lợn	RAS
63	<i>M. myrtifolius Pit</i>		RAS
64	<i>M. sylvaticus Pit</i>	Dom rừng	RAS
65	<i>Rauwolfia verticillata (lour.) Baill.</i>	Ba gạc vòng	RAS
66	<i>Strophantus sp.</i>		VR
67	<i>Tabernaemontana jasminiflora Pit</i>	Ly lài	RAS
68	<i>T. laotica</i>		VR
69	<i>T. microphylla Pit</i>	Ly lài lá nhỏ	RAS
70	<i>Wrightia annamensis Eb.et Dub.</i>	Thùng mức trung-Gỗ nhỏ	RAS
71	<i>W.pubescens R.Br.</i>	Thùng mức lông-Gỗ nhỏ, Điều khác	RAS
	11-AQUIFOLIACEAE Benth.	HỌ NHỰA RUỒI	
72	<i>Ilex crenata Thunb.</i>	Nhựa ruồi	RAS
	12. ARALIACEAE Juss.	HỌ NGŨ GIA BÌ	
73	<i>Aralia armata (Wall. ex G.Don) Seem.</i>	Đơn châu chấu - Thuốc	RAS
74	<i>Brassaiopsis Decne et Planch.</i>		RAS
75	<i>B.sp<sub>1</sub></i>		RAS

No.	Scientific name	Vietnamese name	Source
76	<i>B.sp<sub>2</sub></i>		RAS
77	<i>Heteropanax fragrans</i> Seem	Lọng - Gỗ nhỏ	RAS
78	<i>Schefflera octophylla</i> Harms	Chân chim - gỗ nhỏ, Thuốc	RAS
79	<i>Trevesia</i> sp.		VR
80	<i>Tubidantus calyptratus</i> Hòk f. tb.		RAS
	13- ARISTOLOCHIACEAE	HỌ GIẾ RÁCH	
81	<i>Aristolochia contorta</i> Bge	Khố rách	RAS
82	<i>A.elongnaiensis</i> Pierre ex Lec.	Khố rách	RAS
83	<i>A. pierrei</i> H. Lec	Khố rách	RAS
84	<i>Asarum tragala</i> chamiss	Sơn dịch	RAS
85	<i>A. caudigerum</i> Hance	Sơn dịch	RAS
	14-ASCLEPIADACEAE R.Br.	HỌ THIÊN LÝ	
86	<i>Dischidia collyris</i> Wall	Tai chuột	RAS
87	<i>Hoya diversifolia</i> Bl.	Cắm cù lá khác	RAS
88	<i>H. macrophylla</i> Bl.	Cắm cù lá lớn	RAS
89	<i>H. obovata</i> Druce	Cắm cù lá dầy	RAS
90	<i>H. sp.</i>	Cắm cù lạ	RAS
91	<i>Streptocaulon juvenas</i> Merr	Hà thủ ô trắng - Thuốc	RAS
	15- ASTERACEAE Dum.	HỌ CÚC	
92	<i>Ageratum conyzoides</i> L.	Cỏ hôi, Cứt lợn	RAS
93	<i>Artemisia vulgaris</i> L.	Ngải cứu-Thuốc, rau	RAS
94	<i>Bidens pilosa</i> L.	Đơn buốt - Thuốc	RAS
95	<i>Blumea balsamifera</i> DC.	Đại bị -Thuốc	RAS
96	<i>B. lacera</i> (Burm. f.) DC.	Hoàng đầu	RAS
97	<i>Conyza canadensis</i>		VR
98	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Rau tàu bay - Rau	RAS
99	<i>Eclipta alba</i> (L.) Hassk.	Nhọ nôi - Thuốc	RAS
100	<i>Elephantopus scaber</i> L.	Cúc chỉ thiên	RAS
101	<i>Emilia scabra</i> DC.	Chua lè nhám	RAS
102	<i>E.sonchifolia</i> (L.) DC	Rau má lá rau muống- Rau, Thuốc	RAS

No.	Scientific name	Vietnamese name	Source
103	<i>Epaltes australis</i> Less	Lúc bò	RAS
104	<i>Erigeron canadensis</i> L.	Thượng lão - Rau, Thuốc	RAS
105	<i>Eupatorium odoratum</i> L.f.	Cỏ lào - Phân xanh	RAS
106	<i>Sphaeranthus africanus</i> L.	Cỏ chân vịt	RAS
107	<i>Synedrella nodiflora</i> (L.) Gaertn.	Bọ xít - Thức ăn vật nuôi	RAS
108	<i>Vernonia patula</i> (Dryand) Merr.	Cúc bạc đầu nhỏ	RAS
109	<i>Wedelia urticaefolia</i> DC	Sơn cúc nhám	RAS
110	<i>Xanthium strumarium</i>	Ké đầu ngựa - Thuốc	RAS
	16-BALSAMINACEAE		
111	<i>Impatiens</i> sp.1.		VR
112	<i>I.</i> sp.2.		VR
	17- BEGONIACEAE Agardh.	HỌ THU HẢI ĐƯỜNG	
113	<i>Begonia boisiana</i> Gagn.	Thu hải đường	RAS
114	<i>B. davisii</i> Veitch.	Thu hải đường đa vit	RAS
115	<i>B. eberhardtii</i> Gagn.	Thu hải đường	RAS
116	<i>B. lecontei</i> Gagnep.	Thu hải đường	RAS
117	<i>B. sp</i>	Thu hải đường lá lệch	RAS
	18- BIGNONIACEAE Juss	HỌ CHÙM ỚT	
118	<i>Oroxylon indicum</i> (L.) Vent		RAS
119	<i>Markhamia indica</i> (Lour.) Phamh.	Đinh - gỗ	RAS
120	<i>M. stipulata</i>	Đinh	RAS
121	<i>Radermachera alata</i> Dop.		RAS
122	<i>R. boniana</i> Merr.		RAS
123	<i>R. hainanensis</i> Merr.		RAS
124	<i>Stereospermum neuranthum</i> Kuzz	Quao	RAS
	19- BORAGINACEAE Juss.	HỌ VÒI VOI	
125	<i>Heliotropium indicum</i> L.	Vòi voi - Thuốc	RAS
	20 - BUDDLEIACEAE Salisb.	HỌ BỌ CHÓ	
126	<i>Buddleia asiatica</i> Lour	Bọ chó - Thuốc	RAS
	21- BURSERACEAE Kunth.	HỌ TRÁM	

No.	Scientific name	Vietnamese name	Source
127	<i>Canarium album</i> (Lour.) Raeusch. ex DC.	Trám trắng	RAS
128	<i>Garuga pinnata</i> Roxb	Trám mao	RAS
129	<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Cọ phèn	RAS
	22-CAESALPINIACEAE R.Br	HỌ VANG	
130	<i>Bauhinia pierrei</i> Gugn	Móng bò	RAS
131	<i>Cassia hirsuta</i> L.	Muống lông-Phân xanh	RAS
132	<i>C. siamea</i> Lam	Muống đen-Gỗ rất tốt, Cây cảnh	RAS
133	<i>C. tora</i> L.	Thảo quyết minh - thuốc	RAS
134	<i>Dialium cochinchinensis</i> Pierre	Xoay	RAS
135	<i>Erythrophleum fordii</i> Oliv.	Lim xanh	RAS
136	<i>Gleiditschia australis</i> Hemsl.	Bồ kết - Cho saponin	RAS
137	<i>Lasiobema curtisii</i> (Prain) de Wit.	Móng bò lá xẻ	RAS
138	<i>L. scandens</i> (L.) de wit. var. <i>horsfieldii</i> (Wll. ex (Prain.) de Wit.		RAS
139	<i>Pelthophorum tonkinensis</i> Pierre	Lim xẹt - gỗ tốt	RAS
140	<i>Piliostigma saccocalyx</i> (Pierre) Phamh.	Móng bò	RAS
	23- CAMPANALACEAE Juss.	HỌ HOA CHUÔNG	
141	<i>Pentaphragma sinense</i> (Hemsl.) Wills.	Rau tai voi - Rau ăn	RAS
	24. CAPPARACEAE Juss.	HỌ MÀM MÀN	
142	<i>Capparis acutifolia</i> Sw. spp. <i>obovata</i> Jacob	Cáp nhọn	RAS
143	<i>Cleome gynandra</i> L.	Màn màn trắng - Rau	RAS
144	<i>C. vicosa</i> L.	Màn màn vàng	RAS
145	<i>Crateva nurvala</i> Buch. - Ham.	Bún	RAS
146	<i>C. unilocularis</i>		VR
147	<i>Stixis mollis</i> Pierre	Tiết xích lông	RAS
	25. CAPRIFOLIACEAE Juss	HỌ CƠM CHÁY	
148	<i>Sambucus eberhardtii</i>		VR
149	<i>S. javanica</i> Reinw. ex Bl.	Cơm cháy - Thuốc	RAS
	26- CARICACEAE Dum.	HỌ ĐU ĐỦ	
150	<i>Carica papaya</i> L.	Đu đủ - Ăn quả	RAS
	27-CELASTRACEAE R.Br	HỌ VỆ MAO	

No.	Scientific name	Vietnamese name	Source
151	<i>Euvonymus longipedicellata</i> Merr. et Chun	Vệ mao	RAS
152	<i>Glyptopetalum calyptratum</i> Pierre	Xâm cánh chóp	RAS
153	<i>G. chaudocensis</i> Pierre	Xâm cánh	RAS
	28-CHENOPODIACEAE Vent.	HỌ RAU MUỐI	
154	<i>Chenopodium ambrosioides</i> L.	Dầu giun - Thuốc	RAS
	29-CHLORANTHACEAE R.Br	HỌ HOA SÓI	
155	<i>Chloranthus</i> sp.	Hoa sói	RAS
	30-CLUSIACEAE Lindl.	HỌ BỨA	
156	<i>Callophyllum calaba</i> L.var. <i>bracteatum</i> (Wight) Stevens	Công tía	RAS
157	<i>C. balansae</i> Pit.	Công rừ rì	RAS
158	<i>C. dryobalanoides</i> Pierre	Công trắng	RAS
159	<i>C. touranenense</i> Gagn. ex Stevens	Công chai	RAS
160	<i>Cratoxylon cochinchinense</i> (Lour.) Bl.	Thành ngạnh-Gỗ nhỏ, Thuốc	RAS, VR
161	<i>C. formosum</i> (Jack.) Dyer. ssp. <i>Pruniflorum</i> (Kurz)	Đỏ ngọn-Gỗ nhỏ-Thuốc	RAS
162	<i>Garcinia cowa</i>		RAS
163	<i>G. fagraeoides</i> A.Chev.	Trai	RAS
164	<i>G. fusca</i> Pierre	Bứa sơn vé	RAS
165	<i>G. merguensis</i> Wight	Bứa lửa	RAS
166	<i>G. schfferi</i> Pierre	Bứa	RAS
167	<i>Mesua feruginea</i> (Pierre) Kosterm	Vấp	RAS
168	<i>Hypericum japonicum</i> Thunb.	Ban - Thuốc	RAS
	31-COMBRETACEAE R.Br.	HỌ BÀNG	
169	<i>Anogeissus tonkinensis</i> Gagnep.	Chò nhai - Gỗ	RAS
170	<i>Calycopteris floribunda</i> (Roxb.) Lamk	Dây cánh sao	RAS
171	<i>Quisqualis indica</i> L.	Sử quân tử - Thuốc	RAS
172	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Choại - Gỗ	RAS
173	<i>T. myriocarpa</i> Heurck et Muell.	Chò xanh - Gỗ	RAS
	32-CONNARACEAE R.Br	HỌ DÂY KHẾ	
174	<i>Connarus paniculatus</i>		VR
175	<i>Rourea minor</i> (Gaertn.) Aubl	Tróc cầu, Dây khế	RAS

No.	Scientific name	Vietnamese name	Source
176	<i>Agelaea sp.</i>		VR
	33-CONVOLVULACEAE Juss	HỌ BÌM BÌM	
177	<i>Argyrea mollis (Burm.f.) Choisy</i>	Bạc thau - Thuốc	RAS
178	<i>Hewittia sublobata (L.f) O. ktze</i>	Bìm lưỡng sắc	RAS
	34. CUCURBITACEAE Juss.	HỌ BẦU BÍ	
179	<i>Citrullus lanatus (Thunb.) Mansf.</i>	Dưa hấu - Ăn quả	RAS
180	<i>Gymnopetalum cochinchinense (Lour.) Mak.</i>	Cức quạ - Thuốc	RAS
181	<i>Gynostemma pentaphyllum (Thumb.) Mak</i>	Dây lữa hùng	RAS
182	<i>Hodgsonia macrocarpa (Bl.) Cogn.</i>	Đại hái - Dầu, Thuốc	RAS
183	<i>Lagenaria siceraria (Molina) Stadley</i>	Bầu - Rau	RAS
184	<i>Melothria heterophylla</i>		VR
185	<i>Solena heterophylla Lour.</i>	Hoa bát - Thuốc	RAS
186	<i>Thladiantha cordifolia (bl.) Cogn.</i>		RAS
187	<i>Trichosanthes rubriflos Thorel ex Cayla</i>	Dây tơ mua	RAS
	35-DATISCACEAE	HỌ TUNG	
188	<i>Tetramenles nudiflora</i>	Tung	VR
	36- DILLENACEAE Salisb	HỌ SỔ	
189	<i>Dillenia aurea Sw.</i>	Sổ đỏ	RAS
190	<i>D. pentagyna Roxb.</i>	Sổ năm nhụy - Gỗ	RAS
191	<i>D. turbinata Fin. et Gagn.</i>	Sổ con quay - Gỗ	RAS
192	<i>Tetracea scandens</i>		VR
	37- DIPTEROCARPACEAE Bl.	HỌ DẦU	
193	<i>Dipterocarpus hasseltii Bl.</i>	Dầu hạt xen ti	RAS
194	<i>D. gracilis Bl.</i>	Dầu lá cứng dài	RAS
195	<i>D. kerrii King</i>	Dầu keo - Gỗ	RAS, VR
196	<i>Hopea hainanese</i>	Sao hải nam - gỗ	RAS
197	<i>H. pierrei Hance</i>	Kiên kiên, Tấu mặt - gỗ	RAS
198	<i>H. siamensis Heim</i>	Kiên kiên - gỗ	RAS
199	<i>H. reticulata Tardieu</i>	Sao mạng - Gỗ	RAS
200	<i>H. mollissima.</i>	Sao mặt quý - Gỗ	RAS
201	<i>H. sp.</i>	Sao đá	RAS

No.	Scientific name	Vietnamese name	Source
202	<i>Parashorea chinensis</i>	Chò chỉ	RAS
203	<i>Vatica diospyroides</i> Sym.	Tấu muối	RAS
	38-EBENACEAE Gurke	HỌ THỊ	
204	<i>Diospyros eriantha</i> Champ	Thị lộ nổi - Gỗ nhỏ	RAS
205	<i>D. eugenii</i> H.Lec	Thị trám - Gỗ nhỏ	RAS
206	<i>D. kaki</i> Lin. f. var. <i>sylvestris</i> Mak.	Hồng rừng - Gỗ	RAS
207	<i>D. lucida</i> Hiem	Săng đen	RAS
208	<i>D. Salleti</i> H.Lec.?	Mun - Gỗ rất quý	RAS
209	<i>D. pilosella</i> H.Lec.	Nhọ nổi	RAS
	39-ELAEOCARPACEAE DC.	HỌ CÔM	
210	<i>Elaeocarpus bachmaensis</i> Gagn.	Côm bạch mã - Gỗ	RAS
211	<i>E. dubius</i> A.DC	Lôm côm - Gỗ	
212	<i>E. hainanensis</i> Oliv.	Côm hải nam	
213	<i>E. laoticus</i>	Côm Lào	VR
214	<i>E. limitaneus</i> Hand - Mazz.	Côm núi - Gỗ	RAS
215	<i>E. sylvestris</i> (Lous) Poir.	Côm rừng - Gỗ	RAS
216	<i>E. varunua</i>		VR
217	<i>E. hardmandii</i>		VR
218	<i>Sloanea</i> sp.		VR
	40-ERICACEAE Juss.	HỌ ĐỔ QUYÊN	
219	<i>Lyonia ovalifolia</i> (Wall.) Drude	Nam chúc - Gỗ nhỏ	RAS
220	<i>Vaccinium exaristatum</i> Kurz.	Ổng ảnh	RAS
221	<i>Rhododendron</i> sp.		VR
	41-EUPHORBIACEAE Juss	HỌ THẦU DẦU	
222	<i>Acalypha camophylla</i> Hemsl	Tai tượng	RAS
223	<i>A. australis</i> L.		RAS
224	<i>A. evrardii</i> Gagn.	Trà cộc rào - Hàng rào, Thuốc	RAS
225	<i>A. lanceolata</i> Willd		RAS
226	<i>Actephila excelsa</i> var <i>aucuminata</i> Airy Shaw	Quả treo	RAS
227	<i>Alchornea annamica</i> Gagn.	Bọ nẹt	RAS
228	<i>A. rugosa</i> (Lour.) Muell. Arg.	Bọ nẹt	RAS

No.	Scientific name	Vietnamese name	Source
229	<i>A. rugosa</i> Muell. Arg.	Sòi đại	RAS
230	<i>Aleurites montana</i> (Lour) E. H. Wils.	Chấu - Dầu béo	RAS
231	<i>Antidesma bunius</i> Spreng.	Chòi mòi	RAS
232	<i>A. cochinchinensis</i> Gagnep.	Chòi mòi nam	RAS
233	<i>A. diandrum</i> Roth.	Chòi mòi song hùng	RAS
234	<i>A. henryi</i> Paz, et Hoffm.	Chòi mòi	RAS
235	<i>A. montanum</i> Bl.	Chòi mòi	RAS
236	<i>Aporosa</i> sp	Thầu tấu	RAS
237	<i>Baccaurea sapida</i> Muell - Arg.	Giâu gia - Ăn quả	RAS
238	<i>B. sp</i>	Dầu trắng - Ăn quả	RAS
239	<i>Bischofia javanica</i> Bl.	Nhội	RAS
240	<i>Breynia fruticosa</i> (L.) Benth	Bò cu vẽ - thuốc	RAS
241	<i>B. grandiflora</i> Beille	Dé dón	RAS
242	<i>B. septata</i> Beille	Bồ cu vẽ	RAS
243	<i>Bridelia balansae</i> Tutch	Đóm	RAS
244	<i>B. monoica</i> (Lour.) Merr.	Đóm lá nhỏ- Gỗ nhỏ	RAS
245	<i>B. poilanei</i> Gag.		RAS
246	<i>Breyniopsis</i> sp.		VR
247	<i>Claoxylon longifolium</i> (Bl.) Endl. ex Hassk	Lộc mại	RAS
248	<i>C. polot</i> (Burm. f.) Merr	Bồ lột	RAS
249	<i>Cleistanthus acuminatus</i> Muell. - Arg.	Bế hoa	RAS
250	<i>C. pierrei</i>	Song bế - Gỗ nhỏ	RAS
251	<i>Croton roxburghianus</i> Bal.	Cô tông rốc	RAS
252	<i>C. yunanensis</i> W.W.Swith	Công tông vân nam	RAS
253	<i>Deutzianthus tonkinensis</i> Gagnep.	Mọ	RAS
254	<i>Drypetes perreticulata</i>	Hèo đá	RAS
255	<i>Endospermum chinense</i> Benth .	Vạng trứng - Gỗ xấu	RAS
256	<i>Euphorbia hirta</i> L.	Cỏ sữa lá lớn - Thuốc	RAS
257	<i>E. thymifolia</i> Burm.	Cỏ sữa lá nhỏ - Thuốc	RAS
258	<i>Excoecaria cochinchinensis</i> Lour.	Bê hê	RAS
259	<i>Glochidion eriocarpum</i> Champ.	Sóc quả lông	RAS
260	<i>G. hirsutum</i> L.	Bọt ếch lông	RAS
261	<i>G.lanceolarium</i> (Roxb.) Voight.	Bọt ếch lá mác	RAS



No.	Scientific name	Vietnamese name	Source
262	<i>G. molle</i> Hook. et Arn	Sóc	RAS
263	<i>G. obliquum</i> Dcne	Bột ếch thôn	RAS
264	<i>G. Zeylanicum</i> A.Juss.	Sóc	RAS
265	<i>Homonoia riparia</i> Lour	Rù rì - Cố định bãi cát	RAS
266	<i>Jatropha curcas</i> L.	Dầu mè - Dầu béo, Thuốc	RAS
267	<i>Macaranga denticulata</i> Muell. - Arg.	Lá nển - Gỗ nhỏ	RAS
268	<i>M. tanarius</i> Muell. - Arg.	Lá nển nhẵn - Gỗ nhỏ	RAS
269	<i>Mallotus apelta</i> Muell. - Arg.	Ba bét - Thuốc độc với cá	RAS
270	<i>M. bartatus</i> Muell. - Arg.	Hu nâu - Củi	RAS
271	<i>M. hookerianus</i> Muell. Arg.	Bùm bụp	RAS
272	<i>M. paniculatus</i> (Lamk.) Muell. - Arg.	Ba soi - Củi	RAS
273	<i>M.peltatus</i> . (Geis.) Muell. Arg.	Bum bụp	RAS
274	<i>Manihot esculenta</i> Crantz.	Sắn, Củ mì - Bột	RAS
275	<i>Microdesmis casearifolia</i> Pl.	Chấn - Gỗ nhỏ, Thuốc	RAS
276	<i>Oligoceras eberhardtii</i> Gagnep.	Noi	RAS
277	<i>Ostodes paniculata</i> Bl.	- Gỗ ót	RAS, VR
278	<i>Phyllanthus nirurii</i> L.	Cỏ chó đẻ	RAS
279	<i>P. quangtriensis</i> Beille	Chó đẻ quảng trị	RAS
280	<i>P. rubes</i> Spreng	Diệp châu	RAS
281	<i>P. urinaria</i> L.	Chó đẻ - Thuốc	RAS
282	<i>Sapium baccatum</i> Roxb.	Sòi - Gỗ nhỏ	RAS
283	<i>S. cochinchinensis</i> (Lour.) Chun et Chen	Sòi nam - Gỗ nhỏ	RAS
284	<i>S.sebiferum</i> Roxb	Sòi trắng - Dầu béo, Nhuộm	RAS, VR
285	<i>Securinega spirei</i> (Beille) Phamh.	Bông nổ - Thuốc	RAS
286	<i>Sumbaviopsis albicans</i> (Bl) J.J. Smith	Nàng hai	RAS
287	<i>Trewia nudiflora</i> L.	Lưu bưou - Gỗ nhỏ	RAS
288	<i>Trigonostemon eberhardtii</i> Gagn.	Mộc cải	RAS
289	<i>T.pinnata</i> Gagnep	Tam thụ hùng lông chim-Gỗ nhỏ	RAS
290	<i>Vernicia montana</i>	Trấu	VR
	42-FABACEAE Lindl.	HỌ ĐẬU	

No.	Scientific name	Vietnamese name	Source
291	<i>Antheroporum Gagnep.</i>	Săng mây	RAS
292	<i>A.pierrei Gagnep</i>	Mát - Hạt thuốc cá	RAS
293	<i>Arachis hypogaea L.</i>	Đậu phộng Đậu phộng-Ăn hạt,	RAS
294	<i>Crotalaria muerolata Desv.</i>	Lục lạc - Cải tạo đất	RAS
295	<i>Dalbergia balansea Prain</i>	Cọ khẹt trắng	RAS
296	<i>D. cochinchinensis Pierre in Lamk.</i>	Cắm lai nam	RAS
297	<i>D. hupeana Hance var laccifero Eberh</i>	Cọ khẹt	RAS
298	<i>D. tonkinensis Prain.</i>	Sưa, trác khối	RAS
299	<i>D. rimosa Roxb</i>	Cọ khẹt leo	RAS
300	<i>D. sp.</i>	Huê mộc	RAS
301	<i>Deris elliptica (Roxb.) Benth.</i>	Dây mật - Thuốc trừ sâu	RAS
302	<i>Desmodium gangeticum (L.) DC.</i>	Tràng quả ấn -Cây phân xanh	RAS
303	<i>D.triflorum DC</i>	Tràng quả ba hoa-Cây phân xanh	RAS
304	<i>Erythrina orientalis (L.) Murr.</i>	Vòng nem - Cảnh, Thuốc	RAS
305	<i>Milletia sp</i>	Thần mát	RAS
306	<i>Mucuna interrupta Gagnep.</i>	Đỗ cộ	RAS
307	<i>Ormosia semicastrata Hance f. litchifolia How.</i>	Ràng ràng - Gỗ nhỏ	RAS
308	<i>Parochetus communis buch - Ham. ex D.Don</i>	Sơn đậu	RAS
309	<i>Pterocarpus macrocarpus Kurz .</i>	Giáng hương quả to	RAS
310	<i>Pueraria triloba (Lour.) Mak.</i>	Sắn dây rừng	RAS
311	<i>Sindora tonkinensis A.Chev.</i>	Gụ bắc - Gỗ tốt	RAS
	43- FAGACEAE Dum	HỌ GIỀ	RAS
312	<i>Castanopsis echinocarpa A. DC</i>	Giẻ gai - Gỗ	RAS
313	<i>C. indica (Roxb.) DC</i>	Cà ổi ấn độ - Gỗ	RAS
314	<i>Lithocarpus cornea (Lour.) Rchd</i>	Sồi đá - Gỗ nhỏ	RAS
315	<i>L. obovalifolia Hick. et Camus.</i>	Giẻ lá xoan - Gỗ	RAS
316	<i>Quercus arbutifolia Hick. et Camus</i>	Sồi lá tròn - Gỗ	RAS
317	<i>Q. glauca Thumb</i>	Sồi lá bạc - Gỗ	RAS

No.	Scientific name	Vietnamese name	Source
318	<i>Q. quangtrienensis</i> Hick. et Camus	Sôi quảng trị - Gỗ	RAS
	44-FLACOURTIACEAE DC.	HỌ MỪNG QUÂN	RAS
319	<i>Casearia grewiaefolia</i> var. <i>deylabrata</i> Koord et Val.	Nhôi	RAS
320	<i>Flacourtia rukam</i> Zoll. et Mor	Mừng quân - Gỗ	RAS
321	<i>Homalium hainanensis</i> (Merr.) Sleum.	Chà ran	RAS
322	<i>Hydnocarpus annamensis</i> H.Lec	Chùm bao trung - Gỗ	RAS
323	<i>H.sp</i>	Chùm bao- Gỗ nhỏ	RAS
324	<i>Scolopia chinensis</i> (Lour.) Clos.	Gai bom	RAS
	45-GESNERACEAE Juss.	HỌ PHONG LỮ	RAS
325	<i>Chirita eberhardtii</i> Pell.	Lá bóm đá	RAS
326	<i>Rhynchotechum latifolium</i> Hook.	Thạch điệp	RAS
	46-ICACINACEAE Miers.	HỌ THỤ ĐÀO	RAS
327	<i>Gomphandra hainanensis</i> Merr.	Tiết hùng hải nam	RAS
328	<i>Gonocarium sp.</i>		VR
	47-ILLICIAEAE A.C.Smith	HỌ HỒI	
329	<i>Illicium griffithii</i> Hook.	Đại hồi núi - Gỗ, tinh dầu	RAS
330	<i>I. parviflorum</i> Merr.	Hồi núi	RAS
	48-JUGLANDACEAE A.Rich.ex Kunth	HỌ HỒ ĐÀO	
331	<i>Annamocarya sinensis</i> Dode	Chò đái - Gỗ	RAS
332	<i>Engelhardtia roxburghiana</i> Wall	Chẹo	RAS
333	<i>E. serrata</i> Bl.	Chẹo lá răng	RAS
	49-LAMIACEAE Lindl.	HỌ HOA MÔI	
334	<i>Basilicum sp.</i>		RAS
	50-LAURACEAE Juss.	HỌ LONG LÃO	
335	<i>Actinodaphne cochinchinensis</i> Meissn.	Bộp nam	RAS
336	<i>A. Rehderiana</i> (All) Kost.	Bộp	RAS
337	<i>A. pilosa</i> (Lour.) Merr.	Bộp lông	RAS
338	<i>Alseodaphne hainanensis</i> Merr	Re dàu - Gỗ	RAS
339	<i>A. petiolaris</i> Hook. f		RAS
340	<i>A.utilis</i> Kost.		RAS
341	<i>A. velutina</i> Chev.		RAS

No.	Scientific name	Vietnamese name	Source
342	<i>Beilschmiedia leavis</i> Allen.	Chấp tron - Gỗ	RAS
343	<i>B. perricorea</i> Allen.	Chấp xanh - Gỗ	RAS
344	<i>Cinnamomum burmanii</i> (Nees) Bl.	Re trên trên	RAS
345	<i>C. iners</i> Reinw.	Quế lợn	RAS
346	<i>C. litsaefolium</i> Thw.	Re lá bời lời	RAS
347	<i>C. mairei</i> Levl.	Re mai rây	RAS
348	<i>C. melastomaceum</i> Kost	Re lá mua	RAS
349	<i>C. tetragonum</i> A.Chev.	Re đỏ - Gỗ	RAS
350	<i>C. tonkinensis</i> (Lec.) Chev.	Re bắc bộ	RAS
351	<i>C. validinerve</i> var. <i>poilanei</i> Liouho	-Gỗ	RAS
352	<i>C. sp.</i>	Vàng tim - Gỗ, Tinh dầu	RAS
353	<i>Cryptocarya lenticellata</i> H.Lec	Nanh chuột - Gỗ	RAS
354	<i>C. maclurei</i> Merr.	Nanh chuột trắng - Gỗ	RAS
355	<i>Lindera annamensis</i> Liouho	Lòng trứng	RAS
356	<i>L. caudata</i> (Nees) Hook. f.	Lòng trứng	RAS
357	<i>L. chunii</i> Merr.	Lòng trứng	RAS
358	<i>L. hemsleyana</i> (Diels.) Allen	Lòng trứng	RAS
359	<i>Litsea baviensis</i> H. Lec	Bời lời ba vì - Gỗ	RAS
360	<i>L. clemensii</i> Allen	Bời lời clê men	RAS
361	<i>L. cambodiana</i>	Bời lời cam bột	RAS
362	<i>L. cubeba</i> (Lour.) Pers.	Màng tang - Tinh dầu	RAS
363	<i>L. glutinosa</i> (Lour.) C.B.Roxb.	Bời lời nhọt - Gỗ, Thuốc	RAS
364	<i>L. ferruginea</i> Liouh.	Bời lời rỉ sắt	RAS
365	<i>L. firma</i> Hook. f.	Bời lời xanh	RAS
366	<i>L. monopetala</i> (Roxb.) Pers.	Bời lời lá tròn	RAS
367	<i>L. polyantha</i> Juss.	Bờilời nhiều hoa - Gỗ	RAS
368	<i>L. viridis</i> Liouho	Bời lời xanh	RAS
369	<i>L.sp</i>	Bời lời bụi	RAS
370	<i>Machilus bombycina</i> King	Kháo	RAS
371	<i>M. cochinchinensis</i> Lec.	Rè	RAS
372	<i>M. platycarpa</i> chun.	Rè	RAS
373	<i>M. odoratissima</i> Ness	Rè hương - gỗ	RAS

No.	Scientific name	Vietnamese name	Source
374	<i>Neolitsea chunii</i> Merr. f. <i>annamensis</i> Liouho	Bời lời mới	RAS
375	<i>N. eleocarpa</i> Liouho	Bời lời quả tròn	RAS
376	<i>N. caudata</i> (Nees.) Hook. f.	Bời lời lá đuôi	RAS
377	<i>Phoebe cuneata</i> Nees	Sự cụt	RAS
378	<i>P. henryi</i> Chun	Sự hen ri	RAS
379	<i>P. lanceolata</i> Nees	Sự lá mác	RAS
380	<i>P. paniculata</i> Nees	Sự	RAS
381	<i>P. pierrei</i> Lec.	Sự	RAS
382	<i>P. sheareri</i> Gamble	Sự	RAS
	51-LEEACEAE Dum.	HỌ GỐI HẠC	
383	<i>Leea acumiata</i> Wall	Gối hạc - Thuốc	RAS
384	<i>L. robusta</i> Roxb	Củ rổi mạnh	RAS
385	<i>L. sambucina</i> (L.) Roxb.	Củ rổi đen - Thuốc	RAS
	52-LECYTHIDACEAE Poit.	HỌ LỘC VỪNG	
386	<i>Barringtonia racemosa</i> (L.) Bl. ex DC.	Lộc vừng	RAS
387	<i>B. acutangula</i>	Lộc vừng	VR
	53. LOBELIACEAE R. Br.	HỌ LỖ BÌNH	
388	<i>Pratia begoniifolia</i> Lindl.	Nhã hoa	RAS
389	54-LOGANIACEAE Mart.	HỌ MÃ TIỀN	
390	<i>Strychnos gauthierana</i> Pierre ex Less.	Hoàng nàn - Thuốc	RAS
	55-LORANTHACEAE		
391	<i>Macrosolen</i> sp.		VR
	56-LYTHRACEAE St0. -Hil	SĂNG LÊ	
392	<i>Lagerstroemia tomentosa</i> Presl.	Bàng lăng lông - Gỗ	RAS
	57-MAGNOLIACEAE Juss.	HỌ MỘC LAN	
393	<i>Magnolia</i> sp.	Ngọc lan	VR
394	<i>Manglietia rufibarbata</i> Dandy	Giổi xanh	RAS
395	<i>Michelia faveolata</i> Merr. ex Dandy	Giổi nhung - Gỗ	RAS
396	<i>M. hypolampra</i> Dandy	Giổi vàng	RAS
397	<i>Paramichelia baillonii</i> (Pierre) Hu	Giổi	RAS
398	<i>Talauma</i> sp.	Giổi	RAS
	58-MALVACEAE Juss.	HỌ BÔNG	

No.	Scientific name	Vietnamese name	Source
399	<i>Hibiscus rosa-chinensis</i> L.	Hoa dâm bụt - Cây cảnh, Thuốc	RAS
400	<i>H. sagittifolia</i> var. <i>quinquelobus</i> Gagep	Vông vang - Thuốc	RAS
401	<i>Malvastrum</i> sp.		VR
402	<i>Sida acuta</i>		VR
403	<i>S. rhombifolia</i> L.	Ké hoa vàng - Thuốc	RAS, VR
404	<i>Urena lobata</i> L.	Ké hoa đào	RAS
	59-MELASTOMACEAE Juss.	HỌ MUA	
405	<i>Blastus cochinchinensis</i> Lour .	Bo nam	RAS
406	<i>B. eberhardtii</i> Guill.	Bo rừng	RAS
407	<i>Medinilla</i> sp.		VR
408	<i>Melastoma candidum</i> D.Don	Mua	RAS
409	<i>M. sanguineum</i> D.Don	Mua bà	RAS
410	<i>M. villosum</i>	Mua	VR
411	<i>Vietsenia</i> sp.		VR
	60. MELIACEAE Juss.	HỌ XOAN	
412	<i>Aglaia cochinchinensis</i> (Pierre) Pell.	Gội nàng gia - Gỗ	RAS
413	<i>A. roxburghiana</i> Pierre	Gội	RAS
414	<i>A. sp.</i>	Gội - Gỗ nhỏ	RAS
415	<i>Amoora gigantea</i> Pierre	Gội nếp	RAS
416	<i>Aphanamixis polystachys</i> (Wall.) R.N.Park	Gội trắng - Gỗ	RAS
417	<i>Chisocheton thorelli</i> Pierre	Quếch	RAS
418	<i>Chukrasia tabularis</i> A.Juss. var. <i>dongnaiensis</i>	Lát hoa đồng nai - Gỗ	RAS
419	<i>C. tabularis</i> A.Juss. var. <i>velutina</i> King	Lát lông-Gỗ	RAS
420	<i>Dysoxylum binectariferum</i> Hook. f.	Huỳnh đường - Gỗ	RAS
421	<i>D. hainanense</i>	Chò vầy	RAS
422	<i>Melia azedarach</i> L.	Xoan - Gỗ, Thuốc	RAS, VR
423	<i>Sandoricum koetjape</i>		VR
424	<i>Toona febrifuga</i> Roem	Trương vân - Gỗ	RAS
425	<i>Walsura</i> sp.		VR
	61-MENISPERMACEAE Juss	HỌ TIẾT DÊ	
426	<i>Cissampelos pareira</i> L.	Hồ đàng lông - Thuốc	RAS

No.	Scientific name	Vietnamese name	Source
427	<i>C. poilanei</i> Gagnep	Hồ đàng	RAS
428	<i>Coscinium fenestratum</i> (Gaetn.) Colebr.	Dây vàng đắng - Thuốc	RAS
429	<i>Fibrauria</i> sp.		VR
430	<i>Pericampilus glaucus</i> (Lamk.) Merr.	Dây châu đảo	RAS
431	<i>Stephania hernandifolia</i> Spreng.	Lõi tiên	RAS
432	<i>Tinospora</i> sp		VR
	62-MIMOSACEAE R.Br.	HỌ TRINH NỮ	
433	<i>Acacia donnaiensis</i> Gagnep.	Keo đồng nai	RAS
434	<i>Albizia chinensis</i> (Osborne) Merr.	Sống rắn	RAS
435	<i>A.lebekoides</i> (DC) Benth.	Bồ kết tây - Gỗ	RAS
436	<i>A.lucida</i> Benth.	Cọ thè - Gỗ	RAS
437	<i>Entada phaseoloides</i> (L.) Merr.	Bàm bàm	RAS
438	<i>E. tonkinensis</i> Gagnep.	Bàm bàm bắc	RAS
439	<i>Mimosa invisa</i> Mart. ex Colla	Trinh nữ gai - Phân xanh	RAS
440	<i>M.pudica</i> L.	Trinh nữ	RAS
	63-MORACEAE Link	HỌ DÂU TẦM	
441	<i>Antiaris toxicaria</i>		RAS, VR
442	<i>Artocarpus heterophyllus</i> Lamk.	Mít - Ăn quả, Gỗ, Bột	RAS
443	<i>A. steracifolia</i> Pierre	Chay lá bồ đề	RAS
444	<i>Broussonetia papyrifera</i> (L.) Vent.	Dương-Sợi, Thức ăn vật nuôi, Thuốc	RAS, VR
445	<i>Cudrania cochinchinensis</i> (Lour.) Kudo et Masam	Mỏ quạ - Thuốc	RAS
446	<i>Dimerocarpus brenierii</i> Gagnep.	Mây tèo - Củi	RAS
447	<i>Ficus altissima</i> Bl	Đa tía - Gỗ xấu	RAS
448	<i>F. callosa</i> Willd.	Đa gù - Gỗ to	RAS
449	<i>F. fulva</i> Reinw. ex Bl.	Vả	RAS
450	<i>F. racemosa</i> L.	Sung-thức ăn vật nuôi	RAS
451	<i>F. heterophylla</i> L.f.var. <i>heterophylla</i>	Vú bò - Thức ăn vật nuôi	RAS
452	<i>F. heteropleura</i> Bl.	Sung đôi	RAS
453	<i>F. hispida</i> L.f.	Ngái	RAS

No.	Scientific name	Vietnamese name	Source
454	<i>F. langkoensis</i> Drake	Sung lãng kô	RAS
455	<i>F. macilenta</i> king	Sung lá hẹp	RAS
456	<i>F. sumatrana</i> Miq.var. <i>sumatrana</i> (Gagnep.) Corv.	Đa da cua	RAS
457	<i>Malaisia scandens</i> (Lour.)Planch.	Duối leo	RAS
458	<i>Morus acidosa</i> Griff.	Dâu tằm	RAS
459	<i>Poikilospermum mollis</i> (Gagnep.) Phamh	Rum	RAS
460	<i>Streblus asper</i> Lour.	Duối - Ăn quả, Thuốc	RAS
461	<i>S. ilicifolius</i> (Kurz) Corn	Ô rô núi - Thuốc	RAS
	64-MYRISTICACEAE R.Br	HỌ MÁU CHÓ	
462	<i>Horsfieldia amygdalina</i> (Wall.) Warb	Săng máu	RAS
463	<i>H. longiflora</i> de Wilde	Săng máu	RAS
464	<i>Knema conferta</i> Warbg.	Máu chó - Gỗ	RAS
465	<i>K. linifolia</i>		VR
466	<i>K. corticosa</i> Lour.	Máu chó lá nhỏ - Gỗ nhỏ	RAS
467	<i>K. laurina</i> (L.) Warbg.	Máu chó - gỗ nhỏ	RAS
468	<i>K. poilanei</i> de Wild.	Máu chó lá dài	RAS
	65-MYRSINACEAE R.Br	HỌ ĐƠN NEM	
469	<i>Ardisia aciphylla</i> Pit.	Cơm nguội lá nhọn	RAS
470	<i>A. florida</i> Pit.	Hà bua	RAS
471	<i>A. gigantifolia</i>		VR
472	<i>A. mamillata</i>		VR
473	<i>A. quinquengolas</i> Bl.	Trọng đũa	RAS
474	<i>A. sylvestris</i> Pit.	Lá khô rừng	RAS, VR
475	<i>A.sp.</i>		RAS
476	<i>Maesa tonkinensis</i> var. <i>annamensis</i> Pit	Đơn nem	RAS
477	<i>M. sinensis</i> A.DC	Đông tàu	RAS
	66-MYRTACEAE Juss	HỌ TRÂM	
478	<i>Eugenia bullockii</i> Hance	Trâm bụi	RAS
479	<i>E. longiflora</i> F.Will.	Trâm nước	RAS
480	<i>E. sp1</i>	Trâm trắng	RAS
481	<i>E. sp2</i>	Trâm hoán	RAS



No.	Scientific name	Vietnamese name	Source
482	<i>E.sp3</i>	- Gỗ nhỏ	RAS
483	<i>Psidium guava L.</i>	Ổi - Ăn quả	RAS
484	<i>Syzygium tomentosa Wight.</i>	Sim - Ăn quả, thuốc	RAS
485	<i>S. cumini (L.) Druce.</i>	Trâm trắng	RAS
486	<i>S. finetii Gagn.</i>	Trâm fi-nét	RAS
	67-OLEACEAE Hoffn. et link	HỌ NHÀI	
487	<i>Jasminum longipetalum King et Gamble</i>	Nhài	RAS
488	<i>J. undulatum Ker - G.</i>	Lài dợn	RAS
489	<i>Osmanthus sp.</i>	Hoa mộc	RAS
	68-ONAGRACEAE Jass.	HỌ RAU RỪA NƯỚC	
490	<i>Ludwigia hyssopifolia (G.Don) Exell.</i>	Rau mương - Thuốc	RAS
491	<i>L. octovalis (Jacq.) Rav.</i>	Rau mương đứng	RAS
	69-OPILIACEAE Valetton	HỌ RAU SẮNG	
492	<i>Melientha suavis Pierre</i>	Rau sắng - Rau	RAS
	70-OXALIDACEAE R.Br.	HỌ KHẾ	
493	<i>Averrhoa carambola L.</i>	Khế - Ăn quả	RAS
494	<i>Biophytum sensitivum DC.</i>	Sinh diệp - Thuốc	RAS
495	<i>Oxalis corniculata L.</i>	Chua me đất - Thuốc	RAS
	71. PASSIFLORACEAE Juss.	HỌ LẠC TIÊN	
496	<i>Adenia sp.</i>		VR
497	<i>Passiflora foetida L.</i>	Lạc tiên - Thuốc	RAS
	72-PHYTOCRENACEAE R.Br.	HỌ MỘC THÔNG	RAS
498	<i>Iodes ovalis Bl</i>	Mộc thông	RAS
	73-PIPERACEAE Agardh	HỌ HỒ TIÊU	
499	<i>Peperonia sp.</i>		VR
500	<i>P. baccatum Bl.</i>	Lá lốt	RAS
501	<i>P. betle L.</i>	Trâu không - Nhai nhuận nước bọt	RAS
502	<i>P. bonii A.DC.</i>	Lá lốt	RAS
503	<i>P. griffithii C.DC.</i>	Lá lốt	RAS
504	<i>P. harmandii C.DC.</i>	Lá lốt	RAS
505	<i>P. lolot A.DC.</i>	Lá lốt - Rau, Thuốc	RAS

No.	Scientific name	Vietnamese name	Source
506	<i>P. mekongensis</i> C.DC.	Lá lốt	RAS
507	<i>P. rubrum</i> C.DC .	Lá lốt	RAS
508	<i>P. sp</i>		RAS
509	<i>Zippelia begonifolia</i>	Tiêu rận	RAS
	74-PLANTAGINACEAE Juss.	HỌ MÃ ĐÊ	
510	<i>Plantago major</i> L.	Mã đề - Rau, thuốc	RAS
	75-PLATANACEAE Lindl.	HỌ CHÒ NƯỚC	
511	<i>Platanus kerri</i> Gagn.	Chò nước	RAS
512	<i>P. pierre</i>	Chò nước	RAS
	76-POLYGONACEAE Juss.	HỌ RAU RĂM	
513	<i>Polygonum chinense</i> L.	Thồm lồm - Thuốc	RAS
514	<i>P. hydropiper</i> L.	Nghể nước - Thuốc	RAS
515	<i>P. leptostachyum</i> de Byruyn	Nghể gié mìn	RAS
516	<i>P. persicaria</i> var, <i>agreste</i> Meissn.	Nghể ruộng	RAS
517	<i>P. sp.</i>		RAS
	77-PORTULACACEAE Juss.	HỌ RAU SAM	
518	<i>Portulaca oleracea</i> L.	Rau sam	RAS
	78-PRIMULACEAE Vent	HỌ ANH THẢO	
519	<i>Lysimachia decurens</i> Forst.	Lý mạch	RAS
	79-PROTEACEAE Juss.	HỌ CỜM VÀNG	
520	<i>Helicia grandifolia</i> H.Lec	Mạ sưa lá lớn - Gỗ	RAS
521	<i>H. obovalifolia</i> Merr. et Chun	Mạ sưa lá thuôn	RAS
522	<i>H. petiolaris</i> Benn.		RAS
523	<i>H. robusta</i> (Roxb.) R.Br.	Mạ sưa	RAS
	80-RANUNCULACEAE Juss.	HỌ MAO LƯƠNG	
524	<i>Naravelia</i> sp.	Dây bạch tu	RAS
	81-RHAMNACEAE. Juss.	HỌ TÁO TA	
525	<i>Berchemia lineata</i> DC.	Dây biệt sâm	RAS
526	<i>Ventilago</i> sp.		VR
527	<i>Ziziphus</i> sp.		VR
	82-RHIZOPHORACEAE DC.	HỌ ĐUỐC	
528	<i>Carallia brachiata</i> (Lour.) Merr.	Xăng mả - Ăn quả, Thuốc	RAS

No.	Scientific name	Vietnamese name	Source
		Thuốc	
	83-RHODOLEIACEAE		
529	<i>Rhodoleia parvipelata</i>		VR
	84-ROSACEAE Juss.	HỌ HOA HỒNG	
530	<i>Duchesnia indica</i>		VR
531	<i>Eriobotrya sp.</i>		VR
532	<i>Fragaria indica</i> Andr.	Dây tây ấn	RAS
533	<i>Photinia prunifolia</i> (H. et A.) Lindl.	Sến đào - Gỗ nhỏ	RAS
534	<i>P. sp</i>	Sến đào - Gỗ nhỏ	RAS
535	<i>Pygeum arboreum</i> Engl.	Xoan đào - Gỗ	RAS
536	<i>Pyros granulosa</i>		VR
537	<i>Rubus alcaefolius</i> Poir.	Mân xôi - Uống nước	RAS
538	<i>R. cochinchinensis</i> Tratt.	Ngán nam - Uống nước	RAS
	85-RUBIACEAE Juss	HỌ CÀ PHÊ	RAS
539	<i>Adina sp.</i>	Gáo	VR
540	<i>Canthium dicoccum</i> Gaertn. var. <i>rostrata</i> Thw.	Xương cá	RAS
541	<i>C. umbellatum</i> Wight.	Găng dù	RAS
542	<i>Chasalia curviflora</i> (Wall. ex Roxb.) Thwaites	Xương sơn	RAS
543	<i>Hedyotis capitellata</i> Wall. ex D Don	Dạ cẩm - Thuốc	RAS
544	<i>H. racemora</i> Pierre	Dạ cẩm chùm	RAS
545	<i>H. verticillata</i> (L.) Lamk.	Dạ cẩm vòng	RAS
546	<i>Ixora cocinea</i> L.	Đơn đỏ - Cây cảnh	RAS
547	<i>I. pavettaefolia</i> Craib.	Đơn lá ba vết	RAS
548	<i>Lasianthus kambutensis</i> Pierre ex Pit.	Xu hương cam bột	RAS
549	<i>L. tonkinensis</i> (Drake) Pit.	Xu hương bắc	RAS
550	<i>Morinda officinalis</i> L.	Ba kích - Thuốc	RAS
551	<i>M. umbellata</i> L.	Ba kích tán	RAS
552	<i>Mussaenda cambodiana</i> var. <i>annamensis</i> Pit.	Bướm bạc trung	RAS
553	<i>Nauclea sp.</i>	Vàng kiên - Gỗ tốt	RAS
554	<i>Neonauclea purpurea</i> (Roxb.) Phamh.	Gáo - Gỗ	RAS

No.	Scientific name	Vietnamese name	Source
555	<i>N. stellata (Lour.) Phamh.</i>	Gáo - Gỗ	RAS
556	<i>Ophiorrhiza harrisiana Heyne</i>	Xà căn	RAS
557	<i>Paedelia consimilis Pierre ex Pit.</i>	Lá mơ - Thuốc	RAS
558	<i>Psychotria montana Bl</i>	Lấu - Thuốc	RAS
559	<i>P. sp</i>	Lấu đại	RAS
560	<i>Randia oxydonta Drake</i>	Mãi tấp - Gỗ nhỏ	RAS
561	<i>R. spinosa Bl.</i>	Găng gai - Hàng rào	RAS
562	<i>Uncaria tonkinensis Havil</i>	Câu đằng - Thuốc	RAS
563	<i>Wendlandia paniculata DC</i>	Hắc quang	RAS
	86-RUTACEAE Forst. et Forst. f.	HỌ CAM QUÍT	
564	<i>Acronychia laurifolia Bl</i>	Bưởi bung - Gỗ	RAS
565	<i>Citrus grandis (L.) Osb.</i>	Bưởi - Ăn quả	RAS
566	<i>Clausena sp.</i>		VR
567	<i>Euodia lepida (Spreng.) Merr.</i>	Ba gạc - thuốc	RAS
568	<i>E. leptá</i>		VR
569	<i>E. meliaefolia (Hance) Benth.</i>	Ba gạc lá xoan - Gỗ	RAS
570	<i>E. simplicifolia Ridl</i>	Ba gạc đơn	RAS
571	<i>E. trichotoma Pierre</i>	Ba gạc chẻ ba	RAS
572	<i>Glycosmis cochinchinensis (Lour.) Poir.</i>	Cơm rọu - Thuốc	RAS
573	<i>Micromelum falcatum Nataca</i>	Kim sương - Thuốc	RAS
574	<i>Murraya alata Drake</i>		RAS
575	<i>M. koienigii (L.) Spreng.</i>	Nguyệt quí	RAS
576	<i>Xanthophyllum cucullipetalum Guill</i>		RAS
	87-SALICACEAE Mirb.	HỌ LIỄU	
577	<i>Salix cavaleriei Lev.</i>	Và nước	RAS
	88-SAPINDACEAE Juss	HỌ BỒ HÒN	
578	<i>Allophylus cochinchinensis Pierre</i>	Ngoại mộc nam	RAS
579	<i>Cardiospermum halicacabum L.</i>	Dây tâm phồng - Thuốc	RAS
580	<i>Euphoria obtusa Radlk</i>	Nhãn rừng - Gỗ	RAS
581	<i>Mischocarpus fucescens Bl</i>	Trường	RAS
582	<i>M. poilanei Gagnep</i>	Trường - Gỗ	RAS
583	<i>M. sundaicus Bl</i>	Trường - gỗ	RAS

No.	Scientific name	Vietnamese name	Source
584	<i>Nephelium bassacense</i> Pierre	Vải rừng - Gỗ, Ăn quả	RAS
585	<i>N. melliferum</i> Gagn	Trương núi đá	RAS
586	<i>Pometia pinnata</i> Forst. et Forst. f.	Trường - Gỗ tốt	RAS, VR
	89-SAPOTACEAE.	HỌ SẾN	RAS
587	<i>Eberhardtia krempfii</i> Kec.	Mắc niếng	RAS
588	<i>E. tonkinensis</i> Lec.	Mắc niếng	RAS
589	<i>Madhuca hainanensis</i> Chun. et How	Sến hải nam	RAS
590	<i>M. pasquiera</i> (Dub.) H.J.Lam	Sến mật	RAS
591	<i>Palaquium annamensis</i> Lec.	Chây trung - Gỗ	RAS
592	<i>Planchonella annamensis</i> Pierre ex Dub.	Tâm chặc	RAS
593	<i>Pouteria obovata</i> (Lour.)	Nóng - Gỗ	RAS
594	<i>Sinosideroxylon racemosum</i> (Dub.) Aubr.	Sến đất	RAS
	90-SAURAUJACEAE J.G. Agardl.	HỌ NÓNG	
595	<i>Houttuynia cordata</i>		VR
596	<i>Saurauja oldhami</i> . Hemsl.	Nóng	RAS
	91-SCROPHULARIACEAE Juss	HỌ HOA MỠM CHÓ	
597	<i>Bacopa monnieri</i> (L.) Penn.	Rau đắng biển - Rau	RAS
598	<i>Lindernia</i> sp.		VR
599	<i>Scoparia dulcis</i> L.	Cam thảo nam - Thuốc	RAS
600	<i>Torenia peduncularis</i> Benth.	Tô liên cọng	RAS
	92-SIMAROUBACEAE		
601	<i>Harrisonia perforata</i>		VR
	93-SOLANACEAE Juss.	HỌ CÀ	
602	<i>Lycopersicon esculentum</i> (L.) Mill. var. <i>cerasiforme</i> Alef.	Cà chua leo	RAS
603	<i>Solanum biflorum</i> Lour.	Cà hai hoa	RAS
604	<i>S. nigrum</i> L.	Lu lu đực - Thuốc	RAS
605	<i>S. torvum</i> Swartx.	Ngoi - Thuốc	RAS
606	<i>S. xanthocarpum</i> Schrad. et Wendl.	Cà vàng	RAS
	94-SONNERATACEAE Nied	HỌ BẦN	
607	<i>Duabanga grandiflora</i> (Roxb.) ex DC. Walp	Phay - Gỗ	RAS
	95-STERCULIACEAE Vent.	HỌ TRÔM	

No.	Scientific name	Vietnamese name	Source
608	<i>Abroma augusta</i> (L.) Willd	Bát thực	RAS
609	<i>Byttneria aspera</i> Colebr.	Bích mỡ	RAS
610	<i>Commersonia bartramia</i> (L.) Merr.	Rệt - Sợi	RAS
611	<i>Firmiana colorata</i> (Roxb.) R.Br.	TRôm đỏ - Gỗ	RAS
612	<i>Helicteres angustifolia</i> L.	Tổ kén	RAS
613	<i>H. viscida</i> Bl	Trín, Dò	RAS
614	<i>Heritiera macrophylla</i> Wall.	Vôi cui lá to - Gỗ	RAS
615	<i>Pterospermum angustifolium</i> Jard.	Lòng mang lá hẹp - Gỗ	RAS
616	<i>P. diversifolium</i>		VR
617	<i>P. heterophyllum</i> Hance	Lòng mang gỗ	RAS
618	<i>P. jackianum</i> Wall.	Lòng mang	RAS
619	<i>P. lancaefolium</i> Roxb.	Lòng mang lá mác - Gỗ	RAS
620	<i>P. megalocarpum</i> Tard.	Lòng mang quả gỗ - Gỗ	RAS
621	<i>P. truncatolobatum</i> Gagn		RAS, VR
622	<i>Reevesia Gagnepainiana</i> Iard.	Trường hùng	RAS
623	<i>Sterculia hyposticta</i> Miq	Trôm hoa rủ - Gỗ	RAS
624	<i>S. lanceolata</i> Cav.	Trôm lá mác - Gỗ	RAS
625	<i>S. parviflora</i> L.	Trôm hoa thưa - Gỗ	RAS
626	<i>S. radicans</i> Gagnep.	Trôm hoa trắng thân lùn	RAS
627	<i>Tarrietia javanica</i> Bl	Huỳnh - Gỗ	RAS
	96- STYRACACEAE Dum	HỌ BỒ ĐỀ	
628	<i>Styrax tonkinensis</i> Pierre	Bồ đề - Gỗ diêm, Guốc	RAS
	97-SYMPLOCACEAE Desf.	HỌ DUNG	
629	<i>Symplocos adenophylla</i> Wall. ex G. Don	Dung chề - Gỗ nhỏ	RAS
630	<i>S. chapaensis</i> Guill.	Dung sapa - Gỗ nhỏ	RAS
631	<i>S. cochinchinensis</i> (Lour.) Moore	Dung nam - Gỗ nhỏ, Nhuộm	RAS
632	<i>S. poilanei</i> Guill.	Dung sạn - Gỗ nhỏ	RAS
633	<i>S. sordida</i> Guill.	Dung úa - Gỗ nhỏ	RAS
	98-THEACEAE D. Don	HỌ CHÈ	

No.	Scientific name	Vietnamese name	Source
634	<i>Adiandra sp.</i>	Dương đồng	RAS
635	<i>Annesla fragrans Wall.</i>	Chè béo	RAS
636	<i>A. japonica Thunb.</i>		RAS
637	<i>A. annamense Gagnep</i>	Dương đồng	RAS
638	<i>Eurya acuminata DC. var. euprista Kost.</i>	Súm	RAS
639	<i>E. cuneata Kob var glabra Kol.</i>	Súm	RAS
640	<i>E. japonica Thunb.</i>	Súm nhật - Thuốc, Gỗ nhỏ	RAS
641	<i>E. nitida</i>	Súm	RAS
642	<i>E. tonkinensis Gagn.</i>		RAS
643	<i>E. trichocarpa Korth</i>	Súm - Gỗ nhỏ	RAS
644	<i>Schima sp.</i>		VR
645	<i>Ternstroemia sp.</i>		VR
	99-THYMELEACEAE Juss	HỌ TRÂM	
646	<i>Aquilaria crassna Pierre</i>	Trâm hương - Đặc sản quý	RAS
	100-TILIACEAE Juss.	HỌ ĐAY	
647	<i>Burretiodendron hsiemu</i>	Nghiến - Gỗ nhỏ	RAS
648	<i>Corchorus sp.</i>		VR
649	<i>Grewia annamica Gagnep</i>	Cò ke trung - Gỗ nhỏ	RAS
650	<i>G. asiatica L.</i>	Cò ke á	RAS
651	<i>G. bulot Gagnep</i>	Cò ke bu lô - Gỗ	RAS
652	<i>G. microcos L.</i>	Cò ke - Gỗ, Thuốc	RAS
653	<i>G. sp</i>	Cò ke - Gỗ	RAS
654	<i>Paragrewia poilanei Gagnep</i>	Á cò ke	RAS
655	<i>Schoutenia hypoleuca Pierre</i>	Sơn tân - Gỗ	RAS
656	<i>Triumfetta rhomboidea Jacq.</i>	Ké gai dầu	RAS
657	101-ULMACEAE Mirb	HỌ DU	
658	<i>Celtis orientalis Thunb.</i>	Sếu đông - Gỗ	RAS
659	<i>C. sp.</i>	Sếu lá re - Gỗ	RAS
660	<i>Gironniera cuspidata (Bl.) Pl. ex Kurz</i>	Ngát trơn - Gỗ	RAS
661	<i>G. subaequalis Planch.</i>	Ngát - Gỗ	RAS
662	<i>Trema cannabina Lour.</i>	Hu đay lá nhỏ - Gỗ	RAS

No.	Scientific name	Vietnamese name	Source
663	<i>T. orientalis</i> (L.) Bl.	Hu đen - Gỗ nhỏ	RAS
664	<i>T. tomentosa</i>	Hu	VR
	102-URTICACEAE Juss	HỌ GAI	
665	<i>Boehmeria platyphylla</i> Don.	Gai lá hẹp	RAS
666	<i>B. tonkinensis</i> Gagnep.	Gai bắc	RAS
667	<i>Debregearia squamata</i> King	Gia vầy	RAS
668	<i>Dendrocnide sinuata</i> (Bl.) Chew	Lá han - Cây độc	RAS
669	<i>Elatostema cuneatum</i> Wight	Cao hùng	RAS, VR
670	<i>Laportea violacea</i> Gagnep	Lá han tím - Cây độc	RAS
671	<i>Pelionia repens</i> Lour.	Phu lệ bỏ	RAS
672	<i>Pouzolzia sanguinea</i> (Bl.) Merr.	Thuốc dòi	RAS
673	<i>P. zeylanica</i> (L.) Benn.	Thuốc dòi - Thuốc	RAS
674	<i>Villebrunea frutescens</i> Bl.		RAS
675	<i>V. petelotii</i> Gagnep.	Cây nai	RAS
	103-VERBENACEAE St. - Hil	HỌ CỎ ROI NGỰA	
676	<i>Callicarpa alpida</i> Bl.	Tu hú	RAS
677	<i>Clerodendrum cyrtophyllum</i> Turz	Mơ - thuốc, Rau	RAS
678	<i>C. javanicum</i>		RAS
679	<i>Gmelina annamensis</i> Dop.	Lõi thọ trung	RAS
680	<i>G. arborea</i> Roxb.	Lõi thọ - Gỗ	RAS
681	<i>G. lecomtei</i> Dop.	Lõi thọ lá hẹp	RAS
682	<i>G. philippinensis</i> Champ.	Tu hú - Thuốc, Hàng rào	RAS
683	<i>Premna balansae</i> Dop.	Cách - Gỗ nhỏ	RAS
684	<i>P. cambodiana</i> Dop.	Cách miên - Gỗ	RAS
685	<i>P. scandens</i> Roxb.	Cách nhỏ	RAS
686	<i>Stachytarpheta indica</i> (L.) Vah;	Hoàng thảo cách	RAS
687	<i>S. jamaicensis</i> (L.) Vahl	Hải tiên	RAS
688	<i>Vitex negundo</i> L.	Ngũ Trảo - Gỗ nhỏ	RAS
689	<i>V. sumatra</i> var. <i>urceolata</i> King. et Gamble	Bình linh	RAS
690	<i>V. trifolia</i> L.	Đẹn ba lá - Gỗ	RAS
	104-VIOLACEAE	HỌ HOA TÍM	
691	<i>Viola annamensis</i> Bak. f	Hoa tím nam	RAS



No.	Scientific name	Vietnamese name	Source
692	<i>V. sumatrana</i> Miq.		RAS
	105-VITACEAE Juss.	HỌ NHO	
693	<i>Ampelopsis</i> sp.		VR
694	<i>Cayratia japonica</i> (Thunb.) Gagnep.	Cay nhật	RAS
695	<i>Cissus annamica</i> Gagnep.	Hồ đăng	RAS
696	<i>C. assamica</i> Graib.	Hồ đăng át sam	RAS
697	<i>Partenocissus</i> sp.		VR
698	<i>Tetrastigma annamense</i> Gagnep.	Tứ thư hồng	RAS

**MAGNOLIOPHYTA - LILIOPSIDA - THỰC VẬT MỘT LÁ MẦM**  
(ANGIOSPERMAE - MONOCOTYLEDONES)

No.	Scientific name	Vietnamese name	Source
	1-ALISMATACEAE Vent.	HỌ TRẠCH TẢ	
1	<i>Sagittaria sagittaeifolia</i> L.	Rau mác	RAS
	2- AMARYLLIDACEAE St. Hil.	HỌ THỦY TIÊN	
2	<i>Zephyranthes rosea</i> (Spreng.) Lindl.	Hoa hiên, Huệ đỏ - Rau	RAS
	3-ARACEAE Juss.	HỌ RÁY	
3	<i>Acorus</i> sp.		VR
4	<i>Aglaonema</i> sp		VR
5	<i>Alocaria macrorrhiza</i> (L.) G.Don.	Ráy	RAS
6	<i>Amorphophallus</i> sp.	Khoai nửa	RAS
7	<i>Arisaema</i> sp.		VR
8	<i>Colocasia</i> sp.		VR
9	<i>Epipremnum giganteum</i> Schott.	Thượng cán-Cây cảnh	RAS, VR
10	<i>Homalonema aromatica</i> Schott.	Thiên niên kiện - Thuốc	RAS
11	<i>H. oculata</i>		VR
12	<i>Lasia spinosa</i> (L.) Thw.		RAS
13	<i>Pothos peniciliger</i>	Chân rết	VR
14	<i>P. pilulifer</i> Buch. et Gagn.	Cơm lênh	RAS

No.	Scientific name	Vietnamese name	Source
15	<i>P. repens</i> (Lour.) Druce	Ráy bò	RAS
16	<i>P. scandens</i>		VR
17	<i>P. yunnanensis</i> Engl.	Cơm lênh vãn nam	RAS
18	<i>P. sp</i>		RAS
19	<i>Rhaphidophora aurea</i> (Lindl. et Andre) Birdsey		RAS
20	<i>Thyphonium sp.</i>		VR
	4-ARECACEAE Schultz	HỌ CAU DỪA	
21	<i>Areca laosensis</i> Becc.	Cau núi - Cây cảnh	RAS
22	<i>Arenga pinnata</i> (Wurmb.) Merr.	Búng báng, Đoác - Bột	RAS, VR
23	<i>Calamus dioicus</i> Lour.	Mây tất - đan lát	RAS
24	<i>C. rudentum</i> Lour.	Song đá	RAS
25	<i>C. platyacanthus</i> Warb.	Song mật	RAS
26	<i>C. tonkinensis</i> Becc.	Mây	RAS
27	<i>C. viminalis</i> Will	My	RAS
28	<i>C. poilanei</i> Conrard	Song bột	RAS
29	<i>C. sp1</i>	Song cát	RAS
30	<i>C. sp2</i>	Mây nước	RAS
31	<i>Caryota mitis</i>		VR
32	<i>C. urens</i> L.	Móc - Cây cảnh	RAS, VR
33	<i>Didiosperma caudatum</i> Wendl. et Drude	Song châu	RAS
34	<i>Licuala spiiiosa</i> Wurmb.	Mật cật - Cây cảnh	RAS
35	<i>Livistona chinensis</i> R.Br.	Lá nón	RAS
36	<i>Korthalsea sp.</i>		VR
37	<i>Pinaga sp.</i>		VR
	5-ASPARAGACEAE Juss.	HỌ THIÊN MÔN	
38	<i>Ophiophogon longifolius</i> Dcne.	Xà thảo - Cây cảnh	RAS
39	<i>O. reptans</i> Hook.	Cao cẳng lá bé - Cây cảnh	RAS
40	<i>Peliosanthes serrulata</i> Hook.	Pê li vàng - Cây cảnh	RAS
	6-BROMELIACEAE Juss	HỌ DỪA	
41	<i>Ananas comosus</i> (L.) Merr.	Dứa, thơm - Ăn quả	RAS

No.	Scientific name	Vietnamese name	Source
	7-CANNACEAE Juss	HỌ RONG RIÊNG	
42	<i>Canna edulis</i> Ker.	Rong riêng - Bột	RAS
	8-COMMELINACEAE R.Br	HỌ THÀI LÀI	
43	<i>Aneilema ovalifolium</i> Hook. f.	Rau trai lá xoan	RAS
44	<i>Commelina</i> sp.	Thài lài	VR
45	<i>Cyanotis burmanniana</i>	Bích trai	VR
46	<i>C. sp</i>	Bích trai	RAS
	9-CYPERACEAE Juss	HỌ CỎI	
47	<i>Cyperus halpan</i> L.	Củ cơm	RAS
48	<i>C. malaccensis</i> Lamk.	Cói nước	RAS
49	<i>Fimbristylis</i> sp.	Cói tôm	RAS
	10- DIOSCOREACEAE R.Br.	HỌ CỦ NÂU	
50	<i>Dioscorea bulbifera</i>		VR
51	<i>D. persimilis</i> Prain et Burkill	Củ mài - Bột, Thuốc	RAS
52	<i>D. poilanei</i> Prain et Burkill	Củ lóc - Thuốc	RAS
53	<i>D. triphyllus</i> var. <i>reticulata</i> Prain et Benth.		RAS
	11-DRACAENACEAE Salisb.	HỌ HUYẾT DỤ	
54	<i>D. cambodiana</i> Pierre ex Gagnep.	Bông bông miên	RAS, VR
55	<i>D. gracilis</i> Wall. ex Hook. f.	Bông bông hoa vàng - Cây cảnh	RAS
	12-HYPOXIDACEAE R.Br.	HỌ HẠ TRÂM	RAS
56	<i>Curculigo anamitica</i>	Sâm cau - Cây cảnh	RAS, VR
	13-LILIACEAE	HỌ HÀNH TỎI	
57	<i>Aspidistra</i> sp.		VR
58	<i>Disporum</i> sp.		VR
59	<i>Dianella</i> sp.		VR
60	<i>Liriop</i> sp.		VR
61	<i>Peliosanthes</i> sp.		VR
62	<i>Ophiopogon</i> sp.		VR
	14-MARANTACEAE Peters.	HỌ CỦ DONG	
63	<i>Maranta arundinacea</i> L.	Hoàng tinh - Bột	RAS
64	<i>Phrygnum parviflorum</i> Roxb.	Lá dong - gói bánh	RAS
	15- MUSACEAE Juss	HỌ CHUỐI	

No.	Scientific name	Vietnamese name	Source
65	<i>Musa sp</i>	Chuối rừng - Thức ăn gia súc	RAS
	16-ORCHIDACEAE Juss.	HỌ LAN	
66	<i>Aerides falcatum Lindl.</i>	Lan lưỡi hái-Cây cảnh	RAS
67	<i>A. odoratum Lour.</i>	Lan quế - Cây cảnh	RAS
68	<i>Anoectochilus lylei Rolfe ex Downies</i>	Lan gấm - Cây cảnh	RAS
69	<i>A. setaceus Blume</i>	Lam lá gấm - Cây cảnh	RAS
70	<i>Coelogyne fimbriata Lindl.</i>	Lan củ hành	RAS
71	<i>C. trinervis Lindl.</i>	Lan củ hành	RAS
72	<i>Cymbidium aloifolium Lindl.</i>	Lan lô hội	RAS
73	<i>Dendrobium amabile (Lour.)</i>	Hoàng thảo	RAS
74	<i>D. anceps Sw.</i>	Hoàng thảo móng rùa-Cây cảnh,	RAS
75	<i>D. chrysanthum Lindl.</i>	Hoàng thảo	RAS
76	<i>D. cretaceum Lindl.</i>	Kim thoa thạch học-Cây cảnh, Thuốc	RAS
77	<i>D. farmeri Paxtan.</i>	Lan ngọc điểm - Cây cảnh	RAS
78	<i>D. moscharum (Buch. Ham.) Sw.</i>	Hoàng thảo	RAS
79	<i>D. parviflorum Reich. f. ex Lindl</i>	Hoàng thảo	RAS
80	<i>D. terminale Parish. et Reich. f.</i>	Hoàng thảo	RAS
81	<i>D. tortile Lindl.</i>	Hoàng thảo	RAS
82	<i>Doritis pulcherrima Wall.</i>	Địa lan lá dừa - Cây cảnh	RAS
83	<i>Eria sp.</i>		VR
84	<i>Haemaria sp.</i>		VR
85	<i>Oberonia pachyphylla King. et Panth.</i>	Hoàng thảo	RAS
86	<i>Paphiopedium sp.</i>		VR
87	<i>Phalenopsis decumbens (Griff.) Holtt.</i>	Điệp lan - Cây cảnh	RAS
88	<i>Pholidota convallariae (Reich.)</i>		RAS
89	<i>Renanthera coccinea Lour.</i>	Huyết nhung-Cây cảnh	RAS
90	<i>Saccolabium intermedium griff. ex Lindl</i>	Lan còng cua	RAS
91	<i>Thrixspermum ancoriferum (Guill.)</i>	Lan cây số	RAS

No.	Scientific name	Vietnamese name	Source
92	<i>T. centipeda</i> Lour.	Bạch điếm - Cây cảnh	RAS
	17-PANDANACEAE R.Br	HỌ DỪA DẠI	
93	<i>Pandanus leucocephalus</i> Gagnep.	Dừa đầu trắng	RAS
94	<i>P. tonkinensis</i> Mart.	Dừa đại bắc	RAS
	18-POACEAE Barnh.	HỌ HÒA THẢO	
95	<i>Arundinaria birmanica</i> Hook. f.	Trúc thảo	RAS
96	<i>A. vicinia</i> King	Sặt	RAS
97	<i>Bambus spinosa</i>	Tre gai-nguyên liệu đan lát, xây dựng	RAS
98	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Cỏ may	RAS
99	<i>Coix lacryma Jobi</i> L.	Ý dĩ - Thuốc, bột	RAS
100	<i>Cymbopogon citratus</i> (DC) Staf.	Sả - tinh dầu, gia vị, Thuốc	RAS
101	<i>Cynodon dactylon</i> (L.) Pers.	Cỏ gà	RAS
102	<i>Dactyloctenium aegyptiacum</i> (L.) Willd	Cỏ chân vịt - Thức ăn gia súc	RAS
103	<i>Dendrocalamus</i> sp	Giang-dan lát, Dây buộc	RAS
104	<i>Digitaria adscendens</i> (H.B.K) Henr.	Cỏ chỉ leo - Thức ăn gia súc	RAS
105	<i>Eragrostis brizoides</i> L.	Xuân bông thảo	RAS
106	<i>E. unioloides</i> Ness	Bông tím thảo	RAS
107	<i>E. zeylanica</i> Ness et Mey	Cỏ bông xây lan-thức ăn gia súc	RAS
108	<i>Imperata cylindrica</i> (L.) P.Beauv	Cỏ tranh - Lợp nhĩ	RAS
109	<i>Ischaemum timorense</i> Kunth.	Cỏ mồm	RAS
110	<i>Miscanthus floridulus</i> (Labill) Warb	Chè vè	RAS
111	<i>Saccharum arundinaceum</i> Retz	Sậy	RAS
112	<i>Thysanolaena maxima</i> (Roxb.) O.Kuntze	Chít, Đót -Làm chổi	RAS
	19-POTAMOGETONACEAE Dum	HỌ RONG MÁI CHÈO	
113	<i>Potamogeton manoiianus</i> Miq.	Rong mái chèo	RAS
	20-SMILACACEAE Vent.	HỌ KHÚC KHÁC	
114	<i>Smilax grabla</i> Roxb.	Thổ phục linh - Thuốc	RAS
115	<i>S. macrophylla</i>	Kim cang lá to - Thuốc	RAS

No.	Scientific name	Vietnamese name	Source
116	<i>S. perfoliata</i> Lour.	Cơm lang	RAS
	21-STEMONACEAE Engl.	HỌ BÁCH BỘ	
117	<i>Stemona tuberosa</i> Lour	Bách bộ - Thuốc	RAS
	22-TACCACEAE	HỌ BẠCH LINH	
118	<i>Tacca paxiana</i>	Râu hùm	VR
119	<i>T. integrifolia</i>	Hạ túc	VR
	23-ZINGIBERACEAE Roxb	HỌ GỪNG	
120	<i>Alpinia bracteata</i> Roxb	Sẹ	RAS
121	<i>A.sp.</i>	Riêng rừng	RAS
122	<i>Amomum xanthioides</i>	Sa nhân - Thuốc	RAS
123	<i>Costus speciosus</i>	Chóc	VR
124	<i>Curcuma sp.</i>		VR
125	<i>Globba sp.</i>		VR
126	<i>Hedychium sp.</i>		VR
127	<i>Zingiber sp.</i>	Giềng gió	VR

**Legend:**

- RAS: RAS 93/102/WWF/UNDP
- VR: Vietnam - Russian Tropical Centre

**Appendix 3a****LIST OF MAMMAL SPECIES AT PHONG NHA-KE BANG**

No.	Scientific name	English name	Source
	<b>Insectivora</b>		
	<b>Soricidae</b>		
1	<i>Suncus murinus</i>		12
	<b>Scandenta</b>	<b>Treeshrews</b>	
	<b>Tupaiaidae</b>	<b>Treeshrews</b>	
2	<i>Tupaia glis</i>		12
	<b>Dermoptera</b>		
	<b>Cynocephalidae</b>		
3	<i>Cynocephalus variegatus</i>		12
	<b>Chiroptera</b>		
	<b>Pteropodidae</b>		
4	<i>Cynopterus brachyotis</i>	Lesser Short-nosed Fruit Bat	1
5	<i>Cynopterus sphinx</i>	Greater Short-nosed Fruit Bat	1
6	<i>Eonycteris spelaea</i>	Cave Dwelling Nectar-eating Bat	1
7	<i>Megaerops niphanea</i>		12
8	<i>Pteropus hypomelanus</i>	Island Flying Fox	1
9	<i>Pteropus vampirus</i>	Common Flying Fox	1
10	<i>Rousettus leschenaulti</i>	Leschenault's Rousetter	1
11	<i>Macroglossus minimus</i>	Lesser Long-tongued Fruit Bat	1
	<b>Megadermatidae</b>		
12	<i>Megaderma lyra</i>		1
13	<i>Megaderma spasma</i>		1
	<b>Rhinolophidae</b>		
14	<i>Aselliscus stoliezkanus</i>	Trident-nosed Bat	1
15	<i>Hipposideros armiger</i>	Great Roundleaf Bat	12
16	<i>Hipposideros lylei</i>	Shield-faced Roundleaf Bat	1
17	<i>Hipposideros bicolor</i>		1
18	<i>Hipposideros larvatus</i>	Intermediate Roundleaf Bat	1
19	<i>Hipposideros pratti</i>		12
20	<i>Rhinolophus affinis</i>	Intermediate Horseshoe Bat	1

No.	Scientific name	English name	Source
21	<i>Rhinolophus luctus</i>	Great Eastern Horseshoe Bat	1
22	<i>Rhinolophus malayanus</i>	North Malayan Horseshoe Bat	1
23	<i>Rhinolophus paradoxolophus</i>	Bouret's Horseshoe Bat	1
24	<i>Rhinolophus pearsoni</i>	Pearson's Horseshoe Bat	1
25	<i>Rhinolophus rouxi</i>		1
	<b>Vespertilionidae</b>		
26	<i>Ia io</i>	Great Evening Bat	12
27	<i>Murina cyclotis</i>	Tube-nosed Bat	1
28	<i>Murina huttoni</i>		1
29	<i>Murina binaris</i>		1
30	<i>Myotis chinensis</i>	Large Myotis	1
31	<i>Myotis fimosus</i>		1
32	<i>Myotis muricula</i>		1
33	<i>Myotis horsefeldii</i>	Deignan's Bat	1
34	<i>Myotis ornatus</i>		1
35	<i>Myotis mystacinus</i>	Whiskered Bat	1
36	<i>Myotis siligorensis</i>	Small-toothed Whiskered Bat	1
37	<i>Miniopterus schreibersii</i>		1
	<b>Primates</b>	<b>Primates</b>	
	<b>Loricidae</b>	<b>Lorises</b>	
38	<i>Nycticebus coucang</i>	Slow Loris	123
39	<i>Nycticebus pygmaeus</i>	Pygmy Loris	123
	<b>Cercopithecidae</b>	<b>Old-world monkeys</b>	
40	<i>Macaca arctoides</i>	Stump-tailed Macaque	123
41	<i>Macaca assamensis</i>	Assam Macaque	123
42	<i>Macaca mulatta</i>	Rhesus Macaque	123
43	<i>Macaca nemestrina</i>	Pig-tailed Macaque	13
44	<i>Trachypithecus francoisi hatinhensis</i>	Ha Tinh Leaf-eating Monkey	12
45	<i>Trachypithecus francoisi ebenus</i>		13
46	<i>Pygathrix nemaeus nemaeus</i>		123
	<b>Hylobatidae</b>	<b>Gibbons</b>	
47	<i>Hylobates concolor leucogenis</i>		3



No.	Scientific name	English name	Source
48	<i>Hylobates concolor siki</i>		1
	<b>Carnivora</b>	<b>Canivores</b>	
	<b>Canidae</b>	<b>Dog and Foxes</b>	
49	<i>Canis aureus</i>		3
50	<i>Cuon alpinus</i>	Asian Wild Dog	12
	<b>Ursidae</b>	<b>Bears</b>	
51	<i>Helarctos malayanus</i>	Malayan Sun Bear	123
52	<i>Selenarctos thibetanus</i>	Asiatic Black Bear	123
	<b>Mustelidae</b>	<b>Weasels etc.</b>	
53	<i>Aonyx cinerea</i>	Small-clawed Otter	123
54	<i>Lutra lutra</i>	Common Otter	123
55	<i>Lutra perspicilata</i>	Smooth-coated Otter	1
56	<i>Martes flavigula</i>	Yellow-throated Marten	13
57	<i>Melogale moschata</i>		123
58	<i>Melogale personata</i>	Burmese Ferret-badger	1
	<b>Viverridae</b>	<b>Civets</b>	
59	<i>Arctictis binturong</i>	Binturong	123
60	<i>Arctogalidia trivirgata</i>		12
61	<i>Chrotogale owstoni</i>		3
62	<i>Prionodon pardicolor</i>		3
63	<i>Paguma larvata</i>	Masted Palm Civet	13
64	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	12
65	<i>Viverra megaspila</i>	Large Spotted Civet	13
66	<i>Viverra zibetha</i>	Large Indian Civet	12
67	<i>Viverricula indica</i>		1
	<b>Herpestidae</b>	<b>Mongoose</b>	
68	<i>Herpestes javanicus</i>	Javan Mongoose	1
	<b>Felidae</b>	<b>Cats</b>	
69	<i>Felis bengalensis</i>	Leopard Cat	12
70	<i>Felis marmorata</i>	Marbled Cat	12
71	<i>Felis temmincki</i>	Clouded Leopard	12
72	<i>Neofelis nebulosa</i>	Leopard	23

No.	Scientific name	English name	Source
73	<i>Panthera pardus</i>		123
74	<i>Panthera tigris</i>	Tiger	123
	<b>Proboscide</b>		
	<b>Elephantidae</b>		
75	<i>Elephas maximus</i>	Elephant	12
	<b>Artiodactyla</b>	<b>Even-Toed ungulates</b>	
	<b>Suidae</b>	<b>Pigs</b>	
76	<i>Sus scrofa</i>	Common Wild Pig	123
77	<i>Sus bucculentus</i>		1
	<b>Tragulidae</b>	<b>Chevrotains</b>	
78	<i>Tragulus javanicus</i>	Lesser Mouse Deer	123
	<b>Cervidae</b>	<b>Deer</b>	
79	<i>Cervus unicolor</i>	Sambar	123
80	<i>Muntiacus muntjak</i>	Common Barking Deer	123
81	<i>Megamunticus vuquangensis</i>	Giant munjac	123
	<b>Bovidae</b>	<b>Cattle, goats</b>	
82	<i>Bos gaurus</i>	Gaus	13
83	<i>Capricornis sumatraensis</i>	Serow	123
84	<i>Pseudoryx nghetinhensis</i>		12
	<b>Pholidota</b>	<b>Pangolins</b>	
	<b>Manidae</b>	<b>Pangolins</b>	
85	<i>Manis javanica</i>	Malayan Pangoln	123
	<b>Rodentia</b>	<b>Rodents</b>	
	<b>Pteromyidae</b>	<b>Flying squirrel</b>	
86	<i>Hylopetes alboniger</i>		12
87	<i>Petaurista petaurista</i>	Giant Flying Squirrel	123
	<b>Sciuridae</b>	<b>Non-flying squirrels</b>	
88	<i>Callosciurus flavimanus</i>	Belly-banded Squirrel	123
89	<i>Callosciurus erythraeus</i>		13
90	<i>Callosciurus inornatus</i>		12
91	<i>Dremomys rufigenis</i>	Red-cheeked Squirrel	12
92	<i>Ratufa bicolor</i>	Black Giant Squirrel	13

No.	Scientific name	English name	Source
93	<i>Tamiops rodolpheii</i>	Cambodian Striped Tree Squirrel	12
	<b>Rhizomyidae</b>	<b>Bamboo rats</b>	
94	<i>Rhizomys pruinosus</i>		23
95	<i>Rhizomys sumatrensis</i>	Large Bamboo Rat	12
	<b>Muridae</b>		
96	<i>Bandicota indica</i>	Great Bandicoot	12
97	<i>Bandicota savilei</i>	Lesser Bandicoot	1
98	<i>Mus caroli</i>	Rynkyn Mouse	23
99	<i>Mus cervicolor</i>	Fawn-colored Mouse	3
100	<i>Mus musculus</i>	House Mouse	123
101	<i>Rattus bukit</i>	Chestnut Rat	3
102	<i>Rattus fulvescens</i>		23
103	<i>Rattus moi</i>		123
104	<i>Rattus tenaster</i>		3
105	<i>Rattus argentiventer</i>	Ricefield Rat	12
106	<i>Rattus flavipectus</i>		3
107	<i>Rattus koratensis</i>	Sladen's Rat	12
108	<i>Rattus molliculus</i>		3
109	<i>Rattus sabanus</i>	Noisy Rat	12
110	<i>Rattus surifer</i>	Yellow Rajah Rat	1
	<b>Hystricidae</b>	<b>Porcupines</b>	
111	<i>Hystrix hodgson</i>		12
112	<i>Atherurus macrourus</i>		123
	<b>Lagomorpha</b>	<b>Lagomorphs</b>	
	<b>Leporidae</b>	<b>Rabbits</b>	
113	<i>Lepus nigricollis</i>		12

**Appendix 3a**

**LIST OF BIRD SPECIES AT PHONG NHA-KE BANG**

No.	Scientific name	English name	Source
	<b>PODICIPEDIFORMES</b>		
	<b>Podicipedidae</b>		
1	<i>Tachybaptus ruficollis</i>	Little Grebe	12
	<b>PELECANIFORMES</b>		
	<b>Pharacrocoracidae</b>		
2	<i>Pharacrocorax niger</i>	Javanese Cormorant	12
	<b>CICONIIFORMES</b>		
	<b>Ardeidae</b>	<b>Hérons, Bitterns</b>	
3	<i>Ardea cinerea</i>	Grey Heron	12
4	<i>Egretta alba</i>	Great Egret	12
5	<i>E. garzetta</i>	Little Egret	12
6	<i>Ardeola bacchus</i>	Chinese Pond Heron	12
7	<i>Butorides striatus</i>	Green-backed Heron	123
8	<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	123
	<b>ANSERIFORMES</b>		
	<b>Anatidae</b>		
9	<i>Dendrocygna javanica</i>	Indian Whistling-Duck	12
10	<i>Nettapus coromandelianus</i>	Cotton Teal	12
11	<i>Anas poecilorhyncha</i>	Spot billed Duck	12
12	<i>A. querquedula</i>	Garganey	12
	<b>FALCONIFORMES</b>		
	<b>Pandionidae</b>		
13	<i>Pandion haliaetus</i>	Osprey	12
	<b>Accipitridae</b>		
14	<i>Aviceda leuphotes</i>	Black Baza	12
15	<i>Circus melanoleucos</i>	Pied Harrier	2
16	<i>Elanus caeruleus</i>	Black-shouldered Kite	2
17	<i>Pernis ptilorhynchus</i>	Oriental Honey Buzzard	12
18	<i>Spilornis cheela</i>	Crested Serpent Eagle	12
19	<i>Icthyophaga humilis</i>	Lesser Fishing Eagle	2
20	<i>Ictinaetus malayensis</i>	Indian Black Eagle	2

No.	Scientific name	English name	Source
21	<i>Spizaetus cirrhatus</i>	Crested Hawk Eagle	2
22	<i>Accipiter trivirgatus</i>	Asian Crested Goshawk	123
23	<i>A. badius</i>	Shikra	12
	<b>Falconidae</b>		
24	<i>Microhierax caerulescens</i>	Collared Falconet	12
25	<i>Falco tinnunculus</i>	Common Kestrel	12
26	<i>F. severus</i>	Oriental Hobby	12
27	<i>F. peregrinus</i>	Peregrine Falcon	12
	<b>GALLIFORMES</b>		
	<b>Phasianidae</b>		
28	<i>Francolinus pintadeanus</i>	Chinese Francolin	12
29	<i>Arborophila brunneopectus</i>	Brown-breasted Hill Partridge	12
30	<i>Gallus gallus</i>	Red Jungle-Fowl	2
31	<i>Lophura nycthemera berliozii</i>	Silver Pheasant	123
32	<i>L. imperialis</i>	Imperial Pheasant	12
33	<i>L. hatinhensis</i>	Vietnamese Pheasant	12
34	<i>L. diardi</i>	Siamese Fireback Pheasant	12
35	<i>L. edwardsi</i>	Edward's Pheasant	2
36	<i>Poluplectron bicalcaratum</i>	Burmese Peacock-Pheasant	12
37	<i>Pavo muticus</i>	Green Peafowl	2
38	<i>Rheinartia ocellata</i>	Crested Argus	123
	<b>GRUIFORMES</b>		
	<b>Turnicidae</b>		
39	<i>Turnix suscitator</i>	Bustard Quail	12
	<b>Gruidae</b>		
40	<i>Grus grus</i>	Common Crane	2
	<b>Rallidae</b>		
41	<i>Rallus striatus</i>	Blue-breasted Banded Rail	12
42	<i>Gallicrex cinerea</i>	Water Cock	2
43	<i>G. chloropus</i>	Common Gallinule	2
44	<i>Porzana pusilla</i>	Baillon's Crake	12
45	<i>Amaurornis phoenicurus</i>	White-breasted Water Hen	12
46	<i>Porphyrio porphyrio</i>	Purple Swamphen	12

No.	Scientific name	English name	Source
	<b>CHARADRIIFORMES</b>		
	<b>Charadriidae</b>		
47	<i>Vanellus vanellus</i>	Northern Lapwing	2
48	<i>V. duvaucelii</i>	River Lapwing	12
49	<i>Pluvialis squatarola</i>	Grey Plover	12
50	<i>Charadrius placidus</i>	Long-billed Ringed Plover	2
51	<i>C. dubius</i>	Little Ringed Plover	12
52	<i>C. alexandrinus</i>	Kentish Plover	12
	<b>Scolopacidae</b>		
53	<i>Tringa ochropus</i>	Green Sandpiper	12
54	<i>T. hypoleucos</i>	Common Sandpiper	123
55	<i>Scolopax rusticola</i>	Eurasian Woodcock	12
56	<i>Gallinago stenura</i>	Pintail Snipe	12
57	<i>G. gallinago</i>	Common Snipe	12
	<b>COLUMBIFORMES</b>		
	<b>Columbidae</b>		
58	<i>Streptopelia orientalis</i>	Eastern Turtle Dove	12
59	<i>S. tranquebarica</i>	Red-collared Dove	12
60	<i>S. chinensis</i>	Spotted-necked Dove	123
61	<i>Macropygia unchall</i>	Bar-tailed Cuckoo Dove	2
62	<i>Chalcophaps indica</i>	Emerald Dove	123
63	<i>Treron curvirostra</i>	Thick-billed Green Pigeon	123
64	<i>T. apicaudata</i>	Pin-tailed Green Pigeon	123
65	<i>Ducula aenea</i>	Green Imperial Pigeon	12
66	<i>D. badia</i>	Mountain Imperial Pigeon	123
	<b>PSITTACIFORMES</b>		
	<b>Psittacidae</b>	<b>Parrots</b>	
67	<i>Psittacula himalayana</i>	Slaty-headed Parakeet	12
68	<i>P. roseata</i>	Blossom-headed Parakeet	2
69	<i>P. alexandri</i>	Moustached Parakeet	12
	<b>CUCULIFORMES</b>		
	<b>Cuculidae</b>	<b>Cuckoos</b>	
70	<i>Clamator coromandus</i>	Red-winged Crested Cuckoo	123

No.	Scientific name	English name	Source
71	<i>Cuculus sparverioides</i>	Large Hawk Cuckoo	12
72	<i>C. micropteus</i>	Short-winged Cuckoo	12
73	<i>C. canorus</i>	Eurasian Cuckoo	3
74	<i>C. saturatus</i>		3
75	<i>Cacomantis merulinus</i>	Plaintive Cuckoo	3
76	<i>Surniculus lugubris</i>	Drongo-Cuckoo	3
77	<i>Chalcites sonneratii</i>	Banded Bay Cuckoo	2
78	<i>C. maculatus</i>	Asian Emerald Cuckoo	12
79	<i>C. xanthorhynchus</i>	Violet Cuckoo	12
80	<i>Eudynamys scolopacea</i>	Koel	12
81	<i>Rhopodytes tristis</i>	Greater Green-billed Malcoha	1
82	<i>Carpococcyx renauldi</i>	Coral-billed Ground Cuckoo	1
83	<i>Centropus sinensis</i>	Common Crow-Pheasant	123
84	<i>C. bengalensis</i>	Lesser Coucal	123
	<b>STRIGIFORMES</b>		
	<b>Tytonidae</b>		
85	<i>Tyto alba</i>	Barn Owl	12
	<b>Strigidae</b>	<b>Owls</b>	
86	<i>Otus sunia</i>	Oriental Scpos Owl	123
87	<i>O. spilocephalus</i>	Spotted Scpos Owl	23
88	<i>O. bakkamoena</i>		3
89	<i>Bubo ketupu</i>	Malay Fish Owl	12
90	<i>Strix leptogrammica</i>	Brown Wood Owl	12
91	<i>Glaucidium brodiei</i>	Collared Owlet	2
92	<i>G. cuculoides</i>	Cuckoo Owlet	123
93	<i>Ninox scutulata</i>	Brown Hawk Owl	123
	<b>CAPRIMULGIFORMES</b>		
	<b>Caprimulgidae</b>	<b>Nightjar</b>	
94	<i>Caprimulgus macrurus</i>	Long-tailed Nightjar	12
95	<i>C. indicus</i>	Jungle Nightjar	2
96	<i>C. monticolus</i>	Franklin's Nightjar	12
	<b>APODIFORMES</b>		

No.	Scientific name	English name	Source
	<b>Apididae</b>		
97	<i>Aerodramus fuciphagus</i>	Edible-nest Swiftlet	3
98	<i>Apus facificus</i>	Fork-tailed Swift	12
99	<i>A. affinis</i>	House Swift	23
100	<i>Aerodramus brevirostris</i>	Himalayan Swiftlet	2
101	<i>Cypsiurus batasiensis</i>	Asian Palm Swift	12
	<b>Hemiprocnidae</b>		
102	<i>Hemiprocne coronata</i>	Crested Tree Swift	23
	<b>TROGONIFORMES</b>		
	<b>Trogonidae</b>	<b>Trogons</b>	
103	<i>Harpactes oreskios</i>	Orange-breasted Trogon	2
104	<i>H. erythrocephalus</i>	Red-headed Trogon	12
	<b>CORACIIFORMES</b>		
	<b>Alcedinidae</b>	<b>Kingfishers</b>	
105	<i>Magaceryle lugubris</i>	Greater Pied Kingfisher	12
106	<i>Ceryle rudis</i>	Lesser Pied Kingfisher	12
107	<i>Alcedo atthis</i>	River Kingfisher	123
108	<i>A. meninting</i>	Blue-eared Kingfisher	3
109	<i>Ceyx erithacus</i>	Three-toed Kingfisher	123
110	<i>Halcyon smyrnensis</i>	White-throated Kingfisher	123
	<b>Meropidae</b>	<b>Bee-eaters</b>	
111	<i>Nyctyornis athertoni</i>	Blue-breasted Bee Eater	12
112	<i>Merops viridis</i>	Chestnut-headed Bee Eater	12
113	<i>M. philippinus</i>	Blue-cheeked Bee Eater	12
	<b>Coraciidae</b>	<b>Rollers</b>	
114	<i>Coracias benghalensis</i>	Indian Roller	12
115	<i>Lacedo pulchella</i>		3
116	<i>Eurystomus orientalis</i>	Eastern Broad-billed Roller	123
	<b>Upupidae</b>		
117	<i>Upupa epops</i>	Hoopoe	12
	<b>Bucerotidae</b>	<b>Hornbills</b>	
118	<i>Berenicornis comatus</i>	Long-crested Hornbill	2
119	<i>Ptilolaemus tickelli</i>	Tickell's Hornbill	12



No.	Scientific name	English name	Source
120	<i>Aceros nipalensis</i>	Rufous-necked Hornbill	2
121	<i>A. undulatus</i>	Wreathed Hornbill	123
122	<i>Anthracoceros malabaricus</i>	Indian Pied Hornbill	12
123	<i>Buceros bicornis</i>	Great Indian Hornbill	123
	<b>PICIFORMES</b>		
	<b>Capitonidae</b>	<b>Barbets</b>	
124	<i>Megalaima lagrandieri</i>	Red-vented Barbet	123
125	<i>M. faiostriata</i>	Green-eared Barbet	123
126	<i>M. asiatica</i>	Blue-throated Barbet	12
127	<i>M. franckilli</i>		3
128	<i>M. australis</i>	Blue-eared Barbet	12
	<b>Picidae</b>	<b>Woodpeckers</b>	
129	<i>Sasia ochracea</i>	White-browed Piculed	123
130	<i>Picoides canicapillus</i>	Grey-capped Woodpecker	2
131	<i>Picus chlorolophus</i>	Lesser Yellow-naped Woodpecker	123
132	<i>P. flavinucha</i>	Greater Yellow-naped Woodpecker	123
133	<i>P. rabieri</i>	Red-collared Woodpecker	
134	<i>Chrysocolaptes lucidus</i>	Greater Flamebacked Woodpecker	2
135	<i>Dinopium javanense</i>	Common Gold-backed Woodpecker	12
136	<i>Blythipicus pyrrhotis</i>	Bay Woodpecker	12
	<b>PASSERIFORMES</b>		
	<b>Eurylaimidae</b>	<b>Broadbills</b>	
137	<i>Psarisomus dalhousiae</i>	Long-tailed Broadbill	2
	<b>Pittidae</b>	<b>Pittas</b>	
138	<i>Pitta soror</i>	Blue-backed Pitta	123
139	<i>P. cyanea</i>	Blue Pitta	3
140	<i>P. moluccensis</i>	Moluccan Pitta	2
141	<i>P. elliotii</i>	Elliot's Pitta	123
	<b>Alaudidae</b>		
142	<i>Mirafra javanica</i>	Eastern Singing Busk Lark	2
143	<i>Alauda gulgula</i>	Oriental Lark	12

No.	Scientific name	English name	Source
	<b>Hirundinidae</b>		
144	<i>Hirundo rustica</i>	Swallow	12
145	<i>H. daurica</i>	Red-rumped Swallow	12
	<b>Motacillidae</b>		
146	<i>Motacilla flava</i>	Yellow Wagtail	12
147	<i>M. citreola</i>	Citrine Wagtail	3
148	<i>M. cinerea</i>	Grey Wagtail	123
149	<i>M. alba</i>	Pied Wagtail	12
150	<i>Anthus novaeseelandae</i>	Richard's Pipit	2
151	<i>A. hodgsoni</i>	Water Pipit	123
	<b>Campephagidae</b>		
152	<i>Coracina melaschistos</i>	Dark-grey Cuckoo Shrike	12
153	<i>C. macei</i>	Large Cuckoo Shrike	2
154	<i>Hemipus picatus</i>	Bar-winged Flycatcher Shrike	2
155	<i>Tephrodornis gularis</i>	Brown-tailed Wood Shrike	2
156	<i>Pericrocotus solaris</i>	Yellow-throated Minivet	3
157	<i>P. flammeus</i>	Scarlet Minivet	12
	<b>Pycnonotidae</b>		
158	<i>Pycnonotus melanicterus</i>	Black-crested Bulbul	12
159	<i>P. jocosus</i>	Red-whiskered Bulbul	123
160	<i>P. cafer</i>	Red-venter Bulbul	12
161	<i>P. aurigaster</i>	White-eared Bulbul	12
162	<i>P. finlaysoni</i>	Stripe-throated Bulbul	123
163	<i>P. flavescens</i>	Flavescent Bulbul	12
164	<i>P. striatus</i>	Striated Green Bulbul	2
165	<i>Criniger pallidus</i>	Olivaceous Bearded Bulbul	23
166	<i>Hypsipetes leucocephalus</i>		123
167	<i>H. propinquus</i>	Grey-eyed Bulbul	12
168	<i>H. malaccensis</i>	Green-backed Bulbul	3
169	<i>H. flavalus</i>	Ashy Bulbul	1
170	<i>H. madagascariensis</i>	Black Bulbul	12
	<b>Irenidae</b>	<b>Leafbirds, Ioras</b>	
171	<i>Aegithina tiphia</i>	Common Iora	12

No.	Scientific name	English name	Source
172	<i>A. lafresnayeri</i>	Great Iora	12
173	<i>Chloropsis aurifrons</i>	Golden-fronted Leafbird	2
174	<i>C. cochinchinensis</i>	Blue-winged Leafbird	123
175	<i>C. hardwickei</i>	Orange-bellied Leafbird	23
176	<i>Irena puella</i>	Blue-backed Fairy-bluebird	123
	<b>Laniidae</b>	<b>Shrikes</b>	
177	<i>Lanius collurio</i>	Burmese Shrike	12
178	<i>L. cristatus</i>	Brown Shrike	3
179	<i>L. tephronotus</i>		3
180	<i>L. schach</i>	Black-headed Shrike	12
	<b>Turnidae</b>		
181	<i>Erithacus sibilans</i>	Swinhoe's Robin	12
182	<i>E. calliope</i>	Siberian Rubythroat	12
183	<i>Copsychus saularis</i>	Magpie Robin	123
184	<i>C. malabaricus</i>	White-rumped Shama	123
185	<i>Luscinia cyane</i>		3
186	<i>Enricurus schistaceus</i>	Slaty-backed Fortail	123
187	<i>E. leschenaulti</i>	White-crowned Fortail	123
188	<i>Saxicola torquata</i>	Common Stonechat	12
189	<i>S. ferrea</i>	Grey Buschat	12
190	<i>Myiophonus caeruleus</i>	Himalayan Whistling Thrush	123
191	<i>Monticola solitarius</i>	Blue Rock Thrush	23
192	<i>Turdus boulboul</i>	Grey-winged Blackbird	3
193	<i>T. merula</i>	Blackbird	12
	<b>Timaliidae</b>		
194	<i>Pellomeum ruficeps</i>	Spotted Babbler	2
195	<i>P. albiventris</i>	Plain Brown Babbler	2
196	<i>P. tickelli</i>	Tickell's Jungle Babbler	23
197	<i>Malacocincla abbotti</i>	Abbott's Jungle Babbler	2
198	<i>M. cinereum</i>	Scaly-crowned Babbler	23
199	<i>Pomatorhinus schisticeps</i>	Slaty-headed Scimitar Babbler	12
200	<i>P. hypoleucos</i>	Long-billed Scimitar Babbler	23
201	<i>P. ruficollis</i>	Streak-breasted Scimitar Babbler	23
202	<i>Napothera crispifrons</i>	Limestone Wren Babbler	12

No.	Scientific name	English name	Source
203	<i>N. brevicaudata</i>	Streasked Wren Babbler	123
204	<i>N. epilepidota</i>	Lesser Wren Babbler	123
205	<i>Stachyris ruficeps</i>	Red-headed Tree Babbler	2
206	<i>S. chrysaea</i>	Golden-headed Tree Babbler	2
207	<i>S. herberti</i>	Sooty Tree Babbler	23
208	<i>S. nigriceps</i>	Black-throated Tree Babbler	123
209	<i>S. striolata</i>	Spot-necked Tree Babbler	23
210	<i>Garrulax canorus</i>	Melodious Laughing Thrush	3
211	<i>G. perspicillatus</i>	Spectacled Laughing Thrush	12
212	<i>G. leucolophus</i>	White-crested Laughing Thrush	123
213	<i>G. monileger</i>	Lesser Necklaced Laughing Thrush	12
214	<i>G. pectoralis</i>	Greater Necklaced Laughing Thrush	123
215	<i>G. chinensis</i>	Black-throated Laughing Thrush	12
216	<i>Gampsorhynchus rufulus</i>	White-headed Shrike Babbler	2
217	<i>Jabouilleia danjoui</i>	Danjou's Babbler	2
218	<i>Alcippe nipalensis</i>		2
219	<i>A. rufogularis</i>	Rufous-throated Fulvetta	12
220	<i>A. peracensis</i>	Mountain Fulvetta	1
221	<i>A. poioicephalus</i>	Brown-cheeked Fulvetta	3
222	<i>Macronous gularis</i>	Striped Tit-Babbler	3
223	<i>M. kelleyi</i>	Grey-faced Tit-Babbler	2
224	<i>Yuhina castaniceps</i>	Striated Yuhina	2
225	<i>Y. zantholeuca</i>		2
226	<i>Y. rufogularis</i>		23
	<b>Sylviidae</b>		
227	<i>Cettia diphone</i>	Japanese Bush-Warbler	12
228	<i>Cisticola juncidis</i>	Zitting Cisticola	2
229	<i>Megalurus palustris</i>	Striated Canegrass Warbler	12
230	<i>Acrocephalus bistrigiceps</i>	Schrenk's Reed Warbler	2
231	<i>Prinia rufescens</i>	Lesser Brown Prinia	2
232	<i>P. atrogularis</i>	White-browed Prinia	123
233	<i>P. hodgsonii</i>	Franklin's Prinia	123

No.	Scientific name	English name	Source
234	<i>P. flaviventris</i>	Yellow-bellied Prinia	123
235	<i>P. herberti</i>	Plain Prinia	2
236	<i>Orthotomus sutorius</i>	Long-tailed Tailor Bird	12
237	<i>O. atrogularis</i>	Black-necked Tailor Bird	12
238	<i>Phylloscopus proregulus</i>	Pallas Leaf Warbler	2
239	<i>P. schwarzi</i>	Radde's Bush Warbler	3
240	<i>P. inornatus</i>	Yellow-browed Warbler	23
241	<i>P. trochiloides</i>	Greenish Warbler	3
242	<i>P. fuscatus</i>	Dusky Warbler	12
243	<i>P. borealis</i>	Arctic Warbler	12
244	<i>P. coronatus</i>	Temmink's Crowned Willow Warbler	12
245	<i>P. davisoni</i>	White-tailed Warbler	12
246	<i>P. ricketti</i>	Black-browed Leaf Warbler	123
	<b>Muscicapidae</b>	<b>Old World flycatchers</b>	
247	<i>Muscicapa sibirica</i>	Siberian Flycatcher	12
248	<i>M. thalassina</i>	Indian Verditer Flycatcher	12
249	<i>M. dauurica</i>	Brown Flycatcher	23
250	<i>Culicicapa ceylonensis</i>	Grey-headed Flycatcher	3
251	<i>Ficedura parva</i>	Red-breasted Flycatcher	23
252	<i>Niltava concreta</i>	White-tailed Flycatcher	2
253	<i>N. hainana</i>	Grant's Flycatcher	2
254	<i>N. davidi</i>	Fukien Niltava	23
255	<i>N. rubeculoides</i>	Blue-throated Flycatcher	12
	<b>Monarchidae</b>		
256	<i>Hypothymis azurea</i>	Black-naped Blue Monarch	2
257	<i>Rhipidura albicillis</i>	White-throated Fantail	1
	<b>Paridae</b>		
258	<i>Parus major</i>	Great Tit	12
259	<i>Melanochlora sultanea</i>	Sultan Tit	12
	<b>Sittidae</b>		
260	<i>Sitta frontalis</i>	Velvet-fronted Nuthatch	12
	<b>Dicaeidae</b>		
261	<i>Dicaeum chrysorrheum</i>	Yellow-vented Flowerpecker	12

No.	Scientific name	English name	Source
262	<i>D. concolor</i>	Plain Flowerpecker	123
263	<i>D. cruentatum</i>	Scarlet-backed Flowerpecker	123
	<b>Nectariniidae</b>		
264	<i>Nectarinia jugularis</i>	Olive-backed Sunbird	12
265	<i>Hypogramma hypogrammicum</i>	Blue-naped Sunbird	2
266	<i>Aethopiga siparaja</i>	Yellow-backed Sunbird	12
267	<i>A. christinae</i>	Fork-tailed Sunbird	3
268	<i>Anthreptes singalensis</i>	Ruby-cheeked Sunbird	2
269	<i>Arachnothera longirostra</i>	Little Spiderhunter	12
270	<i>A. magna</i>	Streaked Spiderhunter	123
	<b>Zosteropidae</b>		
271	<i>Zosterops japonica</i>	Japanese White-eye	2
272	<i>Z. palpebrosa</i>	Oriental White-eye	12
	<b>Emberizidae</b>		
273	<i>Emberiza aureola</i>	Yellow-breasted Bunting	12
274	<i>E. rutila</i>	Chestnut Bunting	12
	<b>Estrildidae</b>		
275	<i>Lonchura striata</i>	White-backed Munia	123
276	<i>L. punctulata</i>	Nutmeg Mannikin	123
	<b>Ploceidae</b>		
277	<i>Passer montanus</i>	Eurasian Tree Sparrow	123
278	<i>Ploceus manyar</i>	Streaked Weaver	12
	<b>Sturnidae</b>		
279	<i>Sturnus nigricollis</i>	Black-collared Starling	12
280	<i>S. sinensis</i>	Chinese Starling	12
281	<i>Acridotheres tristis</i>	Common Mynah	12
282	<i>A. grandis</i>	Great Mynah	12
283	<i>A. cristatellus</i>	Chinese Jungle Mynah	2
284	<i>Ampeliceps coronatus</i>	Gold-crested Mynah	12
	<b>Oriolidae</b>		
285	<i>Oriolus xanthornus</i>	Asian Black-headed Oriole	3
286	<i>O. traillii</i>	Maroon Oriole	12
	<b>Dicruridae</b>		

No.	Scientific name	English name	Source
287	<i>Dicrurus macrocercus</i>	Black Drongo	12
288	<i>D. annectans</i>	Crow-billed Drongo	123
289	<i>D. aeneus</i>	Bronzed Drongo	123
290	<i>D. hottentottus</i>	Hair-crested Drongo	12
291	<i>D. leucophaeus</i>	Ashy Drongo	23
292	<i>D. remifer</i>	Lesser Racked-tailed Drongo	3
293	<i>D. paradiseus</i>	Greater Racked-tailed Drongo	123
	<b>Artamidae</b>		
294	<i>Artamus fuscus</i>	Ashy Wood Swallow	123
	<b>Corvidae</b>	<b>Jays, Crows</b>	
295	<i>Urocissa erythrorhyncha</i>	Red-billed Blue Magpie	2
296	<i>U. whiteheadi</i>	White-winged Magpie	2
297	<i>Cissa chinensis</i>	Green Magpie	12
298	<i>C. hypoleuca</i>	Eastern Green Magpie	12
299	<i>Dendrocitta vagabunda</i>	Indian Tree Pie	2
300	<i>Crypsirina temia</i>	Black Racked-tailed Tree Pie	12
301	<i>Temnurus temnurus</i>	Notch-tailed Tree Pie	123
302	<i>Corvus macrorhynchos</i>	Jungle Crow	12

No.	Scientific name	Vietnamese name	Source
	<b>7- Xenopeltidae</b>	<b>Họ rắn móng</b>	
23	<i>Xenopeltis unicolor</i>	Rắn móng	13
	<b>8- Boidae</b>	<b>Họ trăn</b>	
24	<i>Python molurus</i>	Trăn đất	123
	<b>9- Xenopeltidae</b>	<b>Họ rắn móng</b>	
25	<i>Xenopeltis unicolor</i>	Rắn móng	123
	<b>10- Colubridae</b>	<b>Họ rắn nước</b>	
26	<i>Dipsas margaritophorus</i>	Rắn hổ mây ngọc	123
27	<i>Dinodon septentrionalis</i>		3
28	<i>Amphiesma khasiensis</i>	Rắn sãi kha si	12
29	<i>Calamaria pavementata</i>	Rắn mai gấm lát	13
30	<i>Calamaria septentrionalis</i>	Rắn mai gấm bắc	123
31	<i>Dendrelaphis pictus</i>	Rắn leo cây	123
32	<i>Elaphe moellendorffi</i>	Rắn sọc đuôi khoanh	123
33	<i>Elaphe radiata</i>	Rắn sọc dưa	13
34	<i>Ptyas korros</i>	Rắn ráo thường	13
35	<i>Ptyas mucosus</i>	Rắn ráo trâu	12
36	<i>Sibynophis collaris</i>	Rắn rồng cổ đen	123
37	<i>Oligodon taeniatus</i>		3
38	<i>Pareas margaritafolius</i>		2
39	<i>Xenochrophis piscator</i>	Rắn nước	123
40	<i>Ahaetulla prasina</i>	Rắn roi thường	123
41	<i>Boiga multomaculata</i>	Rắn rào đốm	12
42	<i>Chrysopeléea ornata</i>	Rắn cườm	13
43	<i>Enhydris plumbea</i>	Rắn bông chì	123
	<b>11- Elapidae</b>	<b>Họ rắn hổ</b>	
44	<i>Bungarus candidus</i>	Rắn cạp nia	123
45	<i>Bungarus fasciatus</i>	Rắn cạp nong	123
46	<i>Naja naja</i>	Rắn hổ mang	123
47	<i>Ophiophagus hannah</i>	Rắn hổ chúa	13
	<b>12- Viperidae</b>	<b>Họ rắn lục</b>	
48	<i>Trimeresurus albolabris</i>	Rắn lục mép	12



No.	Scientific name	Vietnamese name	Source
	<b>II- TESTUDINATA</b>	<b>BỘ RÙA</b>	
	<b>13- Platysternidae</b>	<b>Họ rùa đầu to</b>	<b>1</b>
49	<i>Platysternum megacephalum</i>	Rùa đầu to	12
	<b>14- Emydidae</b>	<b>Họ rùa đầm</b>	
50	<i>Cistolemys galbinifrons</i>	Rùa hộp trán vàng	13
51	<i>Cuora trifasciata</i>	Rùa hộp ba vạch	1
52	<i>Damonia subtrijuga</i>	Rùa ba gờ	1
53	<i>Geoemyda spengleri</i>	Rùa đất spengle	1
54	<i>Geoemyda tcheponensis</i>	Rùa đất sêpôn	1
55	<i>Pyxidea mouhoti</i>	Rùa sa nhân	12
56	<i>Sacalia quadriocellata</i>	Rùa bốn mắt	13
	<b>15- Testudinidae</b>	<b>Họ rùa núi</b>	
57	<i>Indotestudo elongata</i>	Rùa núi vàng	13
58	<i>Manouria impressa</i>	Rùa núi viền	123
	<b>16- Trionychidae</b>	<b>Họ ba ba</b>	
59	<i>Palea steindachneri</i>	Ba ba gai	1
60	<i>Pelodiscus sinensis</i>	Ba ba trơn	12

**Appendix 3a**

**LIST OF AMPHIBIANS AT PHONG NHA-KE BANG**

No.	Scientific name	Vietnamese name	Source
	<b>ANURA</b>	<b>BỘ KHÔNG ĐUÔI</b>	
	<b>1- Discoglossidae</b>	<b>Họ cóc tía</b>	
1	<i>Bombina maxima</i>	Cóc tía	123
	<b>2- Bufonidae</b>	<b>Họ cóc</b>	
2	<i>Bufo galeatus</i>	Cóc rừng	12
3	<i>Bufo melanostictus</i>	Cóc nhà	123
	<b>3- Hylidae</b>	<b>Họ nhái bén</b>	
4	<i>Hyla simplex</i>	Nhái bén nhỏ	13
	<b>4- Ranidae</b>	<b>Họ ếch nhái</b>	
5	<i>Ooeidozyga lima</i>	Cóc nước sần	123

No.	Scientific name	Vietnamese name	Source
6	<i>Phrynoglossus laevis</i>	Cóc nước nhẵn	123
7	<i>Rana andersoni</i>	Chàng An đéc sơn	123
8	<i>Rana guentheri</i>	Chẫu	123
9	<i>Rana kuhlii</i>	Ếch nhẽo	12
10	<i>Rana limnocharis</i>	Ngoé	123
11	<i>Rana livida</i>	Ếch xanh	13
12	<i>Rana nigrovittata</i>	Ếch sưỡi	123
13	<i>Rana ricketti</i>	Ếch bám đá	123
14	<i>Rana rugulosa</i>	Ếch đồng	12
15	<i>Rana sauteri</i>	Hiu hiu	13
16	<i>Rana taipehensis</i>	Chàng Đài Bắc	123
	<b>5- Rhacophoridae</b>	<b>Họ ếch cây</b>	
17	<i>Rhacophorus leucomystax</i>	Ếch cây mép trắng	123
	<b>6- Microhylidae</b>	<b>Họ nhái bầu</b>	
18	<i>Kaloula pulchra</i>	Ếnh ương	123
19	<i>Microhyla berdmorei</i>	Nhái bầu béc mớ	13
20	<i>Microhyla heymonsi</i>	Nhái bầu hây môn	123
21	<i>Microhyla ornata</i>	Nhái bầu hoa	123
22	<i>Microhyla pulchra</i>	Nhái bầu vân	12



A PRELIMINARY ASSESSMENT OF THE CONSERVATION IMPORTANCE  
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PROPOSED NATIONAL PARK, QUANG BINH PROVINCE, VIETNAM

ĐÁNH GIÁ SƠ BỘ Ý NGHĨA VÀ NHỮNG ƯU TIÊN BẢO TỒN  
ĐỀ XUẤT VƯỜN QUỐC GIA PHONG NHA - KÊ BÀNG,  
TỈNH QUẢNG BÌNH, VIỆT NAM



ROYAL DANISH EMBASSY

R.J. TIMMINS  
DO TUOC  
TRINH VIET CUONG  
D.K. HENDRICHSEN

HANOI, VIETNAM



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*Conserving wildlife since 1903*

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**Đánh giá sơ bộ về ý nghĩa và những ưu tiên bảo tồn  
đề xuất Vườn Quốc gia Phong Nha-Kẻ Bàng,  
tỉnh Quảng Bình, Việt Nam**

by

**R. J. Timmins, Đỗ Tước, Trịnh Việt Cường and D. K. Hendrichsen**

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## 1 INTRODUCTION

R.J. Timmins

### 1.1 Background and context

A large proportion of the remaining habitat in Vietnam and Laos is concentrated along the border between these two countries (Thewis *et al.* in press, J. Hurd/D. Hulse verbally 1998). Principally this is due to the rugged terrain of the Annamite mountains which form a natural border between the two countries and also probably in part the fact that it is a political border with heightened security. Recent work strongly suggests that the Annamite mountains are central to faunal richness within Indochina (Timmins in prep. a, RJT own data). Ongoing work also suggests that a large area of homologous limestone in central Indochina which straddles the Annamite ridge in the Phong Nha-Ke Bang area, has a relatively high degree of endemism in bird and mammal species.

The prominence of Phong Nha-Ke Bang (Figure 1) as one of the larger areas of intact habitat in Vietnam, the predominance of habitats on limestone, and the area's position on the main Annamite ridge have obvious implications for its biological richness and its conservation value. Several previous surveys have given interesting results, of particular note has been confirmation of the presence of Francois' Langur of the distinctive *Semnopithecus francoisi hatinhensis* subspecies (considered by some to be a distinct species (e.g. Brandon-Jones 1995)) (Le Xuan Canh 1992-1993, Pham Nhat *et al.* 1995, 1996-1997), and the rediscovery of Sooty Babbler *Stachyris herberti* (Lambert *et al.* 1994, Eames *et al.* 1995).

Recent work in Laos has shown that the Hin Namno NBCA area directly adjacent to Phong Nha-Ke Bang along the international border (Figure 1) has considerable importance for conservation, particularly of the Annamite fauna, primates and limestone fauna (Timmins and Khamkhoun Khounbolin 1996, Walston and Vinton 1999). The continuity of habitat between the Hin Namno NBCA and Phong Nha-Ke Bang further increase the potential conservation value of both areas. Clearly the Phong Nha-Ke Bang area had considerable potential for conservation of wildlife and habitats, and comprehensive surveys building on previous knowledge were obviously needed.

Despite considerable international interest in the biological richness of Indochina, particularly in response to the recent discovery of large mammal species new to science, there are still relatively few scientific data available on the distributions and status of the majority of wildlife in this region. Of the Indochinese nations Vietnam has had the greatest investment of funds towards biological research and conservation, yet there is still a great paucity of information available internationally; and long-term conservation of much of its wildlife is still an uncertainty. Of the considerable data written and otherwise presented in Vietnamese, interpretation of what valuable data exists is confounded by numerous problems (see for example Duckworth and Hedges 1998). There was and is a great need for well founded information on wildlife status and conservation in Vietnam.

The primate species in Vietnam make one of the most interesting primate assemblages in the world, however an outstandingly large proportion of the taxa is threatened. Despite these facts and the interest it has generated, the most recent primate surveys in Vietnam have provided alarming results, suggesting that primate conservation in Vietnam is at a very critical stage, with the imminent extinction of some taxa not unlikely (Nadler 1996, Nettlebeck *et al.* in press, Duckworth and Walston in prep., R. Boonratana/FFI unpublished data). Clearly there was a need to investigate primate status in Phong Nha-Ke Bang, to determine whether findings elsewhere were also applicable there.



## 1.2 The FFI Phong Nha-Ke Bang project

The FFI Phong Nha-Ke Bang project was conceived with the overall objective to develop the capacity of the reserve's forest protection staff to sustainably manage its biotic resources.

The project, implemented by FFI, ran for four months, drawing technical expertise from both Vietnamese and Foreign institutions, brought together to develop specific conservation strategies for the reserve. The project was broken into two components; the first focused on practical training courses in wildlife survey and monitoring techniques; the second part being a faunal survey focused on birds, large mammals and bats to increase the understanding of the conservation importance of the area. This report covers only the second (survey) component of the project.

Three mammalogists, Nguyen Xuan Dang, Pham Nhat and Pham Trong Anh devised and carried out the training programme. Although the trainers did not focus on a wildlife survey, they gathered incidental records which are presented in Nguyen Xuan Dang *et al.* (1998).

## 1.3 Aim of the bird and mammal survey project component

To initiate broad faunal surveys in the Phong Nha-Ke Bang area, towards a greater understanding of its conservation importance.

## 1.4 Objectives

To carry out broad wide ranging status surveys of birds and large mammals.

To use Key Species to assess conservation priorities within Phong Nha-Ke Bang and the conservation importance of Phong Nha-Ke Bang in national and regional terms.

To undertake the first detailed sampling of the bat fauna of Phong Nha-Ke Bang.

It was not an objective of the survey to concentrate on management issues nor is it a part of this report to prescribe detailed operational recommendations relating to the protected area management.

## 1.5 Participants (with specialisation)

Do Tuoc (DT)	Consultant to FFI from FIPI (Large mammals)
D. K. Hendrichsen (DKH)	Consultant to FFI (Bats)
Nguyen Thien Nga (NTN)	Undergraduate from Columbia University, New York, USA (Francois' Langur sleeping site observations)
R. J. Timmins (RJT)	Consultant to FFI (Birds and mammals)
Trinh Viet Cuong (TVC)	Consultant to FFI from the Institute of Ecology and Biological Resources (Large mammals)

## 1.6 Previous wildlife survey work

Published accounts of work in the Phong Nha-Ke Bang area appear to begin with that of Dao Van Tien (1970) who published the type description of *S. f. hatinhensis* based on material collected in 1942 to the north east of the Ke Bang area (see also Brandon-Jones 1995). In more recent years Phong Nha-Ke Bang has been visited by several researchers to several ends, however these surveys have been mainly based on day-trips from villages and villager information (information on the

itineraries of previous work was given by local people and local government officials during the survey; DT own data). Probably of shortest duration has been a surveys for endemic pheasants which visited the area for only a few days (Lambert *et al.* 1994, Eames *et al.* 1994, 1995, J. C. Eames verbally 1998). While the most substantial has been the work of Pham Nhat *et al.* (1995, 1996-1997) who surveyed the area with an emphasis on primates, particularly Francois' Langur. Other work seems to have been of a reconnaissance nature and has included that of Le Xuan Canh (1992-93), Le Xuan Canh *et al.* (1997) and short surveys for specific faunal groups in the B. Cha Lo area by the American Museum of Natural History (E. Sterling verbally 1998). BirdLife staff have visited the valley between Thuong Hoa and Ban On villages in the Ke Bang area on three occasions since the endemic pheasant surveys, but the data remain unpublished (J. C. Eames verbally 1998). Two surveys have been carried out in Hin Namno NBCA, a preliminary survey to determine a baseline for the areas conservation importance (Timmins and Khamkhoun Khounboline 1996) and a more in-depth survey of wildlife and habitat with emphasis on management requirements (Walston and Vinton 1999).

The majority of previous work suffers from a lack of clarity, particularly with regard to how species confirmation was achieved and on what basis was identification of difficult taxa made. Other weaknesses render the data in reports variously useful; Le Xuan Canh *et al.* (1997) in particular:

- has many internal inconsistencies (i.e. Assamese Macaque *Macaca assamensis* is down as observed in Table 2 and Appendix 2 but according to the text and Table 4 was only recorded as a specimen collected from one village);

- lacks detail particularly regarding species of exceptional conservation importance (i.e. Saola *Pseudoryx nghetinhensis* is reported on the basis of local information but no details are given other than a vague map locality; Imperial Pheasant *Lophura imperialis* and likewise Green Peafowl *Pavo muticus* are stated as being observed without any details given other than vague map localities);

- has obvious improbabilities in the species recorded (e.g. Small Flying Fox *Pteropus hypomelanus*, only known from small offshore islands, was apparently observed without a specimen being taken; Spot-billed Pelican *Pelicanus philippensis* a coastal or large-wetland species now only a sporadic visitor to Vietnam, was apparently seen);

- lacks understanding of regional mammal taxonomy (both *Callosciurus erythraeus* and *C. flavimanus* were apparently stated to be recorded, despite the fact that no recent review of the genus has considered animals of these two named forms to be anything other than allopatric or conspecific and thus not possibly coexisting; see for example Moore and Tate (1965), Corbet and Hill (1992)).

All these features combine to mean that the report has essentially significantly reduced meaning or value.

Some information given in Lambert *et al.* (1994) and a later international journal publication of Eames *et al.* (1994), is misleading; see for example the account of Crested Argus *Rheinardia ocellata* which appears to have been confirmed from remains but does not appear in the full bird list (unlike other species confirmed from remains) in either publication and is stated elsewhere in the text of Eames *et al.* (1994) as not being recorded in the Phong Nha-Ke Bang area yet in the table of sympatry it is down as 'present' in Eames *et al.* (1994) and 'present but rare' in Lambert *et al.* (1994).

There are perhaps likely to be further inherent problems with the interpretation of previous data (see for example the discussion of Duckworth and Hedges 1998; Section 3.2). Given these problems, there was not scope to systematically review past records, but some previous well documented records of significance are included for discussion within this report.

## **2 BACKGROUND TO THE PHONG NHA-KE BANG PROPOSED NATIONAL PARK AREA**

Phong Nha-Ke Bang proposed National Park lies within Quang Binh Province, in central Vietnam, along the Lao-Vietnamese border (Figures 1 and 2). The Phong Nha-Ke Bang proposed National Park and vicinity (hereafter referred to as the Phong Nha-Ke Bang area) consists of two components the Phong Nha Nature Reserve and the Ke Bang limestone forest area. Phong Nha Nature Reserve (41,132 ha.; 17°20'-17°37'N, 106°09'-106°23'E) was created by government decree in 1993 (FIPI in prep.), to conserve the area surrounding the locally famous cave of Phong Nha, used as a refuge by Vietnamese forces during the American-Indochinese War. Later the contiguous area of limestone and forest to the north, the Ke Bang area, was recognised for its biodiversity importance and the area recommended for protection. The Forest Inventory and Planning Institute (FIPI) is currently preparing a proposal to the Vietnamese Government to formally declare 106,813 ha. (17°22'-17°47'N, 105°46'-106°16'E) of the Ke Bang area along with the Phong Nha Nature Reserve as the Phong Nha-Ke Bang National Park (147,945 ha.) (FIPI in prep.). The area proposed will form one of the three largest protected areas in Vietnam.

Phong Nha-Ke Bang is situated on one of the largest contiguous areas of (karstic) limestone in Vietnam, and has the greatest representation of such habitat within the protected area system of Vietnam. The area is directly adjacent, along the international border, with the Hin Namno National Biodiversity Conservation Area (NBCA) (865 sq. km, between 17°40' and 17°15'N) in Laos (Timmins and Khamkhoun Khounboline 1996). Hin Namno NBCA also consist predominantly of limestone habitats and the natural habitats of the two areas are contiguous across the international border.

### ***2.1 Physical characteristics and habitat***

Limestone habitats are predominant over the Phong Nha-Ke Bang area, and are generally characterised by steeply rising but well vegetated karstic limestone hills and small in-lying 'sink' valleys. In peripheral areas within the limestone are larger flat bottomed valleys (below 400 m in altitude), several with permanent water sources. Terrain generally rises westwards with much of the interior being between 500 and 1000 m. Areas of non-limestone bedrock occur probably throughout, generally as small inclusions within the limestone, but become larger and more prominent in the northeastern portion of the Ke Bang area, and the southern portion of Phong Nha Nature Reserve.

On the northern edge of the Ke Bang area the limestone abuts non calcareous formations to the north, the transition is most spectacular to the south of B. Cha Lo where the boundary between these formations forms a narrow pass across the Annamite mountains to Laos, with the limestone rising to the east and non-calcareous formations rising rapidly to the west. The southern end of the pass is still forested making the scene even more spectacular.

The peripheral lowlands support a burgeoning human population and non-forest habitats, these degraded habitats extend to differing degrees onto surrounding limestone and non-limestone slopes. Several of the largest in-lying valleys are settled.

Climate is complex, however it is worth noting that the eastern side of the Annamites is wetter and cooler than the western (Lao) slopes, particularly in the winter, although the onset of the predominant summer rains is later on the eastern slopes than on the western slopes.

## 2.2 Human demography

Phong Nha-Ke Bang lies within the districts of Minh Hoa and Bo Trach, with nine communes around its periphery (see Figures 1 and 2). The main access to the Phong Nha Nature Reserve is by road n° 15A from Dong Hoi provincial town to Th. Phong Nha town, Son Trach commune, from here a poorly maintained road n° 565 (formerly 12A) goes south west to Laos, traversing the Phong Nha Nature Reserve. Another poorly maintained road n° 15 goes north west along the periphery of the karst areas of Phong Nha-Ke Bang to Thung Hoa village, however better access to the Ke Bang area is by road n° 562 from Ba Don town on highway one via Minh Hoa district town to road n° 15 north of Thung Hoa. Road n° 15 continues northwest around the periphery of the Ke Bang area until it meets road n° 561 which runs south to the B. Cha Lo border crossing to Laos in Dan Hoa commune. Son Trach commune is the most densely populated area on the periphery of Phong Nha-Ke Bang (FIPI in prep.).

Access to the in-lying villages of Ban On, Th. Yen Hop, and Mo O is via footpaths from Thung Hoa. The Hoa Son area is accessible from Th. Da Nang.

## 2.3 Protected area management

Phong Nha Nature Reserve has 23 staff, a dedicated head office at Th. Phong Nha, and several other infrastructure (Ovel and Nguyen Thi Dao 1998). The Ke Bang area under the jurisdiction of the Minh Hoa Forest Protection Department, has yet to receive any management, or protected area infrastructure. The World Wide Fund for Nature, Indochina Programme (WWF), has initiated a project to support development of the Phong Nha-Ke Bang proposed National Park (Ovel and Nguyen Thi Dao 1998). The Linking Hin Namno and Phong Nha through Parallel Conservation project (LINK) aims to initiate conservation activities in the combined protected areas of Hin Namno and Phong Nha-Ke Bang. The project takes a two phase approach. Its immediate objectives are to (following Ovel and Nguyen Thi Dao 1998):

- Establish a system for ecological and socio-economic monitoring of the project area for incorporation into management decision making.
- Assist the communities of Phong Nha Ke Bang to practice good stewardship of their valuable forest resources.
- Increase capability of the formal management structures of Phong Nha-Ke Bang to effectively monitor forest resource use co-operatively with communities.
- Initiate a system of transboundary co-operation between Hin Namno NBCA, Phong Nha Nature Reserve and associated provincial authorities.

At the end of this initial phase a comprehensive plan for phase II (October 1999-September 2002) will be developed.

### 3 A PRELIMINARY ASSESSMENT OF BIRD AND LARGE MAMMAL STATUS IN PHONG NHA-KE BANG PROPOSED NATIONAL PARK

R. J. Timmins, Do Tuoc and Trinh Viet Cuong

#### 3.1 Survey areas and effort

Because of the very different nature of the bat work, methodology, results and analysis are treated separately in Section 4 of this report.

Dates, effort and locations of the main bird and large mammal survey component of the project are given in Table 1, and survey sites are mapped on Figure 2.

The main survey component of the project concentrated solely on areas in the Ke Bang section, the rationale behind this being that recommendations for protected status of this area have not yet been formally accepted by provincial or national authorities and thus establishment of conservation importance was a high priority, furthermore this area had received seemingly much less attention in comparison with the Phong Nha Nature Reserve, by previous researchers.

A small number of incidental well documented records from the researchers working on the training programme have also been included where appropriate. The training component of the project visited sites both within Phong Nha Nature Reserve and Ke Bang. Further details of wildlife recorded can be found in Nguyen Xuan Dang *et al.* (1998). Nguyen Thien Nga under the supervision of Pham Nhat (of the training component) attempted to collect detailed data on Francois' Langur through observation of sleeping sites; some data not presented in Nguyen Xuan Dang *et al.* (1998) is included in this report.

Table 1. Dates, effort and locations of the main bird and large mammal survey project component.

Survey area	Dates	Researchers and effort* (person days)	Location	Altitude	c. % of time effected by rain related problems
Hung Ba Dau	15-16/7	NTN / 1	E-48-93-B 17°36'N, 106°17'E	?	0
Suoi Chay valley	4-8, 11-13/7	NTN / 6.5	E-48-93-A 285-322, 370-440	150-350	0
Cha Noi	3-20/9	DT / 15	E-48-93-A 150-200, 480-540	250-800	0
Th. Phu Nhieu	20-26/9	RJT, DT / 4	E-48-81-C 065-110, 540-565	250-450	50
Suoi Chan Loong valley and Hang Ca Tuc area	26/9-5/10	RJT, DT / 14	E-48-92-B 042518- E-48-93-A 470065 and E-48-92-B 057449 - E-48-93-A 062-085, 450-470	300-500	40
Suoi Mo Sang valley	8-13/10	RJT, DT / 9	E-48-80-D 930-950, 583-603	450-550	80
Suoi Cat valley	17-21/10	RJT, TVC / 7	E-48-92-B 967-980, 530-507	520-700	40
B. Cha Lo	24-28/10	RJT, TVC / 6	E-48-80-D 800-835, 560-610	300-700	0

Note: \* does not take into account time affected by rain related problems.

There is a noticeable contrast between the outward appearance of limestone areas of Laos and those of Vietnam which is particularly noteworthy over the Phong Nha-Ke Bang-Hin Namno NBCA area. In the limestone areas of Hin Namno NBCA and other areas of Laos exposed cliffs and open (spectacular) karst are predominant. Open karst areas have a very characteristic open vegetation cover including pandans, shrubs, epiphytes and cycads. The difference may be due partly to geology, however climatic patterns between the eastern and western sides of the Annamites undoubtedly also have a significant influence.

Forested, large valley systems are found through out the Phong Nha-Ke Bang area. Most are dry valleys, although several at lower altitude have very seasonal streams. Some of these valley areas within the limestone are probably largely on non calcareous bedrock. This was possibly the case for sections of valley in all survey areas, but certainly the case in the Suoi Mo Sang valley, where as a result the stream was obviously less seasonal than in the majority of other surveyed valley areas.

Notable extents of level low altitude forest (see also Figure 3) were found to the south and west of Th. Phu Nhieu; in the Suoi Chan Loong valley; the valley between Thuong Hoa and Ban On villages; and the southern portion of the Suoi On valley. Some areas visited by Lambert *et al.* (1994; J. C. Eames verbally 1998) in Phong Nha Nature Reserve were similarly noteworthy. Extensive forested valleys at slightly higher elevation included the Suoi Mo Sang valley, and the Suoi Cat valley system. Some areas of such forest were impressive with large dbh trees predominating, a relatively open midstorey, and understorey composed of saplings and herbage. The understorey differed quite markedly between and even within patches. Notable assemblages included areas composed of mainly saplings, low herbage and small palms, and areas with considerable fern growth and sturdier herbage. Small palms appeared to be particularly associated with (damper) depressions. A distinctive growth of somewhat branched, short, spreading tree growth with an understorey predominated by short, dense, monocotyledonous herb growth was associated with areas clearly experiencing periodic flooding (due to the constriction of run off from heavy rain through underground passages).

The Suoi Mo Sang valley and Suoi Cat valley had areas with perhaps thinner, quickly draining soils, in which 'pebble grit' was very evident. These areas had a particularly open understorey, and a noticeable component of a tree provisionally identified as *Lagerstroemia* spp.

To the south of B. Cha Lo village on the lower slopes of the border pass forest extends up to both sides of the road (Suoi Ken) for several km (all non calcareous to the west; mixed with limestone to the east). Structure and other evidence suggested that during the American-Indochinese conflict forest cover had been severely degraded or diminished over much of the area, however secondary forest regeneration is very good and contiguous, with an unbroken canopy. The canopy is generally low and dbh of trees relatively small with very few trees over 30 cm dbh, ground cover is fairly minimal. Forest structure and size of trees generally increases as the slope is ascended.

#### 3.4.2 Bird and large mammal results

This section details the findings with respect to birds and large mammals. Lists of all species of bird and mammal found during the survey can be found in Annexes 2 and 3, Tables 5 and 6. The findings and discussion of significance in this section mainly focuses on the status of Key Species. These are species which are thought to be at an elevated risk of extinction globally (see conventions). All records of Key Species from the survey are detailed in this section. Some Key Species records of significance to the conservation importance of Phong Nha-Ke Bang, reported by previous work in the Phong Nha-Ke Bang area are included where appropriate; note however that their inclusion is not a judgement of reliability.

The Key Species categories used are as follows (see also conventions):

Global Threat categories (following IUCN 1996)

**GT** Globally Threatened

Species which are facing a high risk of extinction in the wild in the medium term future

**GT-CR** Critically Endangered

This is the highest category of threat, and is only used for species facing an extremely high risk of extinction in the wild in the near future

**GT-EN** Endangered

Species which are not critically endangered but facing a very high risk of extinction in the wild in the near future

**GT-VU** Vulnerable

Species which do not fall into the two higher categories but which are facing a high risk of extinction in the wild in the medium term future

**GNT** Globally Near-threatened

Species at Lower Risk which are close to qualifying for the Globally Threatened Vulnerable category

**DD** Data Deficient

Species for which there is inadequate information to determine whether they are Threatened or at Lower Risk

#### *3.4.2.1 Coverage and significance of results*

It was possible to establish a broad overview of bird and large mammal status and make a reasonable assessment of bird and large mammal exploitation; both factors are crucial for determining the perspective in which conservation priorities within the area should be set and equally important for comparative assessment of the areas general conservation importance in a national and regional framework. Status assessment was reasonable for the majority of bird species, diurnal primates, squirrels and treeshrews. Assessment was particularly good for the conspicuous (including vocally) Key Bird species for which the opportunistic observation methods used are particularly suited.

The species lists given in Annexes 2 and 3, Tables 5 and 6, should not be taken as a complete or even nearly complete inventory, many more species are likely to be found, particularly those species which are only migrants to the area. The numbers of species recorded is related to effort, further effort would have recorded more species. At least in the case of birds, the vast majority of species are widespread within their altitudinal range and preferred major habitat types (forest, river, secondary etc.), it is unlikely that many species were overlooked solely because of a very local natural distribution outside of the areas surveyed.

Assessment was sufficient to determine the general status of large mammal species with obvious signs such as elephants, wild cattle, bears, pigs and big cats (note the former two groups were not found) in Phong Nha-Ke Bang as a whole, but not to determine precise patterns of temporal and spatial use of the area. The nature of the opportunistic diurnal surveys meant that a large proportion of signs would have been found in the areas surveyed if present. To establish more detailed status on a site by site basis requires a proportionally much greater input in terms of areas and distance covered and dedication to searching. Assessment of the status of the majority of other mammals species was less clearly determined, but no methodology based on sign searches is likely to give clearly interpretable data during a short time frame survey.

Very little time was spent spotlighting and no significance can be placed on the few records of nocturnal species.

The time lost to rain was substantial and the level of confidence in bird and large mammal status assessment was necessarily reduced, however it is obviously necessary to establish baseline data at more than one time of year to fully understand wildlife status and abundance in an area. Animal activity is certainly reduced to some extent as a result of rain, overcast skies, dampness, lower temperatures and/or wind with the effects prolonged into dry periods. Gibbon *Hylobates* sp. calling behaviour is almost certainly affected in this way (Brockelman and Sompoad Srikosamatara, 1993) as probably also is the calling frequency of Crested Argus *Rheinardia ocellata*. Calling activity of many bird species is significantly depressed during September and October, when the majority of species have finished breeding and have begun to moult; for instance Grey Peacock-Pheasants *Polyplectron bicalcaratum* are certainly present but their distinctive vocalisations were not heard and barbet *Megalaima* sp. calling was minimal and probably more than one species of forest barbet was overlooked.

The shyness and apparent low densities of Francois' Langur made attempts at studying pelage variability very difficult. Much has yet to be learned of the distribution and ecology of the forms of Francois' Langur present in Phong Nha-Ke Bang.

Most survey work took place at relatively low altitude with no survey work above 750 m. Higher altitudes are represented in Phong Nha-Ke Bang particularly closer to the international border. It is to be expected that these areas have somewhat different wildlife communities to those of the lower altitudes covered during the survey. However the relative levels of threats facing these wildlife communities are likely to be appreciably less than in the peripheral, lower altitude areas surveyed, the same is also probably true of the regional conservation significance of these communities. No very high altitude areas (1500 m+), which have very distinct communities from those of lower altitudes, are represented within Phong Nha-Ke Bang.

Steep wooded karst areas received less attention than more accessible habitats, but the communities in these areas are unlikely to be markedly different. These areas are likely to have fewer species, but the abundance's of a small number of species is likely to be higher than in the forests on gentler slopes with deeper soils. A few species may have gone unrecorded because of their strong association with this type of habitat; this could be the case with a tit species *Parus* cf. *P. monticolus* which has been found in Hin Namno NBCA in such habitat (Timmins and Khamkhoun Khounbolin 1996, Walston and Vinton 1999).

Effectiveness of survey methodology for determining status has been taken into account in the bird and mammal species abundance tables in Annexes 2 and 3 and greater detail on the reliability of data for determination of Key Species status is given where appropriate in individual Key Species accounts.

#### **3.4.2.2 Bird and large mammal communities; their status and patterns of abundance within Phong Nha-Ke Bang proposed National Park**

Human influence is the cause behind some of the clearest patterns of bird and large mammal abundance in Phong Nha-Ke Bang, and confounds attempts to determine natural patterns within the area. Habitat loss and degradation has a clear influence on wildlife populations which requires no explanation, within remaining forest habitat hunting pressure is probably the major determinant of the abundance of quarry species.

Large ungulate and large carnivore populations in Phong Nha-Ke Bang are clearly not numerous, this may be due to several factors but in all cases undoubtedly includes human induced population reductions. Areas of predominantly limestone hill were probably always poor habitat for some of the mammal species, due to terrain and a lack of accessible water. For such species, which probably once



included elephants and rhinoceroses (now almost certainly extirpated), the large valleys and non-calcareous hills in the north were presumably their strong-hold with marginal extension into surrounding limestone hill areas. Unfortunately these areas are the most readily accessible to people. The implication of habitat preference for several large mammal species (i.e. Sambar *Cervus unicolor*, Saola *Pseudoryx nghetinhensis*, Giant Muntjac *Megamuntiacus vuquangensis*, bears *Ursus* sp., large cats, *Panthera* sp., *Pardofelis* sp.), is that it cannot be expected that healthier populations are to be found in the less accessible heart of the area (as would be the case in protected areas covering non precipitous terrain). Unfortunately determination of the natural favourability of limestone areas for many species is probably now no longer possible and may not be so again in the future.

Primate populations seem to follow somewhat different patterns to those of the large mammals, three species Francois' Langur, and possibly Assamese Macaque and Stump-tailed Macaque appear to be relatively common, as they are in limestone areas of Laos (Ruggeri and Timmins 1995-1996, RJT own data). Populations are clearly not numerous in peripheral areas, but probably increase with distance from human habitation. For these three species the less accessible heart of the area almost certainly has higher population densities. The results of surveys in Hin Namno NBCA in Laos, strongly suggest limestone hill areas are able to support reasonable numbers of Douc Langur *Pygathrix nemaeus* (Timmins and Khamkhoun Khounboline 1996, Timmins and Duckworth in prep.). On the basis of such results a major decline has almost certainly taken place in the areas of Phong Nha-Ke Bang surveyed. The less accessible heart of Phong Nha-Ke Bang may still hold a reasonable population but this cannot be assumed, particularly as it appears to be clear that Douc Langurs have undergone more serious declines in the area than either the macaques or Francois' Langur. A low to very low gibbon population is presumably the combined result of unsuitability of limestone hill habitat and human hunting pressure (compare with results in Hin Namno NBCA and other areas of limestone in Laos; Timmins and Khamkhoun Khounboline 1996, Timmins 1997); it seems unlikely that numbers are much higher in the less accessible heart of Phong Nha-Ke Bang. What little is known of habitat use of the Pig-tailed Macaque *Macaca nemestrina* and Rhesus Macaque *Macaca mulatta* from Indochina (Ruggeri and Timmins 1995-1996, RJT own data) and survey data, suggests that both may have restricted distributions to the larger low lying valley areas within the Phong Nha-Ke Bang area.

General patterns of abundance of bird quarry species almost certainly reflects to a large part hunting pressure, for example the poorest registration rates with partridges and hornbills (and also Black Giant Squirrels) were in the Suoi Chan Loong valley, which was arguably the most accessible area visited. There was a relatively high encounter rate with Silver Pheasant *Lophiura nycthemera* over the majority of survey areas which was somewhat surprising.

Not unexpectedly given the range of altitudes covered (150-750 m) the bird fauna (altitude ranges of mammals in general are either very broad or poorly known) was characteristic of low to mid altitudes. Notable however is the presence of Large-spotted Civet *Viverra megaspila*, which may be predominantly dependent on the lowest altitudes. The lowest forested level-valleys may well have particular significance for lowland specialist flora and fauna, although this cannot be determined at present. A number of other species including Pied Falconet *Microhierax melanoleucos*, Scaly-breasted Partridge *Arborophila charltonii*, Mountain Fulvetta *Alcippe peracensis grotei* and Scaly-crowned Babbler *Malacopteron cinereum* are probably naturally noticeably less common at the higher altitudes surveyed.

Several species which over much of their ranges' are considered to be mid to high altitude species were found at low altitude in Phong Nha-Ke Bang, (these included: Black Eagle *Ictinaetus malayensis*, Pin-tailed Green Pigeon *Treron apicauda*, Orange-bellied Leafbird *Chloropsis hardwickii*, Grey Laughingthrush *Garrulax maesi*, and Grey-cheeked Warbler *Seicercus poliogenys*). This is a common pattern on the eastern side of the Annamites (J. C. Eames verbally 1998). This is presumably the influence of a number of factors including the cooler wetter climate of eastern

Annamite slope, but also probably factors intrinsically associated with limestone habitat, as even in Laos some species seem to have lowered altitudinal limits within limestone in comparison to near-by forest on non-calcareous bedrock (Duckworth *et al.* 1998).

Taking altitude factors aside limestone as a habitat has its own characteristic influence on bird and mammal communities with three taxa restricted to or near-restricted to limestone areas of Indochina; Sooty Babbler, a leaf-warbler taxon *Phylloscopus cf. P. ricketti* and Francois' Langur; all three are widespread in limestone habitats of Phong Nha-Ke Bang. A number of other species (Short-tailed Scimitar-Babbler *Jabouilleia danjoui*, Streaked Wren-Babbler *Napothera brevicaudata* and Eyebrowed Wren-Babbler *Napothera epilepidota*) are particularly common in limestone, the association appearing to be with the rockiness of slopes.

### 3.4.2.3 Key Species accounts

Brackets [ ] indicate the species or record is provisional or was unconfirmed. Brackets are also used in the case of Sunda Pangolin *Manis javanica*, Owston's Palm Civet *Hemigalus owstoni* and Saola *Pseudoryx nghetinhensi* to denote that although identification is certain, presence in Phong Nha-Ke Bang is not confirmed. Braces { } indicate species recorded by previous researchers (including Nguyen Xuan Dang *et al.* 1998) but not found during the current survey. Key Species and their significance are summarised in Table 1.

**Table 2. Key Species and other species likely to be at risk in Phong Nha-Ke Bang recorded during the survey or previously, threat status, and a provisional assessment of global, regional and national importance of the Phong Nha-Ke Bang population and the level of threat and priority for conservation action in Phong Nha-Ke Bang.**

Species	Threat Status	Level of threat	Priority for conservation action in Phong Nha-Ke Bang proposed National Park
<b>BIRDS</b>			
Pied Falconet	GNT	Mid?	Unknown?
{Siamese Fireback}	GT-VU	High	High
Crested Argus	GT-VU	High	High
Chestnut-necklaced Partridge	GT-VU	Mid?	Mid?
Yellow-rumped Pigeon	GNT	Low?	Low?
Brown Hornbill	GNT	Mid	Mid
Wreathed Hornbill*	*	Acute?	High
{Great Hornbill}*	*	Acute?	High
Red-collared Woodpecker	GT-VU	Low	Low
Blue-rumped Pitta	GNT	Low	Low
Bar-bellied Pitta	GNT	Low	Low
Eastern Green Magpie	GNT	Low	Low
White-winged Magpie	GNT	Low	Low-Mid
Short-tailed Scimitar-Babbler	GT-VU	Low	Low
Sooty Babbler	GT-VU	Low	Low
Grey Laughingthrush	GNT	Low	Low
{Japanese Paradise-flycatcher}	GNT	Low	Low
<b>MAMMALS</b>			
{Pangolin}	GNT	High?	Unknown
Pig-tailed Macaque	GT-VU	High?	Mid-High
Assamese Macaque	GT-VU	Mid	Mid
{Rhesus Macaque}	GNT	High?	Mid?
Stump-tailed Macaque	GT-VU	Mid	Mid
Francois' Langur	GT-VU	High	Very high

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Species	Threat Status	Level of threat	Priority for conservation action in Phong Nha-Ke Bang proposed National Park
{ Douc Langur }	GT-EN	Acute?	High
White/Buff-checked Gibbon	GT-DD	Acute?	High
Bear	GT-VU/DD	Acute?	High
{ Large-spotted Civet* }	*	High	High?
{ Owston's Palm Civet }	GT-VU	High?	High?
Marbled Cat	DD	High	High?
{ Tiger }	GT-EN	Acute	High
Pig†	†	Mid-High	Unknown
Giant Muntjac*	*probably GT-VU	High?	Unknown
{ Gaur }	GT-VU	Acute	Mid-High
{ Saola }	GT-EN	Acute?	Unknown
Southern Serow	GT-VU	High?	High?
Black Giant Squirrel*	*	Mid	Low-Mid
Inomate Squirrel	GT-VU	Low	Low

#### Notes

\* these species are included because they are under a high level of threat regionally.

† if *Sus bucculentus* were present its population might be of significance; pigs are also an important part of the prey base for large carnivores

[ ] identification provisional or unconfirmed

{ } Species recorded previously but not during the survey.

Threat status: GNT: Globally Near-Threatened; GT-CR: Globally Threatened - Critically Endangered; GT-EN : Globally Threatened - Endangered; GT-VU: Globally Threatened - Vulnerable.

Level of threat in Phong Nha-Ke Bang:

Acute: species at high risk of local extinction in the near future.

High: species experiencing high hunting pressure, often with relatively small populations.

Mid: species still reasonably numerous experiencing mid to high hunting pressure and/or restricted to low valleys.

Low: species widespread in Phong Nha-Ke Bang experiencing little to no hunting pressure.

Priority in Phong Nha-Ke Bang:

Subjective ranking based on likely significance of the Phong Nha-Ke Bang population for the conservation of the species and the level of threat.

#### Birds

Pied Falconet *Microhierax melanoleucos* GNT

*Survey records:* birds were seen on the 28 September the Suoi Chan Loong valley to the south of Hang Cop Tang, seemingly in association with a large-bird mixed species flock (RJT).

The species is a relatively unobtrusive canopy haunting species, and was presumably overlooked to a large extent. The species is mainly found in the lowlands and is patchily distributed in both Laos and Vietnam, and is nowhere known to be numerous (Thewlis *et al.* in press, J. C. Eames verbally 1998).

**{Siamese Fireback *Lophura diardi* GT-VU**

No evidence for the species was found during the survey, but it was previously recorded from the area by Lambert *et al.* (1994) who found remains in the possession of local hunters. Silver Pheasant, which was relatively common in the survey areas, generally replaces Siamese Fireback at higher altitudes (Lambert *et al.* 1994, Thewlis *et al.* in press), thus if still extant firebacks may be restricted to the lowest altitudes.)

**Crested Argus *Rheinardia ocellata* GT-VU**

*Survey records:* a single bird was heard on the 18 October to the south of the Suoi Cat valley (RJT). Two different birds were heard from the Ta Ty area (from B. Cha Lo) on the 25 October (RJT). Two birds were heard from forest to the Suoi Ken area west of the road south of B. Cha Lo, on the 27 October and a single bird heard in the same area on the 28 October (RJT).

The species is notoriously difficult to observe in the field, but its distinctive far-carrying vocalisations provide an excellent means of assessing status. It seems as though the few records indicate a lower than expected natural density, but it is also likely that the calling frequency was depressed at this time of year and further confounded by weather conditions. There are as yet too few data from other areas at the same time of year and weather conditions to assess the relative significance of the potential factors. The species is localised in Laos but more widespread in Vietnam, all populations in Indochina are likely to be under pressure from hunting (Collar *et al.* 1994, Thewlis *et al.* in press, J. C. Eames verbally 1998).

**Chestnut-necklaced Partridge *Arborophila charltonii* GT-VU**

*Survey records:* was recorded in all survey areas except the Suoi Cat valley area and the Ta Ty area from B. Cha Lo (all RJT). In the Suoi Chan Loong valley only a single group was recorded, but in the Suoi Mo Sang valley and in forest to the west of the road south of B. Cha Lo calls were generally heard frequently per day and involved up to four groups.

Populations in the Malay Peninsula and Sunda are now severely reduced (Collar *et al.* 1994), however the disjunct population in north and central Vietnam remains widespread and relatively numerous in some area (J. C. Eames verbally 1998).

**Yellow-vented Pigeon *Treron seimundi* GNT**

*Survey records:* two males in fruiting trees in association with a large, mixed species, bird flock on the 18 October south of the Suoi Cat valley (RJT).

The significance of the records is hard to assess although the species is likely to be widespread in the Phong Nha-Ke Bang area. Green-pigeons are generally unobtrusive and easily overlooked, while large aggregations can form at fruiting trees.

**Brown Hornbill *Ptilolaemus tickelli* GNT**

*Survey records:* one group seen on 9 September to the south of Cha Noi (DT). One group was seen in the Suoi Chan Loong valley on 27 and 29 September (RJT). Groups were encountered on two occasions in the Suoi Mo Sang valley (12 and 13 October) and once in the Suoi Tagiang valley (from the Suoi Mo Sang valley) (13 October), but records probably only related to one or two actual groups (RJT).

The number of encounters were lower than expected in comparison with recent findings in Laos (Thewlis *et al.* in press). As an obvious quarry species, this probably reflects to some degree hunting pressure, although comparative data from Vietnam are few, but the species appears to be still widespread in similar numbers (J. C. Eames verbally 1998, DT own data).

#### Red-collared Woodpecker *Picus rabieri* GT-VU

*Survey records:* singles seen on 28 September in the Suoi Chan Loong valley, 13 October at the end of the Th. Yen Hop valley and twice in the Ta Ty area from B. Cha Lo (25 and 26 October) (RJT).

The species is most common in lowland areas and remains relatively widely distributed in protected areas of Indochina (Thewlis *et al.* in press, J. C. Eames verbally 1998), it was a little surprising that more were not recorded in the low altitude forested valleys.

#### Blue-rumped Pitta *Pitta soror* GNT

*Survey records:* birds were unequivocally identified on 6 occasions with a further 7 records of either this species or Blue-naped Pitta *Pitta nipalensis*, from all of the survey sites (RJT).

The status of this species probably reflects that of Bar-bellied Pitta (see below) however its vocalisations are not as distinctive and given less frequently. Encounter rates were approximately equal to those of Bar-bellied Pitta. Both this species and Bar-bellied Pitta remain widespread and tolerant of habitat degradation and are of low conservation priority (Thewlis *et al.* in press, Eames in prep.)

#### Bar-bellied Pitta *Pitta ellioti* GNT

*Survey records:* probably very common in valley forests of all of the surveyed areas except perhaps the sites visited from B. Cha Lo (RJT).

The frequency of vocalisations differed markedly over time in an area and was probably related to weather and time of day, as such it was difficult to determine detailed status in relation to habitat or site. Despite relatively good weather, very few vocalisations and no observations were registered from sites in the B. Cha Lo area; this contrasts with the vocalisations of Eared/Blue Pitta *Pitta phayrei/cyanea* which were registered more frequently in this area than other areas, and suggests a real difference in abundance with the other areas surveyed.

#### Eastern Green Magpie *Cissa hypoleuca* GNT

*Survey records:* a single identified in a large-bird mixed species flock in the Suoi Chan Loong valley on the 1 October (RJT).

Green Magpies are very difficult to observe, and vocalisations suggested green magpies were common in the areas surveyed, although Long-tailed Green Magpie *Cissa chinensis* is also present (Lambert *et al.* 1994).

#### White-winged Magpie *Urocissa whiteheadi* GNT

*Survey records:* groups were observed frequently at all sites (all RJT). Encounters were as follows: Suoi Chan Loong valley, one group on 26 September and two groups on 27 September, probably all relating to two groups; Hang Ca Tuc area, single groups on 3 and 4 October, probably referable to one group; single group on 13 October close to Th. Yen Hop village in very degraded forest patch; Suoi Mo Sang valley, single groups on 9 and 12 October in two separate areas; single groups on limestone

bordering the main valley north of Mo O village on 13 and 19 October; single groups on 18, [19], 20 and 21 October in the Suoi Cat valley area, probably relating to three different groups; two groups on the 24 October in the Ta Ty area from B. Cha Lo; single groups on 27 and 28 October in forest in the Suoi Kea area to the west of the road south of B. Cha Lo. One group on 27 October south of B. Cha Lo at different location to that seen by RJT (TVC).

The numbers encountered suggest a very healthy population. As with certain other species the abundance in Phong Nha-Ke Bang contrast markedly with the status of the species in Hin Namno NBCA where it is relatively scarce, although some populations further north in Laos are equally numerous (Thewlis *et al.* in press). The species is still widespread and common at several sites in Vietnam (J. C. Eames verbally 1998).

**Short-tailed Scimitar-Babbler *Jabouilleia danjoui* GT-VU**

*Survey records:* common (at all survey sites), usually one to two groups daily, in areas on slopes with at least some exposed rocks in the vicinity (RJT).

The species remains widespread in Vietnam and is common at several protected areas (J. C. Eames verbally 1998). The abundance of the species contrasts strongly with its status in Laos, from where there are only a handful of records (Thewlis *et al.* in press).

**Sooty Babbler *Stachyris herberti* GT-VU**

*Survey records:* common, usually one to two groups daily, in the areas with a prominence of visible limestone (RJT).

The species is endemic to areas of limestone in central Laos and Vietnam (Eames *et al.* 1995, Thewlis *et al.* in press). Recent findings have generally found the species to be relatively common in several limestone areas in Laos including the Hin Namno NBCA area (Thewlis *et al.* in press), but in Vietnam Phong Nha-Ke Bang is almost certainly the only protected area in the species range (J. C. Eames verbally 1998). The species is at little risk in the short to midterm.

**Grey Laughingthrush *Garrulax maesi* GNT**

*Survey records:* one group encountered in the Suoi Mo Sang valley on the 10 October (c. 500 m) (RJT). Encountered on three occasions (once at c. 425 m) in the Suoi Cat valley where the species was probably common (RJT).

The low altitude of some of the records is surprising. The species is probably numerous over the higher altitudes of the Phong Nha-Ke Bang area, as it is over wide areas of both Laos (Thewlis *et al.* in press) and Vietnam (J. C. Eames verbally 1998).

**[Japanese Paradise-flycatcher *Terpsiphone atrocaudata* GNT**

*Survey records:* a single paradise flycatcher thought to be this species was seen on 7 October in the valley between Thuong Hoa and Ban On villages (RJT).

The species is a non breeding migrant to the area and unlikely to be under any threat.]

## Mammals

### [Sunda Pangolin *Manis javanica* GNT

*Survey records:* two animals positively identified in the possession of a trader coming by motorbike from Laos through the B. Cha Lo border post on 23 October, a further two containers seemed to hold further pangolins, their precise origin was not determined (RJT, TVC).

Nguyen Xuan Dang *et al.* (1998) found pangolin scales in local villages during the training programme.

Pangolins appear to be commonly traded in Indochina although there are few data on the effects of exploitation on wild populations.]

### Fig-tailed Macaque *Macaca nemestrina* GT-VU

*Survey records:* a few animals of a group seen and then flushed at the bottom of the east slope of the Suoi Chan Loong valley on 28 September (DT) (identification was based on the distinctive dark radial crown pelage and thin tail).

In Laos the species is characteristic of lowlands and tolerates disturbed habitat (Ruggeri and Timmins 1995-1996, RJT own data), the species range in Phong Nha-Ke Bang is likely to be restricted to peripheral areas retaining tracts of forest in low valleys.

### Assamese Macaque *Macaca assamensis* GT-VU

*Survey records:* [Groups provisionally identified at on the 29 September ('eau' calls heard, seemed not to have contrasting ginger tones to hunches) and at 12.15 hrs on 4 October ('eau' calls heard, no contrasting ginger tones to hunches, contrastingly pale sideburns and beard on at least one animal) in forest on limestone slopes in the Hang Ca Tuc area, and one unidentified macaque seen and flushed and probably macaques heard, in similar habitat in this survey area on the 29 September and 4 October respectively (RJT)]. Two animals seen on 18 October in forest on limestone slopes in the Suoi Cat valley (RJT) (short hair parting seen, 'eau' calls heard, no contrasting ginger tones to hunches, contrastingly pale sideburns and beard on the one animal).

There were the following records of unidentified macaques: at least one unidentified macaque was seen for less than a minute in a tree not far from the sleeping site of Francois' Langur at the Eo Cap site at 17.40 on 7 July (NTN). Branch movements indicated further animals were present. At least three unidentified macaques were seen for less than a minute moving through a tree at the Hang Lao site at 16.50 hrs on 13 July. Branch movements were heard from the tree until 17.10 hrs (NTN). Groups of macaques flushed in the Suoi Mo Sang valley on the 10 and 11 October (DT).

The status of this species seems to largely mirror that of Stump-tailed Macaque. Although populations are depressed from what might naturally be expected the species is likely to be widespread with almost certainly healthier numbers in the less accessible heart of Phong Nha-Ke Bang. Survey findings in Laos suggest that Assamese Macaque is relatively widespread in the evergreen forests of the Annamites, and along with Stump-tailed Macaque, the commonest macaque in karst limestone areas (Ruggeri and Timmins 1995-1996, RJT own data).

Le Xuan Canh *et al.* (1997) found very little evidence for the species, while stating that local people did not recognise or report the species; this is clearly an indication of, the poor quality and dangers, of using information from local people.

### {Rhesus Macaque *Macaca mulatta* GNT

The species has apparently been documented by several past researchers (Pham Nhat *et al.* 1995, 1996-1997, Le Xuan Canh *et al.* 1997, Nguyen Xuan Dang *et al.* 1998).

The distribution and association with habitat of this species in Phong Nha-Ke Bang is not clear, in other areas of Indochina the species is associated with lower altitude forest particularly riverine habitats (Ruggeri and Timmins 1995-1996, RJT own data). Such habitat is clearly limited in Phong Nha-Ke Bang. The species remains common, often in association with high human population density in many areas of its global range.}

#### Stump-tailed Macaque *Macaca arctoides* GT-VU

*Survey records:* one group seen in limestone from Cha Noi on 9 September (DT). One group flushed at the bottom of the east slope of the Suoi Chan Loong valley on 28 September (DT). One animal seen and others heard on a rock face close to Hang Cop Tang in the Suoi Chan Loong valley on the 1 October (RJT). A single group to the south of the Suoi Cat valley on 18 October (RJT).

The low encounter frequency from the survey suggests reduced numbers, although populations of this species and Assamese are likely to be the healthiest of the diurnal primates in the area. Data from Laos suggests that this species and Assamese Macaque are the commonest macaques in karst limestone areas (Ruggeri and Timmins 1995-1996, RJT own data), this was supported by findings from the current survey. The species is still widespread in forested areas of the Annamites of both Laos and Vietnam (Ruggeri and Timmins 1995-1996, DT own data, RJT own data).

#### Francois' Langur *Semnopithecus francoisi* GT-VU

*Survey records:* at the Hung Ba Dau site a sleeping site was watched over the evening, night and morning of 15 and 16 July, branch movements, beginning at 19:25 hrs, and the sound of faeces and urine falling to the ground during the night confirmed the presence of primates. At 05:15 hrs on the 16 July three loud calls were heard from the vicinity (NTN). The sleeping site was a near vertical rock face c. 20x20 m, almost devoid of vegetation and surrounded by sparsely vegetated karst.

One group was sighted at 05:20 hrs on 6 July on a near vertical rock face (400-500 m distant) from the valley floor close to Basecamp 1 in the Suoi Chay valley and was in visual contact until 06:40 hrs (NTN). At least 4 individuals were observed, white hair was seen on the sides of the face of at least two of the four animals. The sleeping site was a near vertical rock face c. 20x20 m lacking in vegetation, between 100-150 m from the valley floor and surrounded by sparsely wooded karst. At 05:40 hrs on the 6 July and again at 05:59 hrs, several loud calls were heard to the southeast in the opposite direction to the animals being watched (NTN).

At 19:10 hrs, on 6 July, the silhouettes of at least 3 large sized animals (one possibly carrying a juvenile ventrally) were seen returning to their sleeping cliff at the Eo Cap site (NTN). At about 01:30 hrs on 7 July, a short burst of alarm vocalisations were heard. On the following morning at 05:05 hrs the silhouettes of at least 3 immature animals and two adult sized animals were seen in a tree adjacent to the sleeping site. The group fled, one animal giving a short burst of alarm vocalisations, when they detected the observers presence at 05:25 hrs. The sleeping site was a near vertical rock face measuring at least 20x20 m and lacking in vegetation and surrounded by sparsely vegetated karst. The group was about 30 m away from the observer.

A group was detected at 18:57 hrs on 7 August from branch movements and several 'chirplike squeaks' presumably as animals returned to their sleeping site located in a hole 75 m deep and measuring about 15 in diameter near the top of a limestone hill at the Hung Lao site, but visual contact was not made until the following morning (NTN). On 8 August, at 05:12 hrs, a series loud calls were heard and at 05:20 hrs at least 5 individuals were briefly observed climbing up out of the sleeping 'hole' towards a forested limestone hill just behind. White hair was seen on the sides of the face of at least one of the five individuals. Branch movements were heard until 05:30 hrs.



Heard twice in different areas in limestone to the east of Cha Noi (DT). Heard once in limestone to the south of Th. Phu Nhieu (DT). In the Suoi Chan Loong valley loud calls were heard four times on the 29 September (from two presumed locations); loud calls heard twice on 1 October (from two presumed locations); and loud calls heard once on the 2 October (RJT). Calls came from four places within the valley (RJT). In the Hang Ca Tuc area loud calls heard five times on the 3 October (from a minimum of three presumed locations); loud calls heard twice and calls thought to be the alarm vocalisations of Francois' Langur heard once on the 4 October (from two presumed locations), suggested at least four locations (RJT). A single animal flushed on the 3 October from forest in limestone to the south of the Hang Ca Tuc area, the head pelage was not seen (RJT). Loud calls heard once from the southern side of the Mo O valley to the west of Mo O village on the 8 October (RJT). In the Suoi Mo Sang valley loud calls heard twice (from different locations) on the 9 October, once on the 10 October (RJT) and once on the 11 October (DT). In the Suoi Cat valley area loud calls were heard once on 18 October, and once on the 21 October, with alarm vocalisations and then subsequently loud calls heard on 19 October, from seemingly three different locations (RJT). Two animals were seen well in forest in limestone in the Ta Ty area from B. Cha Lo on 25 October, both animals had a pattern of white facial hair consistent with that of *S. f. hatinhensis* (RJT).

During the course of the training programme reports of the presence of black-headed animals were received from local people through out the survey areas (Nguyen Xuan Dang *et al.* 1998). The presence of a black-headed form was also widely reported by local people during the main survey (DT, TVC, NTN). The presence of a black-headed form within Hin Namno NBCA has already previously been confirmed (Timmins and Khamkhoun Khounboline 1996, Walston and Vinton 1999). It is a little surprising that previous surveys, which have included specific searches for Francois' Langur have not recorded or reported the presence of a black-headed form (Pham Nhat *et al.* 1995, 1996-1997, Le Xuan Canh *et al.* 1997). If evidence for the inappropriateness of information from village information is needed, then this must be clear and incontrovertible proof. A further implication of the current understanding is that past records of *S. f. hatinhensis* should be reviewed in order to determine on what basis they were identified as this subspecies. The records of *S. f. hatinhensis* presented in Lambert *et al.* (1994) and Eames *et al.* (1994) can not be assumed to be nominate *S. f. hatinhensis*, as although white pelage was seen in the face, pelage features were not carefully checked at the time of observation (J. C. Eames verbally 1998). There is a similar need to gather and review precise localities for all Francois' Langur records of known pelage as a first step towards understanding ecological relationships between the different pelage forms. Some previous record (e.g. Le Xuan Canh 1992-1993) are based on animals of unknown provenance, while the majority of other researchers presenting field records have not given detailed localities. Pham Nhat *et al.* (1995) were exemplary in their effort to provide detail, presumably still further invaluable data on pelage and detailed localities is held by these authors.

The low number of encounters and the relatively few vocalisations heard almost certainly indicates reduced populations in the areas surveyed. The post-dusk return and pre-dawn leaving times of groups observed at sleeping sites also seems to reflect hunting pressure and correlates with changes in behaviour reported by local people in response to hunting (DT, NTN). However it is also likely that some lack of evidence is due to reduced vocal activity, as is the case with other mammal and bird species at this time of year. In suitable areas of limestone in Laos encounters can be daily and vocal registrations much more numerous and audible from several localities from a single spot (Timmins and Khamkhoun Khounboline 1998, Timmins 1997, Timmins in prep. c).

Local people offered various information on the distribution of the different forms, but given the general unreliability of local information, no such information is presented here. It would be easy and perhaps tempting to include such data but the dangers of it becoming 'set in stone' are real, as are the negative implications of hindering and clouding future efforts to infer ecological relationships of the various forms.

A primary need for future study must be a spatial analysis of pelage characters over the area and the degree (if any) of intra-group pelage variation. Basic ecological studies are also of high priority. The use of information from local people as primary evidence is not acceptable.

There should be caution in assuming that the black-headed form, confirmed from adjacent areas of Hin Namno NBCA and presumably present in Phong Nha-Ke Bang, represents *S. f. ebenus* (see for example Nadler 1996-1997). Although Wulsin, the collector of *S. f. ebenus*, did perhaps venture within the range or close to the range of the Hin Namno NBCA/[Phong Nha-Ke Bang] black-headed form (D. Brandon-Jones verbally 1998), at least one pelage feature in the description of *S. f. ebenus* is not consistent with observations of black-headed animals in Hin Namno NBCA (Timmins in prep.). It is certainly not inconceivable that populations with similar pelage to Hin Namno NBCA animals and *S. f. ebenus* exist or existed elsewhere in Vietnam, Laos or China, given that the pelage of the species is clearly very variable between populations and that the form(s) present (or now extirpated) over large areas of limestone in Indochina is(are) completely unknown. Confirmation can perhaps only come from genetic studies using tissue from black-headed animals of known origin within the Hin Namno NBCA-Phong Nha-Ke Bang complex and the type specimen of *S. f. ebenus*.

A previously unpublished record of Francois' Langur is presented here: between ten and twenty animals were seen from road N° 561 to the south of B. Cha Lo returning to a sleeping site on the 19 March and leaving again the following morning (E. Sterling in litt. 1998). The sleeping site was on a high near-vertical limestone cliff face. The distance between animals and observers and poor light conditions precluded detailed observation of pelage.

#### **{Douc Langur *Pygathrix nemaeus* GT-EN**

The red-shanked *P. n. nemaeus* sub-species has apparently been documented by several past researchers (Pham Nhat *et al.* 1995, 1996-1997, Le Xuan Canh *et al.* 1997, Nguyen Xuan Dang *et al.* 1998).

The apparent frequency at which previous researchers have documented the species suggests a major population decline in the Phong Nha-Ke Bang area. The red-shanked *P. n. nemaeus* subspecies (which some authors consider a full species) remains widespread in larger forest areas of central and south Laos, but is certainly declining (Timmins and Duckworth in prep.). The species range in Vietnam is probably similar, although forest areas are smaller and more fragmented, but fewer data are available (e.g. Eames and Robson 1993, Lippold 1995). Douc Langurs have probably undergone more significant declines than most other diurnal primates species in Vietnam, partly as a result of behavioural characteristics which make them easy to hunt (DT own data). The animals in Hin Namno NBCA are part of one of the most important populations in Laos (Timmins and Duckworth in prep.) }

#### **White/Buff-cheeked Gibbons *Hylobates (Nomascus) leucogenys/gabriellae* DD**

*Survey records:* single group heard on 17 August north of Ruc Ma Rinh (DKH). Single groups (probably the same) heard on three mornings from hills to the north of Cha Noi (DT). Single groups (quite possibly the same) heard on 9, 10 and 13 October in the Suoi Mo Sang valley (RJT, DT). Two groups heard on both the 27 and 28 October from forest to the west of the road south of B. Cha Lo (RJT, TVC).

The timing of the survey was not ideal for recording the species, and heavy rain may well reduce calling frequency quite significantly. But the very low number of records from the survey without doubt reflects reduced populations. Although paralleling the findings for other primate species, the implication of so few records are that gibbons numbers have been reduced to a greater extent than those of other primate species with the possible exception of Douc Langur. In Laos gibbon records

have been generally fewer in forested limestone areas than nearby forest not on limestone (even when taking into account the possibility of unsuitability of parts of the habitat mosaic within limestone areas) (Ruggeri and Timmins 1995-1996, RJT own data). Probably gibbons are less able to utilise limestone hill areas than other primates. Gibbon numbers are probably reasonably healthy in the B. Cha Lo area, particularly in the forests to the west and north of the Suoi Ken, which are contiguous with extensive forests over the international border in Laos. Three groups were heard from forest to the south of B. Cha Lo on the 20 March (E. Sterling in litt. 1998).

No gibbons were observed and no recordings of vocalisations were made. It is inadvisable at present to identify animals on the basis of field identification. Species boundaries (in terms of diagnostic character limits) are not clear, with evidence that pelage and vocal characteristics from the same area can suggest different taxa (Geissmann 1995), and that animals with quite different pelage characters in different areas can have relatively much more similar vocalisations (Evans *et al.* in prep.). Animals in the same area can show a relatively large degree of variation particularly in the cheek hair one of the primary features currently used for identification (SFNC unpublished data). Few localities are known where the identification of animals has been precisely recorded by specimen and vocal analysis, and even more importantly there are no localities from which the intra-population variation in pelage and vocal characters has been studied. It is not wise to even speculate the taxonomic affinity of animals in Phong Nha-Ke Bang. Further confusion is due to the differences in opinion in the taxonomic affinities of the different taxa between different authors. Given that at least historically the ranges of the nominal taxa were contiguous, it would not be surprising if there is not an appreciable degree of intergradation between them. There is further reason to caution against the temptation to assign field records to named taxa since no survey team is likely to see a large enough sample of animals well enough to be confident of the degree of morphological variation within the population.

It is obviously a priority to gain a clear understanding of the taxonomy and distribution of forms within the *H. leucogenys/gabriellae* group. To this end field workers should concentrate on detailed observation of pelage characters and tape recording of the song duets, from as large a sample of animals as possible.

#### Bear *Ursus*

*Survey records:* recent claw marks were seen on the trunk of a large tree in relatively good forest showing little disturbance at Hung Lao above the Suoi Chay valley on 7 July (NTN). Old signs were seen once in the Hang Ca Tuc area (RJT).

Old signs are easily overlooked by the methodology used, however recent signs which provide the best indication of status are much more visible and difficult to miss. The lack of such signs surely indicates very few animals were present in the survey areas. There would appear to be a lucrative trade in captive animals, bear parts and products throughout Indochina although data are few (RJT own data). Good status information on either of the two species, Sun Bear *Ursus malayanus* DD and Asian Black Bear *Ursus thibetanus* GT-VU, in Indochina is very scarce, but there are few if any areas where either species are still common in Laos and the same is undoubtedly true for other countries in the region (RJT own data). The suitability of karst limestone areas for either species is unknown, although natural densities in such habitat may well be below those in extensive forests on non precipitous terrain.

#### [Owston's Palm Civet *Hemigalus owstoni* GT-VU

*Survey records:* one live animal was seen on the 23 October being carried by a hunter clearly having just come back from the forest, the animal apparently came from slopes in the Suoi Ken area to the

west of the road to the south of B. Cha Lo (RJT, TVC). Another animal was seen on the 26 October at a collection point for wildlife in B. Cha Lo village (RJT, TVC).

Although identification of the animals seen is certain, presence within Phong Nha-Ke Bang needs to be confirmed. Very few data have been collected on this species in the wild which is endemic to the Annamites although it is regular but not numerous in trade in Vietnam (Schreiber *et al.* 1989, Rozhnov *et al.* 1992, Duckworth 1997, S. Rosenthal verbally 1998). Photo-trapping results in Pu Mat suggest the species is not uncommon in at least certain areas and habitats (SFNC unpublished data.)

#### Marbled Cat *Pardofelis marmorata* DD

*Survey records:* one captured animals seen in Phu Nhieu village on 24 September apparently caught by snare to the south east of the village in the Khe Lan valley (DT).

Little is known of this species which is hard to detect in the field (Nowell and Jackson 1996), although recent records from Laos suggest a relatively wide range, in a variety of habitats (Duckworth *in litt.* 1998).

#### [[Tiger *Panthera tigris* GT-EN

Nguyen Xuan Dang *et al.* (1998) found and photographed footprints measuring 10x11 cm in sand at Hang En. The size of the prints probably rules out Leopard *Panthera pardus*.

Two hunters met during the survey in the Suoi Cat valley area claimed to have trapped two Tigers in 1997 (TVC). How believable this claim is, is open to doubt but it certainly indicates Tiger status is extremely precarious within Phong Nha-Ke Bang.

A very small number of Tigers may still be present, but they are likely to be restricted by habitat requirements and under considerable threat from hunting, and it seems unlikely that they will survive even through the next year or two. Even if they were to survive depletion of the prey base is likely to prevent any significant recovery (Karanth and Stith *in press*.)]

#### [[Asian Elephant *Elephas maximus* GT-EN

Mo O village residents apparently found the remains of an elephant five years previously however they did not know its origin as elephants were previously unknown in the area (TVC). A small group of animals now reduced probably to two was reported to live in the forested hills between Cha Noi and Minh Hoa (outside of the Phong Nha-Ke Bang area) (DT). Le Xuan Canh *et al.* (1997) reported the presence of elephants in the Thuong Hoa and Thuong Trach (commune) areas, but give no further detail. Elephants almost certainly no longer occur in Phong Nha-Ke Bang and any numbers of animals in surrounding areas are so small as to be insignificant for conservation of the species.]]

#### {Gaur *Bos gaurus* GT-VU

Le Xuan Canh *et al.* (1997) records 'about more than 20 [Gaur in] two groups' from the Phong Nha-Ke Bang area on the basis of information from local people with localities mapped for both the north and south, however they do not give further detail. Nguyen Xuan Dang *et al.* (1998) apparently found old footprints in the Da Nui area (although they give no details of identification) and received reports from numerous people of small numbers (1-3) of animals in the same area of northeastern Ke Bang, the same area also as that mapped by Le Xuan Canh *et al.* (1997). Identification as Gaur is presumably an assumption, although from what is known of the ecology of other species of wild cattle, the presence of any other species would seem very unlikely (see Duckworth and Hedges 1998, Hedges *in prep.*).

Taken at face value comparison of the above reports suggests a rapid population reduction, although interpretation of animal numbers from village information is fraught with difficulty (Section 3.3.1). The area from which these records and reports come has a high proportion of non-calcareous hills and valleys and is less precipitous than the majority of the Phong Nha-Ke Bang area. Clearly wild cattle are very localised and persist in only very small numbers, continually under threat from snares and other forms of hunting. It seems unlikely that animals will persist long into the future.)

**{{Saola *Pseudoryx nghetinhensis* GT-EN**

Le Xuan Canh *et al.* (1997) appeared to have gathered information on Saola in the Phong Nha-Ke Bang area on the basis of local information and at least one trophy (photograph included) but no details are given. Nguyen Xuan Dang *et al.* (1998) also found evidence in the form of reports from Ban On village, a c. 50 year old trophy in B. Hoa Luong and another old trophy in Th. Da Nang. An old trophy was seen in B. Tang Hoa in 1994 (DT own data).

No evidence was found for the species during the survey, which is perhaps not surprising since, animals have never been observed in the field by researchers and field signs are unknown, furthermore little time was spent interviewing local people or in villages in search of animal remains.

Provenance of trophies and other remains can not be established with certainty. Although Saola probably once occurred in the area, it should no longer be assumed to be the case. The species has a very restricted range in both Laos and Vietnam (but particularly the former), there is no evidence to suggest that it occurs anywhere commonly (Timmins in prep. b, Mallon and Eames in prep.). So little is known about the Saola that its relative status in various habitat types cannot be ascertained. Its natural status in limestone areas may well be different from that in non-limestone areas (Timmins in prep. b.))

**Southern Serow *Naemorhedus sumatraensis* GT-VU**

*Survey records:* trophies when looked for were found in villages throughout the area, and remains of a recently caught Serow were seen in B. Cha Lo village (see Annex 4) (RJT, DT, TVC). Old droppings were seen in three rock shelters in limestone to the south of Cha Noi (DT). Droppings likely to be those of Serow seen on 3 October in limestone hills to the west of Hang Ca Tuc (RJT). Two rock shelters one seemingly recently used and one with old droppings were found in limestone to the east of the Suoi Chan Loong valley (DT). Footprints and droppings seen on a small karst limestone knoll at Dia Chat camp site in the Suoi Cat valley on 20 October (TVC).

The status of the species in Indochina is poorly known, surveys in Laos suggest it is still widespread (mainly based on trophies and other remains), but field data on local status in survey areas are very poor (perhaps due to low population density), however the frequency with which remains of Serow are seen and associated indications of commercial trade suggests the species may be under considerable pressure (RJT own data). Karst limestone areas may be a strong hold for the species (see Lekagul and McNeely 1977); in Laos signs thought to be attributable to the species have been observed with greatest frequency in such areas (RJT own data).

**Locuste Squirrel *Callosciurus inornatus* GT-VU**

*Survey records:* single animal seen in valley floor, tall secondary growth with bananas at c. 150 m on 17 October in a valley below and to the north of the Suoi Cat valley (RJT).

No sites within its relatively small range are known to support this species commonly.

#### 3.4.2.4 Other species of interest

This section provides details on a number of species or species groups recorded during the survey which are of interest because their status and distribution are poorly known in Indochina, or they are considered to be threatened within the region, or because they may provide a useful indication of hunting pressure.

##### Partridges

*Survey records:* in addition to Chestnut-necklaced only one other species was recorded as follows. Bar-backed Partridge *Arborophila brunneopectus* was recorded in all survey areas (all RJT). In the Suoi Chan Loong valley and at the two sites from B. Cha Lo only single groups were recorded. By contrast in the Hang Ca Tuc area, Suoi Mo Sang valley and Suoi Cat valley calls were generally heard frequently per day and involved several groups.

As with pheasants partridges perhaps give a good indication of hunting pressure. The paucity of records from the Suoi Chan Loong valley probably reflects a low population density, presumably related to hunting pressure.

##### Pheasants

*Survey records:* in addition to Crested Argus two other species were recorded.

Silver Pheasants *Lophura nycthemera* were recorded as follows: in the Suoi Chan Loong valley area a male flushed on the 27 September (in forest on limestone slopes) (DT, RJT), seen on the east slope on the 29 September (DT), seen to the north of Hang Cop Tang on 2 October (DT), [four together flushed on the 28 September, and one on the 2 October (RJT)]. Two males and a female seen together on the 3 October in forest on limestone slopes at the Hang Ca Tuc area (RJT). Seen in the Suoi Mo Sang valley on 10 October (DT). A male and two females seen together in the valley between Thuong Hoa and Ban On villages on the 17 October (RJT). In the Suoi Cat valley and areas to the south a male and two females together and a male on the 18 October and two males and three females together and two males together on the 20 October (RJT).

Grey Peacock-Pheasant *Polyplectron bicalcaratum* was recorded only once when a single bird was flushed on the 29 September in forest on limestone slopes in the Hang Ca Tuc area (RJT).

Although neither Silver Pheasant nor Grey Peacock-Pheasant are threatened regionally (Thewlis *et al.* in press, J. C. Eames verbally 1998) they perhaps give a good indication of hunting pressure. Records are hard to interpret at present but what seems a high number of encounters with Silver Pheasant in the Suoi Chan Loong valley and the valley between Thuong Hoa and Ban On villages was somewhat surprising given the apparent level of human activity in these areas. Status of these widespread species may also be important in interpretation of the likely status of endemic pheasant species if they were ever found.

##### Imperial Pigeons

*Survey records:* there were very few records one over the Mo O valley on 8 October, and one or more on 9 October in the Suoi Mo Sang valley (RJT).

Two species are likely to be present Green Imperial Pigeon *Ducula aenea* and Mountain Imperial Pigeon *Ducula badia*. Green Imperial Pigeon is a lowland species which is 'at risk' in Laos and considered 'near-threatened in Thailand' (Thewlis *et al.* in press, Round 1997). The low sighting rate probably reflects a general scarcity of imperial pigeons at the time of the survey.

### **Wreathed Hornbill *Rhyticeros undulatus* and Great Hornbill *Buceros bicornis***

**Survey records:** three Great Hornbills seen twice (presumably the same birds) on 8 September in limestone from Cha Noi, large hornbills heard on a further occasion (DT). Five probable Wreathed Hornbills were observed south of Th. Phu Nhieu on 25 September (RJT). In the Suoi Chan Loong valley large hornbills were recorded as follows: 'r-ruff' vocalisations were heard on the 28 September and large hornbill wing beats heard and a group of three Wreathed Hornbills observed on the 29 September (RJT). Single registrations of large hornbill wing beats were heard on all days except the last in the Suoi Mo Sang area (additionally vocalisations were heard once on the 8 October) (RJT). There were two registrations of large hornbill wing beats on the 18 October south of the Suoi Cat valley (RJT), on the same day six [Wreathed Hornbills] were seen in the same general area at 08.45 hrs (TVC). A group of four or five birds most probably Wreathed were seen flying over forest to the west of the road south of B. Cha Lo on the 27 October (RJT).

All records were of small groups (certainly no more than ten birds), which taken together with the relative lack of records suggest large hornbill populations are unhealthy, however records from Phong Nha-Ke Bang are comparable and even more numerous than several similarly sized areas in Laos, where both Wreathed and Great Hornbills have undergone a demonstrable decline (Thewlis *et al.* in press). In Vietnam it is rare to record large hornbills with such frequency (J. C. Eames verbally 1998).

As large and very obvious species, they are some of the relatively few birds at risk in the short term from direct human persecution. The numbers recorded were unsurprising, and the spread of records is actually encouraging.

### **Hog Badger *Arctonyx collaris***

**Survey records:** a single animal seen at 13.20 hrs on the 19 October and photographed in the Suoi Cat valley (TVC). A single animal was seen and spotlighted in forest in the Suoi Ken area to the west of the road south of B. Cha Lo at 21.25 hrs on the 27 October and watched for approximately 15 minutes while it foraged (RJT).

Relatively little is known of this species which is only infrequently recorded on surveys in Indochina (Duckworth 1997, DT own data (seen on only four occasions in the field), TVC own data). The species is easily hunted (DT own data), supported by the oblivious behaviour of animals seen during the survey and ones seen in Laos (Duckworth 1997).

### **{Large-spotted Civet *Viverra megaspila***

A dead but recently captured animal was found and photographed on 14 May 1997 in a local market close to Th. Phong Nha (Pham Nhat in Le Xuan Canh *et al.* 1997 and Nguyen Xuan Dang *et al.* 1998)

There are very few verified recent records of this species from anywhere within its range (Schreiber *et al.* 1989, Duckworth 1994, Duckworth 1997), what few data are available suggest it may be largely confined to lowland forest areas (Duckworth 1997)}

### **Pigs *Sus***

**Survey records:** many signs seen and two encounters with groups (heard not seen) in degraded and secondary forest north of Cha Noi (DT). In the Suoi Chan Loong valley, the Hang Ca Tuc area, the Suoi Mo Sang valley and B. Cha Lo areas surveyed, signs of pigs were infrequent (RJT, DT, TVC). In contrast in the Suoi Mo Sang valley rooting signs were very numerous, to the extent that they could be seen along almost any 100 m of trail walked (RJT, TVC). One group of pigs flushed (heard but not seen) on 19 October in the Suoi Cat valley (TVC).

As with all large mammals, pig numbers are likely to be reduced below natural levels. The abundance of rooting signs in the Suoi Mo Sang valley and to the south, was very surprising, RJT had never found signs so frequently before during surveys in Indochina.

It has not been possible to determine the species of pig present in Phong Nha. Two species are quite likely, Eurasian Wild Pig *S. scrofa* and Indochinese Pig *S. bucculentus*. Only recently has the validity of *Sus bucculentus* been confirmed however the information given by Groves *et al.* (1997) is inadequate for diagnosis of the species. Identification of *S. scrofa* is equally problematic, since until recently the genus was considered by most to be monotypically represented in Indochina, and thus no adequate diagnoses of *Sus scrofa* from Indochina have been published. An assumption that greatest skull length alone is useful for identification is misfounded (C. P. Groves *in litt.* 1998). Furthermore there appear to be very few pig specimens with good data in museum collections making it virtually impossible to even speculate with any conviction as to the status and distribution of pig species within Indochina. There is widespread assumption that a type of pig by the Vietnamese name of *Long Rung*, (which is believed to be common) represents *S. scrofa*, and that another type of pig by the Vietnamese name of *Lon Chao Vao* (which is believed to be relatively rare) is a 'new species' (*S. bucculentus* to those aware of its description), although there are no scientific grounds for this.

At present there is a need to collect further specimens of *Sus* species to establish reliable diagnoses for the species. It is misfounded however to just collect specimens of *Lon Chao Vao* with the belief that it is the 'new species', since *Lon Chao Vao* may correspond more closely with *S. scrofa*; and if specimens from only one species are collected, there will be no possibility for comparison and possibly even identification of the species involved. Considerably more good scientific data will even then be necessary to establish the distribution and status of each species. Pelage and other characteristics of pigs are very variable particularly in relation to sex and age and it is unlikely that confidence could ever be put into the use of information from local people to confirm the presence of either species, or to use such information to infer the status of either species even if confirmation of presence has been made by other means.

#### Giant Muntjac *Megamuntiacus vuquangensis*

*Survey records:* frontlets were seen in several villages around the Phong Nha-Ke Bang area (RJT, DT, TVC), but were relatively less abundant than those of Indian Muntjac *Muntiacus muntjak*.

Similar but not more substantial evidence is reported by a number of previous researchers (Lambert *et al.* 1994, Pham Nhat *et al.* 1995, 1996-1997, Le Xuan Canh *et al.* 1997).

Provenance of trophies and other remains can not be established with certainty (see Section 3.3.1). Although the species undoubtedly occurs in parts of the area, the relative status of the species in the various habitat types cannot be ascertained. The natural status in limestone areas may well be different from its status in non-limestone areas.

The species is still widespread in Laos (Timmins *et al.* 1998) and probably Vietnam (DT own data). The significance of Phong Nha-Ke Bang to the species conservation has yet to be determined.

#### Black Giant Squirrel *Ratufa bicolor*

*Survey records:* recorded on three days in forest on limestone to the south of Cha Noi with five registration (probably some duplication) on 14 September (DT). Recorded only once on the 3 October in the Hang Ca Tuc area (RJT). Recorded daily in the Suoi Mo Sang valley with a minimum of three different registrations (groups) on the 9 October (RJT). Recorded on two days in the Suoi Cat valley area with four different registrations (groups) on the 18 October (RJT). Recorded once in



forest on the southern limestone edge of the Mo O valley to the north of Mo O village on 21 October (RJT). In the B. Cha Lo area recorded once in the Ta Ty area, and once to the west of the road (RJT).

The number of records was disappointingly low particularly in the Suoi Chan Loong valley, but also in the B. Cha Lo area, and presumably reflects populations reduced through hunting. In Laos status of this species more closely mirrors that of primates than other squirrels, and in several areas of Laos and elsewhere populations have clearly been reduced or even extirpated through hunting pressure (Wang Sung et al. 1989, Duckworth 1996, RJT own data).

#### Striped Rabbit sp. *Nesolagus*

*Survey records:* one live animal captured in a hunters snare on the night of the 27-28 October to the west of the road south of B. Cha Lo (RJT, TVC).

This genus has only recently been found in the Annamites (Timmins in prep. a). It is not yet possible to establish its specific status in relation to the nominate taxon *N. netscheri* known only from Sumatra. *N. netscheri* is considered GT-CR by IUCN (1996).

### 3.5 Factors of concern in the conservation of Phong Nha-Ke Bang

#### 3.5.1 Bird and large mammal exploitation

Hunting is rife through out the protected area, with evidence found in all areas surveyed (see Annex 4). The majority of hunting takes place within a days walk of habitation, with hunting excursions further than this probably relatively infrequent. The predominant hunting method recorded during the survey was the use of snares. The intensity of snaring was higher than that recorded by RJT and DT in any other area of Laos or Vietnam previously surveyed and one of the highest levels seen by TVC. Nguyen Xuan Dang *et al.* (1998) also report evidence of heavy snaring pressure in areas covered during the project. By far the most common type of snare found or reported during the survey, was one made from a bicycle brake cable, set on the ground with a trigger mechanism and sprung with a wooden pole, to capture animals by the leg. Snares were usually set within a fence made of underbrush at intervals of c. 2-4 m, and fences were commonly several hundred metres long. Such snares are non-selective and presumably catch anything walking over the ground from the size of pheasants to wild cattle. Although large mammals such as large pigs, big cats, bears, Serow and Sambar can probably break free from such snares, injuries and mortalities still occur. Larger snares using several woven cables and much larger spring poles were apparently set for these larger mammals, and although they are less numerous they are more strategically placed. Snares are by their nature continually active for the time they are in place and thus need checking at least every few days, for this reason relatively little snaring takes place more than a days walk from a village. Hunting further afield is likely to be only motivated by animals with a relatively high commercial value, and during excursions for highly valuable natural resources. Snaring is so intensive that several of the larger mammals are highly threatened, and likely to be extirpated in the near future unless action is taken very soon. Information from local people suggested that snaring became intensive about two years ago, principally with a demand for live animals such as civets (DT; the activity was very much less in 1994). Hunting is primarily commercially orientated, with a well established network to take captured animals from the forest to distant markets. From the rural villages around Phong Nha-Ke Bang most animals seem to go directly to Minh Hoa or Dong Hoi where a small number of people buy up animals on a regular basis (DT), and from there presumably dependent on their value even further afield. Although the primary motivation is undoubtedly commercial sale, a relatively large amount (no clear estimation is available but it may be as high as 50% or perhaps even higher) of the animals caught are eaten in rural villages, principally those animals which die during capture and which do not have a value beyond commercial food sale. Motorbike-taxi drivers were seen and

### 3.6 The importance of Phong Nha-Ke Bang for wildlife conservation and conservation priorities

The Phong Nha-Ke Bang area has high intrinsic potential for biodiversity conservation, from a biogeographical viewpoint, from its position within areas of localised endemism. The most significant of these is its position on the eastern slope of the Annamites. The Annamite mountains (in a broad biogeographical sense) have a number of endemic or near endemic bird and mammal taxa, with indications that endemism is centred upon the eastern slope, and presumably linked to the generally cooler wetter climate experienced on the eastern slope in comparison to the western slope (Stattersfield *et al.* 1998, Timmins in prep. a, DT own data, RJT own data). A second superimposed area of localised bird and mammal endemism is associated with large homologous limestone formations covering a substantial area of central Indochina (RJT own data). Protected areas within zones of localised faunal endemism have a greater potential importance (based simply on size related factors) for conservation of biodiversity than similarly sized areas within a larger biogeographic zone with a more widespread faunal community.

There is further biogeographic interest to the Phong Nha-Ke Bang area because of low passes in the Annamite ridge both on its northern and southern edge, this localised continuity between eastern and western Annamite slope wildlife communities (separated elsewhere by the high main Annamite ridge) has interesting ecological implications.

The establishment of Phong Nha-Ke Bang's potential conservation importance is a first step to determining regional and global priorities and a framework for comparison, but the setting of real conservation priorities for management and effective conservation are largely dependent upon field based status assessment of habitats and wildlife in a local and regional perspective.

The Phong Nha-Ke Bang area is one of the largest areas of contiguous karstic limestone in Vietnam, and certainly the largest within the protected area system. The combined area of Phong Nha-Ke Bang-Hin Namno NBCA is certainly the largest contiguous block of such habitat within the protected areas of Indochina. It is thus paramount to the conservation of limestone faunas in Vietnam and Indochina. However for the conservation of the general wildlife community of karstic limestone its priority in relation to other natural habitats within the region is probably not high, given the general resilience of limestone to human encroachment.

The primate populations of Phong Nha-Ke Bang are nationally significant, although the majority of species occur in similar numbers in other protected areas within the Annamites. The indications are however that the numbers of gibbon, Douc Langur and possibly Rhesus Macaque and Pig-tailed Macaque in Phong Nha-Ke Bang are low and cause for concern. Populations of these species may be better represented elsewhere in Vietnam, as they certainly are in Laos (Ruggeri and Timmins 1995-1996, Timmins and Duckworth in prep., DT own data, RJT own data). Undoubtedly however the area is highly significant for its population of Francois' Langur almost certainly the largest population in Vietnam and of a similar magnitude to the two largest populations within protected areas within Laos (Pham Nhat *et al.* 1995, 1996-1997, Nadler 1996, RJT own data). This value is of heightened significance given that the Francois' Langur population is contiguous with that in Hin Namno NBCA, together they form perhaps the most numerous population of Francois' Langur remaining globally (although that in Khammouan Limestone NBCA in Laos is of a similar magnitude) (Timmins in prep. c, RJT own data). The Phong Nha-Ke Bang area has further significance for Francois' Langur in being perhaps the only protected area in Indochina supporting *S. f. hatinhensis*, and almost certainly the most numerous population of this taxon per say (Pham Nhat *et al.* 1996-1997, DT own data). The presence of further forms adds considerable biological interest as well as heightened conservation significance for conservation of the species in the Phong Nha-Ke Bang area because of the possibility of preserving some of the natural variation of the species. Such a potential is probably not encompassed within any other protected area of Vietnam (see for example Nadler 1996 and Fooden

1996). The pressures on this population are relatively high, and although the population is likely to persist because of the relative inaccessibility of the limestone in the medium term, significant ecological changes in population structure might be expected, particularly in relation to the distribution and relationship between the different forms. Conservation of the natural population structure of Francois' Langur is one of the three highest conservation priorities of the area.

Tall lowland forests are regionally one of the most threatened of what were once widespread habitats, with virtually all tall lowland forest having been lost in Thailand (Round 1988, Round 1997), and with only very small and marginal patches of undegraded forests of this type left in Laos (Thewlis *et al.* in press, RJT own data), Cambodia still retains large areas but these are rapidly being logged (Timmins and Men Soriyun in press, D. Ashwell verbally 1998, RJT own data). Remaining patches on the eastern Annamite slope have probably greater conservation importance (in relation to size) and priority to those on the western slope (given the biogeographic differences across the Annamites). The low altitude valley forests could well be some of the best and most important examples of such habitat in Vietnam. Although lowland habitats remain in several areas, few if any have not been logged, defoliated, nor are of secondary in origin for other reasons. Those in Phong Nha-Ke Bang are at least structurally some of the best in Vietnam (J. C. Eames verbally 1998, DT own data). Such habitat is clearly highly threatened regionally and of the highest priority for conservation within Phong Nha-Ke Bang. Not only do these forests have importance for habitat conservation, they are equally likely to support a suite of 'extreme' lowland animal species of which Large-spotted Civet is possibly a component. As such habitats are now rare, the animal communities they support are likely to be equally restricted in extent. The possibility that they may also support populations of one or more of the endemic pheasants is of considerable importance; work in the area to date has been insufficient to determine this.

Although Phong Nha-Ke Bang is clearly no longer of significance for the conservation of the very large mammals (Tiger, wild cattle, Elephants), the general terrestrial mammal communities of Phong Nha-Ke Bang may well be of high conservation significance, but work to date has been too poor to establish this. The extent and unselectivity of snaring must be having very serious deleterious effects on these communities; it is a very high conservation priority to protect and determine the significance of them. Whatever might be the global significance of these communities it would be a tremendous ecological loss, if suites of species were extirpated or reduced to very low levels.

The presence of large populations of several restricted range species in particular Short-tailed Scimitar Babbler, Sooty Babbler, White-winged Magpie, Bar-bellied Pitta and Blue-rumped Pitta give the area an intrinsic value for biodiversity conservation although large populations remain in several other protected areas, and populations globally and within Phong Nha-Ke Bang are not at any immediate risk of extirpation or major population declines (Thewlis *et al.* in press, Eames in prep., J. C. Eames verbally 1998). The large populations of Short-tailed Scimitar Babbler, and Sooty Babbler give the area a somewhat higher conservation priority than a number of other protected areas in Indochina outside of their ranges; Sooty Babbler is likely to be only numerous in two other protected areas, both of which are in Laos (Thewlis *et al.* in press, J. C. Eames verbally 1998), while Short-tailed Scimitar Babbler is largely confined to Vietnam.

Populations of large hornbills and other quarry species to a large degree reflect the large size of remaining natural habitat and its relative inaccessibility to people, and reinforce the assumption that Phong Nha-Ke Bang's size is a considerably significant factor for conservation. However it should not be forgotten that a substantial part of this significance is based on the continuity of habitat and wildlife between Phong Nha-Ke Bang and Hin Namno NBCA. Wildlife populations in general are almost certainly healthier in Hin Namno NBCA (see Timmins and Khamkhoun Khounboline 1996, Walston and Vinton 1999), and in the case of wide ranging species may be bolstering numbers in Vietnamese territory, with the implication that threats acting in Vietnam may be more substantial than

otherwise thought, and that long-term conservation will depend equally on conserving Hin Namno NBCA.

### ***3.7 Recommendations for further study***

These recommendations are aimed at independent external scientific and conservation bodies both in country and without. It is unrealistic and probably not suitable to suggest that park management tackles such studies. Park management would be best employed in solving management issues and finding and providing real solutions to protecting wildlife and habitat. Park management should of course be integrated with scientific work taking place, particularly in the case of monitoring activities.

Faunal and floral surveys (of all taxonomic groups) could usefully be continued in all areas, the work that has been carried out to date is far from complete. Specific priorities in relation to the Phong Nha-Ke Bang area are as follows.

Further investigation of the distribution of and spatial relationship between forms of Francois' Langur is warranted.

Further investigation of the distribution and status of all the diurnal primates is needed, particularly to determine the status of gibbons and Douc Langurs over a wider area, and the distribution of Pig-tailed and Rhesus Macaque.

Mapping of remaining areas of lowland valley forest would be a useful tool for determining likely national importance of such areas and for monitoring encroachment. More detailed analysis of forest structure and composition would be desirable for greater understanding of the ecology of the region and again useful for monitoring, but may be less feasible.

Studies to determine whether valuable timber and oil extraction trees are naturally regenerating, with an aim to identifying future areas where they could be protected indefinitely could usefully be carried out.

Nocturnal spotlighting surveys for mammals are a high priority, to determine species composition and status.

Surveys are needed to determine whether any of the endemic pheasants occur in significant numbers.

While the opportunity exists, it would be worthwhile to have observers based at such points as Th. Phu Nhieu village and B. Cha Lo village, to observe the animal snaring that is occurring, with the aim of gathering data on species composition, relative abundance of captured animals, and the scale of exploitation and trade. Location of snare lines should be investigated, to gain a better indication of where trapped animals are coming from. Observers must appear impartial to and independent from both hunters and park management.

Investigation of the use of forest resources other than wildlife is warranted, particularly in relation to the low altitude forests.

Simple monitoring programs to determine population trends based on the calling behaviour of pheasants (Crested Argus and Grey Peacock Pheasant), partridges and gibbons should be initiated. Calling behaviour of Francois' Langur could also probably be usefully used in monitoring but requires further investigation. Monitoring of sleeping sites might also be useful in determining population trends of Francois' Langur.

### ***3.8 Recommendations on the areas for protected area establishment***

The boundary proposed by FIPI (in prep.) for the Phong Nha-Ke Bang National Park clearly encompasses the most important parts of the area for biodiversity conservation.

Some further thought should perhaps be given to the boundary in the northern extremity of the Ke Bang area in Hoa Son and Dan Hoa communes to ensure optimum cover of wildlife habitats of importance.

FIPI (in prep.) map an area to the east of B. Cha Lo as degraded and in need of 'enrichment'. This belief does not accord with survey findings; the area is little degraded forest on limestone.

Forests west of road n° 561 along the international border in Dan Hoa commune, which are proposed as buffer in FIPI (in prep.) should be given a higher degree of protection. These forests are relatively extensive, and form a corridor between Nakai-Nam Theun NBCA in Laos (and ultimately Vu Quang Nature Reserve in Vietnam) and the Phong Nha-Ke Bang-Hin Namno NBCA complex. They are also important in their own right for wildlife conservation.

## 4 A PRELIMINARY SURVEY OF BATS OF PHONG NHA-KE BANG PROPOSED NATIONAL PARK

D.K.Hendrichsen

### 4.1 Survey areas and effort

The survey was carried out over July and August 1998 partly in Phong Nha Nature Reserve and partly in the Ke Bang forest area. This was the first detailed bat survey to be undertaken in the area and an effort was made to visit both areas. Dates, locations and effort of the survey are given in Table 3.

Table 3. Dates, effort and locations of the bat survey.

Survey Area	Dates <sup>1</sup>	No. metres of net used	Total net hours	No. of harp trap nights	No. of cave sites with collections	Altitude <sup>2</sup>	Location
Suoi May forest	4-11 July	1 x 2.6m 2 x 6m 2 x 9m 1 x 12m 1 x canopy net (6m)	4188	0	1	200-400 m	17°25'-17°30'N 106°17'-106°20'E
Tra An	13 July, 20-24 July	1 x 2.6m 2 x 6m 2 x 9m 1 x 12m	2189	0	2	0-200 m	17°29'-17°34'N 106°15'-106°18'E
Len A	17-19 July	1 x 2.6m 2 x 6m 1 x 9m	1567	0	0	0-100 m	17°34'-17°36'N 106°18'-106°20'E
Ym Hop forest	2-6 Aug	1 x 2.6m 2 x 6m 1 x 9m	655	3	2	250-400 m	17°37'-17°41'N 105°58'-106°00'E
Hoa Son forest	7 Aug, 12-16 Aug	4 x 6m 1 x 9m 1 x 12m 1 x canopy net (6m)	3767	3	0	450-800 m	17°42'-17°50'N 105°44'-105°54'E
Hoa Son village	11, 17, 19 Aug	1 x 2.6m 2 x 6m 1 x 9m 1 x 12m	1751	0	2	250-450 m	17°44'-17°47'N 105°52'-105°54'E

<sup>1</sup> The night on which the nets and harp traps were set up.

<sup>2</sup> Approximate altitudes based on the maps.

## **4.2 Methods**

### **4.2.1 Selection of collecting sites**

A variety of methods were employed to capture bats or otherwise gain information about them and their ecology. Individual bats were captured in mist nets, harp traps and hand nets. Sites for the collection of bats were chosen from information gathered locally about caves where bats were known to roost, and by the identification of potential bat flyways including such sites as streams, small pools, dry stream beds, paths, trails and forest edges. In all survey areas except one both caves and forest sites were netted. An attempt was made to visit a variety of different habitats throughout the area, however the majority of work was carried out in secondary forest with a high level of human disturbance or near open cultivated areas. Tall, little disturbed forest was not visited until the end of the survey. At this point working conditions became too difficult because of rain and the survey was terminated.

### **4.2.2 Mist netting**

Mist nets, set at ground level or raised 2-3m above ground, were the most common method of bat capture. Nine Japanese and American Avinet mist-nets were employed; one 12 m x 3 m; two 9 m x 2.6 m; two 6 m x 2.6 m; two 6 m x 3 m and one 2.6 m x 2.6 m. Each net was of 70 denier nylon construction with four shelves. An American Avinet Canopy net was used only occasionally. Various methods of net combination were used (following Kunz 1988). Nets were set up in the late afternoon and raised at 18.00 hrs, approximately an hour before sunset. On certain occasions, when netting in caves or on dark days nets were raised earlier. They were generally taken down at 05.30 hrs although on some dark mornings, when bats were still flying, nets were left open until 06.00 hrs. When conditions were not favourable or team members not capable, only peak activity hours were worked. From dusk until the peak activities had ceased, nets were checked every five to ten minutes. During the remainder of the night nets were checked at intervals of 15-20 minutes, and from 04.00 hrs until the nets were taken down, they were again checked every five to ten minutes. Preferably nets were never left for more than 20 minutes, however there were considerable problems with preventing assistants from sleeping through their shift, so at times the nets were left for more than 20 minutes between 10.00 hrs and 03.00 hrs.

### **4.2.3 Harp traps**

During the second half of the survey a single harp trap was used. It was a locally made aluminium trap of approximately 1.7 m<sup>2</sup> with 0.3 mm fishing line strung on four frames. The trap was set on narrow fly-paths such as small cave entrances, trails, small streams and other gaps in the vegetation that might serve as potential fly-paths.

### **4.2.4 Specimen collection**

Whenever possible two specimens were taken for each species, preferably one of each sex and deposited at the Harrison Zoological Museum, U.K. for further examination. Additional specimens of each species were collected to be deposited at the Xuan Mai, Hanoi University, zoological collection Vietnam. All specimens were killed using ether. Specimens were then preserved in 70% alcohol, and 70% alcohol was injected directly into the muscle blocks and skull. Pregnant and lactating females were not taken as specimens and were released immediately after capture. Bats not kept for specimens for were identified, measured and weighed then released at the point of collection, either on the night they were caught or the following morning. Bats were kept in cotton draw-string bags.

#### 4.2.5 Identification

Preliminary identification was done in the field based on information from Corbet & Hill (1992) and Lekagul & McNeely (1977). Further examination of the specimens will be carried out at Harrison Zoological Museum, England. The taxonomy used in this report follows Corbet & Hill (1992).

#### 4.2.6 Data collected

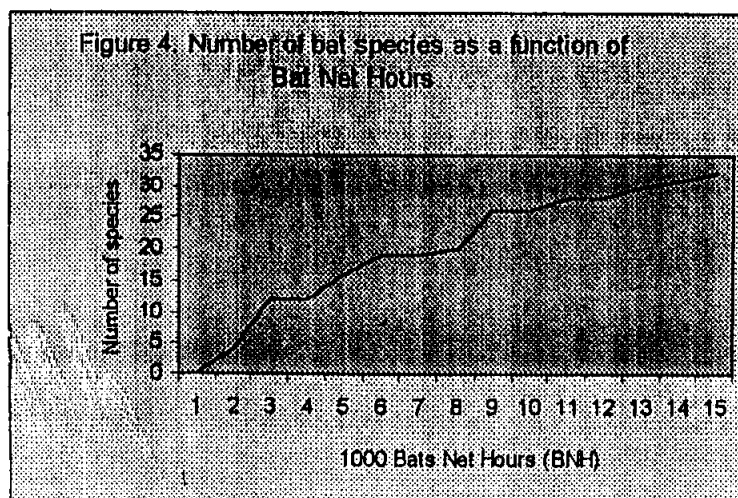
Captured bats were identified, sexed and the time of capture recorded. For dead specimens measurement of forearm, thumb, third finger parts a and b, fourth finger, fifth finger, foot, tail, ear and head-body length were recorded to the nearest 0.1 mm using callipers. For live animals measurements of head-body and tail were rarely taken. All live bats were weighed in a draw-string bag of known weight using a 100g Avinet balance. Dead specimens were weighed directly using either a 30g or a 100g Avinet spring balance. Bats were generally not aged, but at times a rough age estimate (adult – juvenile) was attempted. For summary of key measurements see Annex 9.

#### 4.2.7 Survey site information

A Trimble GPS receiver was used to obtain locations of survey sites. At each survey site general information on weather conditions was recorded. A description of the location of each net was made i.e. whether it was set over a stream, over a trail, in gaps in vegetation etc. General observations on the survey site included vegetation, the depth and width of streams and the presence of slow-flowing, fast-flowing or still water. In caves notes on number, location and size of entrances was recorded as well as the size and general appearance of the cave, the presence of water and surrounding vegetation.

### 4.3 Results

Altogether 259 bats were caught during 14,117 Bat Net Hours (BNH) and six harp trap nights. Twenty nine different sites including seven caves were netted over a total of 32 working nights. Thirty one species of bats were preliminary identified although this number may change when the taxonomic examinations are complete. A complete list of all specimens collected can be found in Annex 8. The actual number of individuals of each species caught in the different survey areas are listed in Annex 7 which also contains a list of which species were found in each of the different caves surveyed. A number of the species are of special conservation interest, new records to Vietnam or species about which little is known and/or which are underrepresented in collections. Some of the most interesting bats were caught in areas of tall, little disturbed forest in the Ke Bang area and species new to the survey were captured until the very last night of working. Figure 4 shows the number of species plotted against BNH. It shows no signs of levelling off towards the end of the survey, indicating that more species are likely to be found in the area.





#### 4.3.1 Survey areas

##### *Suoi May forest*

(17°25'-17°30'N, 106°17'-106°20'E). Located inside the Phong Nha Nature Reserve. Five different sites were surveyed over eight working nights including two successive nights in Lam Hang On cave (Hang En cave). One large stream, Rau Con/Rau Thuong, and several smaller streams. There were several signs of human disturbance especially in lowland areas although the hill sides seemed to have less disturbed forest. All survey sites were at lower altitudes. The vegetation here was mostly scrub or trees with a small dbh (<30 cm) and dense understorey. One site (Ba Cay) had banana as the main vegetation. A small settlement is located inside the area. The valley of the Rau Thuong stream is open with extensive areas of open rush-like vegetation.

##### *Tra An*

(17°29'-17°34'N, 106°15'-106°18'E). Khe Tra An is a wide stream along road N° 565 inside the Reserve. Five working nights were spent at four different sites along the main stream and smaller branches of it, and two caves in the area were visited; the Hang So Dua cave and a small cave near Khe Lo Do. There were many signs of human use in the area and the vegetation along the stream and road consists mainly of scrub and young forest but there were also areas of older forest with occasional large trees (>50 cm dbh). Steep hill sides with much denser forest rise on the western side of the road.

##### *Len A*

(17°34'-17°36'N, 106°18'-106°20'E). Three working nights were spent here. Numerous smaller streams in young, open forest 2-3 km from Phong Nha village. The area is immediately next to human settlement and is heavily used. Fields and large areas of scrub.

##### *Yen Hop forest*

(17°37'-17°41'N, 105°58'-106°00'E). In the Ke Bang forest area. Five working nights were spent in this area including one night in Hang Lon cave and one night in Pu Ru cave. There were extensive areas of tall, old-growth forest, but the forest in some larger valleys had been burnt down and was then replaced with grass. Several places were burning during the time of the survey.

##### *Hoa Son forest*

(17°42'-17°50'N, 105°44'-105°54'E). Large area of little disturbed, old-growth forest in Ke Bang. The majority of the areas visited were at an altitude above 500 m. Five working nights were spent here. Several streams including both permanent watercourses and small seasonal streams. Large trees with a dbh >50 were generally frequent (several trees in sight at most times) and the understorey dense.

##### *Hoa Son village*

(17°44'-17°47'N, 105°52'-105°54'E). Study sites at or near the settlements of B. Hoa Son and B. Loung. Four nights were worked including one night in Hang Ruc Moi cave and one night in Hang Cha Ra cave. Although the hill sides still had forest, the majority of the area had been cleared. Extensive areas of fields and grass.

#### 4.3.1.1 Caves with collections

##### *Lam Hang On cave*

(17°26.03'N, 106°18.185'E) also called *Hang En cave*. Large cave inside Phong Nha Nature Reserve. The cave has three major entrances and numerous levels, smaller galleries and crevices, which provides a number of different roost habitats in terms of light intensity, temperature and level

of disturbance. The Rau Thuong stream passes through the cave. It was located in an open valley, with large areas of rush-like vegetation; the limestone hill sides seemed to have good, undisturbed forest.

*Hang So Dua (Hang Voi)*

(17°31'N, 106°17'E). Large cave near the Khe So Dua stream approximately 1 km from the road N° 565 traversing the Reserve. There are two large main entrances and a number of smaller gaps in the ceiling. The whole cave appeared to be fairly well lit and open, although there may be smaller galleries and holes. A few colonies of large bats could be seen, although the cave generally was too high to make any observations. The cave was not netted, but two dead fruit-bats, [*Rousettus leschenaulti*], of which one were pregnant, were collected. The surrounding area was subject to rather high levels of human use and also the cave showed signs of frequent use.

*A cave near Khe Lo Do*

(17°33.266'N, 106°17.535'E). Small, simple cave in dense forest. The cave has one small, narrow entrance and access is further limited by a large rock outcrop immediately outside the cave. A roost of c. 70 *Hipposideros armiger* of both sexes was observed on the low ceiling about three meters above the floor in the back of the cave during a daytime visit.

*Hang Lon cave*

(17°38.686'N, 105°58.689'E). Smaller cave with two entrances, one facing southeast and one facing north. A few bats were seen during a daytime visit. The cave was in rather young forest with large deforested and frequently burned areas in the nearby valley but there were areas of older, less disturbed forest within a few km of the cave.

*Pu Ru cave*

(17°38.949'N, 105°59.063'E). Small, but highly complex cave. There are numerous levels, tunnels and shafts and the cave could easily support several colonies of bats, although no signs of bats were observed on a visit during the day. There is only one entrance, a small c. 2 x 5 m opening, divided in two. The cave is on a hill side in a narrow stripe of forest but with grassland and burnt scrub in the immediate area. A harp trap was set up at the lower half of the entrance.

*Hang Ruc Muoi cave*

(17°44.753'N, 106°54.031'E). A large cave 3-4 km from Hoa Son village into which a large stream passes through its the western entrance. Another smaller entrance faces northwest. The first part of the cave is very high so nets were set up over the stream. The surrounding area was very open and consists mainly of grasslands, fields and scrub.

*Hang Cha Ra cave*

(17°46.074'N, 105°53.713'E). Large and highly complex cave with several levels and smaller galleries with one wide entrance facing south. The surrounding area was very open and heavily used, but there was a 50-100 m stripe of dense forest around the cave.

#### 4.3.2 Key species accounts

A list of all bat species recorded can be found in Annex 7, Table 7.1. Key Species are defined as species included in the IUCN List of Threatened Animals (1996) under the categories Globally Threatened, Globally Near-threatened and Data Deficient (See section 3.4.2 of this report). Brackets [ ] indicate that the identification of the species is provisional. The confirmation of these species awaits the taxonomic examination of the specimens sent to Harrison Zoological Museum, England.

**Bourret's Horseshoe Bat *Rhinolophus paradoxolophus* GT-VU**

The species was previously known from only two specimens; one from Vietnam (type specimen from Lao Cai) and one from Thailand (Corbet and Hill 1992); but has recently been recorded from Cuc Phuong National Park (Walston *et al.* 1998) and from a number of areas in Laos including Hin Namno NBCA (Walston and Vinton 1999).

A single male *Rhinolophus paradoxolophus* was caught between 18.00 hrs and 21.00 hrs in a harp trap set at the lower half of the entrance of the Pu Ru cave on 5 August. The specimen was slightly smaller (forearm 53.0) than measurements given in Corbet and Hill 1992 (forearm 54-55), but only slightly smaller than the female *R. paradoxolophus* (forearm 53.3) found in Cuc Phuong National Park, North Vietnam, in 1997 (Walston *et al.* 1998).

**[Little Nepalese Horseshoe Bat *Rhinolophus subbadius* DD**

Recorded from NE India, Nepal, Burma and North Vietnam (Corbet and Hill 1992).

A single male of this species was caught in a harp trap at Pu Ru cave on 5 August. Very little is known about the biology of this species and it is generally under represented in collections. Furthermore there are certain unclear issues about the systematics of this species and its relationship with *R. pusillus* (Bates & Harrison 1998).]

**[Andersen's Leaf-nosed Bat *Hipposideros pomona* DD**

Widespread in Southeast Asia including Burma, Thailand, south China and Indochina (Corbet and Hill 1992).

A single male was caught on 16 August at 19.20 hrs at Ruc Ma Rinh in Hoa Son forest. It was caught in tall, undisturbed forest at an altitude of c. 750 m when flying over a wide stream with overhanging canopy.]

**[Pratt's Leaf-nosed Bat *Hipposideros pratti* GNT**

Found in north Vietnam and south China with the type specimen collected from Sichuan in China (Corbet and Hill 1992).

A male *H. pratti* was caught on 8 July at 19.25 hrs in Lam Hang On cave. Two females belonging either to this species or to *Hipposideros lylei* were caught during the survey; one at the same site as the male *H. pratti*, the other in Hang Lon cave where also a male *H. lylei* was found. The two females could represent either species (although their forearm measurements suggest that they might belong to the slightly smaller *H. lylei*) and identification must remain provisional until the specimens have been examined by a taxonomist.]

**[Shield-faced Leaf-nosed Bat *Hipposideros lylei* GNT**

Corbet and Hill (1992) list *H. lylei* to be found in Thailand, Burma and the Malay Peninsula. There is however a recent Vietnamese record from Cuc Phuong National Park (Walston *et al.* 1998) which represents the first record of this species from Indochina.

An adult male was caught at 20.10 hrs on 3 August in Hang Lon cave. Two females of either this species or *H. pratti*, were also caught, see above.]

[Rickett's Big-footed Bat *Myotis ricketti* GNT

Previously known from southeast China (Corbet and Hill 1992), the finding of this species represents the first ever recording from Vietnam. It has recently been recorded from Hin Namno NBCA (Walston and Vinton 1999) and it has subsequently been found in Pu Mat Nature Reserve (SFNC 1998; record provisional) in Central Vietnam and in Huu Lien Nature Reserve (DKH own data; record provisional) near the Chinese border.

Five males were caught during the survey. Four of these were caught within an hour of sunset, while the fifth were caught shortly before midnight. Two were taken as specimens in Lam Hang On cave, in a net set in front of a smaller, narrow gallery separated from the main body of the cave right at the entrance. On two successive days, the 21 July and 22 July, *M. ricketti* were caught flying over a stream at Ma Da. One further individual was captured in a net over water just outside the Hang Ruc Moi cave. Although no conclusions can be drawn the findings of this species in areas with large, slow streams in fairly open, secondary vegetation and in or near large caves with running water suggest that these habitats might be of importance to the species. The observations also corresponds well with observations from Pu Mat Nature Reserve, Central Vietnam (B. D. Hayes pers. comm. 1998) and Huu Lien Nature Reserve, North Vietnam (DKH own data).]

Harlequin Bat *Scotomanes ornatus* GNT

Distributed from NE India into south China including the northern parts of Thailand and Vietnam (Corbet and Hill 1992). The species has recently been recorded from Laos for the first time from Hin Namno NBCA (Walston and Vinton 1999).

Five *Scotomanes ornatus* were captured during the survey. A female was caught over a stream on 22 July at Nouc Moc, Khe Tra An (altitude c. 300 m) at 19.15 hrs. On 4 August at Khe Nhai (Yen Hop forest) at about the same time another two females were caught and one more at 22.00 hrs. They were found flying in a dry streambed with small pools of water in fairly good, undisturbed forest at an altitude of c. 300 m. The only male *S. ornatus* was caught on 13 August in a partly dry streambed at Khe Da Nui in Hoa Son forest (c. 750 m) at 20.35 hrs.

Great Evening Bat *Ia io* GNT

The species is known from Thailand, Vietnam and South China (Corbet and Hill 1992) and has recently been recorded from Laos from Hin Namno NBCA (Walston and Vinton 1999) and Khammouan Limestone NBCA, (Robinson and Webber in Walston and Vinton 1999).

Several *Ia io* were caught in the two caves, Lam Hang On and Hang Cha Ra. The species has generally been considered to be extremely rare (P. J. J. Bates pers. comm. 1998), but records from Ba Be National Park (B. D. Hayes pers. comm. 1998), Cuc Phuong (Walston *et al.* 1998) and those from Phong Nha-Ke Bang as well as the recent records from Laos suggest that this might not be the case. The *Ia io* from Lam Hang On cave were almost completely black, while the ones captured in Hang Cha Ra cave were more of a dark brown, however no specimens were taken from the latter site. Topal in Nowak (1994) states that the species is mostly found at altitudes between 400 and 1700 m. While Hang Cha Ra cave is within this range, Lam Hang On is located at an altitude of c. 200 m.

[Kelaart's Pipistrelle *Pipistrellus ceylonicus* / Chinese Pipistrelle *Pipistrellus pulveratus* GNT

Previously known from south China and Thailand (Corbet and Hill 1992), *Pipistrellus pulveratus* was recently recorded from Vietnam (Bates *et al.* 1998). *Pipistrellus ceylonicus* is known from India through Thailand and northern Indochina to Borneo.

Seven individuals either representing *Pipistrellus pulveratus* or *Pipistrellus ceylonicus* were caught in Hang Cha Ra cave on 19 August. Pipistrelle bats are difficult to identify in the field based on the available keys (i.e. Corbet and Hill 1992 and Lekagul and McNeely 1977). The species are mainly separated by cranial characters, teeth and differences in baculum shape and size none of which are suitable for examination in field or on live bats. Due to the uncertainty of the identification, the recording of *Pipistrellus pulveratus/ceylonicus* from Phong Nha-Ke Bang must remain provisional until the specimens have been examined by a taxonomist.]

[Schreibers' Bent-winged Bat *Miniopterus schreibersii* GNT

Found from Europe and Africa, throughout Southeast Asia to Australia (Corbet and Hill 1992).

Two *Miniopterus*, a male and a female were caught on 14 August at Duong Cau, a small stream in Hoa Son forest at an altitude of c. 800 m. Identification of *Miniopterus* based upon external characters is not entirely reliable, so although the specimens are likely to be *M. schreibersii* (P. J. J. Bates pers. comm. 1998), identification must remain provisional until they have been thoroughly examined.]

Bat *Harpiocephalus mordax* GNT / Bat *H. harpia*

*Harpiocephalus mordax* is known from Thailand, Burma and Borneo while *H. harpia* is known from patches in India, Indochina (including Vietnam), Sumatra, Java and Borneo (Corbet and Hill 1992).

Recently two large *Harpiocephalus* were caught in Hin Namno NBCA (Walston and Vinton 1999). The taxonomic examination may reveal these to be *Harpiocephalus mordax*.

A male *Harpiocephalus* was caught on 18 July at 22.30 hrs at Len A over a small stream in secondary forest. A female was caught on 8 August at 04.35 hrs. in a net set over a small stream at Khe Mu Hon (Hoa Son forest) in an area with tall, undisturbed forest. The male is probably a *H. harpia*, well known from Vietnam while the other specimen, the female, is most likely to be a *Harpiocephalus mordax* (P. J. J. Bates pers. comm. 1998) in which case it represent the first recording ever of *H. mordax* from Vietnam.]

#### 4.3.3 Other species of interest

This section provides details on a number of bat species recorded during the survey, which are of interest because they have not previously or only rarely been recorded from Vietnam. Others are included due to size or colouration differences from published accounts of the species or because reproductive information was collected.

[Leschenault's Rousette *Rousettus leschenaulti*

All together eight *Rousettus leschenaulti* were found during the survey at three different sites. Two dead bats were found on 13 July in Hang So Dua cave. One of these was dry and sex determination in the field was hence impossible. The other was a pregnant female carrying a well developed and almost full grown foetus. A further five pregnant females were captured a week later, on the night between 21 July and 22 July at Ma Da. They were caught flying over the 15-30 m wide, rather deep, slow-flowing stream where they presumably came down to drink. It was an open, only partly forested area with secondary forest interchanging with scrub and banana plantation. The site is immediately next to road N° 565 and there are many signs of human use in the area. The site is approximately 1 km southwest of the Hang So Dua cave, where the dead bats were found, however there may very well be other caves in the immediate area. The species is known to be a cave dweller (Lekagul and McNeely 1977). Three of the bats were caught shortly after dusk, one at 20.35 hrs and one an hour after midnight. The only male of the species was caught on the night between 19 August and 20 August at 00.20 hrs. It was caught at the Cha Ra cave near Hoa Son Village. It differed from the females by

having a small white stripe on the forehead extending down the snout and also in having a considerably smaller forearm (73.5 as opposed to an average of 81.95 among the females) although males are generally known to be larger than females (Rookmaaker and Bergmans 1981 in Bates and Harrison 1997). It was collected as a specimen and has been deposited at Xuan Mai, Hanoi University, Vietnam.

The dates of pregnancy corresponds with observations from India where each female has two successive pregnancies, one terminating in May and one terminating by the end of July (Bates and Harrison 1998).]

[Short-nosed Fruit Bat *Cynopterus sphinx*

Twenty one individuals represented by five males and sixteen females, of which four were pregnant, were caught during the survey. Two of the pregnant females were caught on 19 July (20.35 hrs and 22.10 hrs) at the edge of a small pool in open land outside of Len A forest, one was caught on the same night near the pool in a dry stream bed with dense, overhanging scrub at 01.00 hrs and on 21 July one was caught (22.00 hrs) over the Khe Tra An stream at Ma Da. Six juvenile *C. sphinx* were caught during the survey, five in Len A and one in Hoa Son forest. They were all females and were caught between 18.55 hrs and 20.35 hrs.

*Cynopterus sphinx* were caught several times during the survey in many different areas including undisturbed, old-growth forest, open land and secondary forest and two individuals of which one was caught in an improvised hand net, were observed roosting during the day in shade under horizontal palm leaves c. 4 m above the ground behind a house in Th. Hoa Son.]

[Dawn Fruit Bat *Eonycteris spelaea*

Two male *Eonycteris spelaea* were caught during the survey, one on 6 July at 19.15 hrs. and one on 11 July at 21.25 hrs. They differed significantly in size, the latter being the smallest with a forearm of 62.2 and a weight of c. 29 g as opposed to a forearm of 72.2 and a weight of c. 54 g for the other. Both specimens, however, fall within the size range of the species as stated in Corbet & Hill (1992). The smaller could not in the field be identified as a juvenile. The species is easily identified because of the lacking claw on the first finger, the only other species in the Indo-Malayan region with this characteristic being the larger *Eonycteris major* found on Borneo and the Philippines (Corbet & Hill 1992).]

Stoliczka's Trident Bat *Aselliscus stoliczkanus*

On 5 August three male *A. Stoliczkanus*, were caught in a harp trap set in Pu Ru cave. While two of these had the grey-brown pelage normal for the species, one had extraordinary long, white fur on its ventral side and around the genitalia. It had a slightly smaller forearm and was slightly heavier than the remaining two, but did not otherwise differ from them in any other external features that could be examined in the field. It was taken as a specimen and has been sent to the Harrison Zoological Museum, England, for further examination.

Large Myotis *Myotis chinensis*

Previously known from south China and north Thailand (Corbet and Hill 1992), this species was recently recorded for the first time from Vietnam from Cuc Phuong National Park (Walston *et al.* 1998).

Four males and two females were caught at sunset in Hang En cave on 9 and 10 July. The species has also recently been found in Huu Lien Nature Reserve (DKH own data).

[Whiskered Bat *Myotis mystacinus* / Nepalese Whiskered Bat *Myotis muricola*

*Myotis muricola* is widely distributed throughout Southeast Asia, while *Myotis mystacinus* is known from India and Thailand as well as from Europe and Africa. (Corbet and Hill 1992). Identification of the specimens to be *M. mystacinus* will represent the first recording of this species from Vietnam and possibly for Indochina, however the identification must remain provisional until further examination of the specimens has taken place.

Altogether 10 individuals, six males and four females, were captured in a variety of different habitats. Three were caught at dusk (19.10 hrs and 19.50 hrs) and shortly after sunrise (05.20 hrs), flying over streams in secondary forest on 5, 11 and 23 July. Four were caught in a harp trap at Pu Ru cave on 5 August. Two were caught on 14 and 15 August in undisturbed forest at dusk (18.40-19.25 hrs). One was caught over a stream in a small belt of vegetation in an otherwise open area near Hoa Son village at dusk (18.40-19.25 hrs) on 17 August. ]

[Greater Tube-nosed Bat *Murina leucogaster*

Previously known from China and from NE India and Thailand (Corbet and Hill 1992) this is the first record for Vietnam. The species has subsequently been recorded from Pu Mat Nature Reserve, central Vietnam (SFNC 1998).

A female was caught in tall, old-growth forest at Khe Mu Hon on 7 August at 19.45 hrs.]

#### 4.3.4 Discussion

More than a third of the species recorded from the Phong Nha-Ke Bang area are listed in the IUCN List of Threatened Species (IUCN 1996) with two of these, if confirmed, being new records to Vietnam (*Myotis ricketti*) and [*Harpiocephalus mordax*]). A further two species, if confirmed, represent first records for Vietnam (with [*Murina leucogaster*] being new to Indochina) although neither of these are of particular conservation interest. The area holds populations of little known species and still further species are likely to be found with further surveying. The species composition of Phong Nha-Ke Bang recorded during this survey apparently does not differ significantly from that found on the western side of the Annamite mountains in Hin Namno NBCA Walston and Davidson (in prep.). Several species known from a number of sites in northern Vietnam including Pu Mat Nature Reserve (SFNC 1998), Cuc Phuong National Park (Walston *et al.* 1998) and Huu Lien Nature Reserve (DKH own data) were found. Several species about which very little is known i.e. *Rhinolophus paradoxolophus* and [*R. subadiatus*] were also recorded.

Although human presence was obvious in most of the surveyed areas, Phong Nha-Ke Bang still retains large areas of natural habitat, which are relatively inaccessible and are not under immediate threat. There are still areas of tall lowland forest present, see Section 3.4.1, and these may possibly support an important bat fauna although this could not be shown based on the data collected during the survey. Numerous caves of all sizes are found throughout the area in both forest and in more open areas and these provide a large number of different roosting sites essential for a number of bat species. These factors together with the large size of the area probably places Phong Nha-Ke Bang amongst the most important areas for the conservation of bats in Vietnam.

It was not possible to assess to what degree the bat populations in the Phong Nha-Ke Bang area is subject to harvesting, although a certain harvesting pressure is expected. Harvest of bats is well known from other areas in Vietnam and Indochina (J. L. Walston pers. comm. 1998, Walston and Vinton 1999). On one occasion a small, easily accessible cave, Hang Ruc Pha (17°45.559' N, 105°50.920' E) reported by locals to contain bats was visited, but examination of the cave revealed no signs of bats nor any recent droppings. Surprisingly fruit bats of the species [*Cynopterus sphinx*] were

observed and caught roosting in palm leaves in Hoa Son village. Their presence was well known by the villagers and they were easily captured. Reportedly bats are not captured by these people and the presence of medium-sized, easily caught fruit bats in the immediate area of the houses suggest that this is indeed the case. Bat manure on the other hand is reportedly regularly collected for fertilisers.

Bats may be under threat due to disturbance of their roost sites. All caves visited including some that were not netted showed signs of human use. All caves were reportedly regularly used as camp sites and fire places and litter were abundant. On one occasion (Hang So Dua cave) a pregnant [*Rousettus leschenaulti*] was brought in dead by the guide. It was apparently freshly killed. During a previous visit to the cave several large bats were observed roosting on the wall and a bat could easily have been shot down. The species is known to be easily disturbed by humans (Brosset 1962 in Lekagul and McNeely 1977).

#### **4.4 Recommendations for further study**

Further surveys are required as to obtain more knowledge on the bat fauna of Phong Nha-Ke Bang. No detailed survey of the bat fauna in the area has previously been carried out although bats were also included in a survey by Le Xuan Canh (1997). The status and distribution for a number of species is poorly known. Several surveys carried out in the region recently have recorded significant range extensions (Francis *et al.* 1996, Guillen *et al.* 1997, Walston *et al.* 1998, SFNC 1998 and Walston and Vinton 1999) and in one case possibly species new to science (Guillen *et al.* 1997).

The majority of work was carried out at altitudes below 500 m, with no study sites above 800 m. The higher altitudes near the Vietnam-Lao border, occasionally exceeding 1000 m were not visited during this survey and a somewhat different bat species composition is to be expected there.

Further surveys are needed to assess to what extent harvesting takes place and the level of disturbance of most sites. Key roost sites should be identified and possibly receive special attention for protection.



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Table 4. Gazetteer of survey localities and other localities mentioned in the text.

Name in text	Surveyed by	Type of location/habitat	Name on maps	Name in local use	Location	Altitude	Survey dates
B. Cha Lo	RJT, TVC	Village in degraded valley	B. Cha Lo	B. Cha Lo	E-48-80-D 816603	250	23-24, 26, 28/10
B. Cha Lo border crossing	RJT	Border crossing	None	Unknown	E-48-80-D 811548	450	23/10
B. Cha Lo survey area	RJT, TVC	Survey area; forest on limestone and non-limestone	None	Unknown	E-48-80-D 800-835, 560-610	300-600 (-700)	23-28/10
B. Hoa Luong	NS: Saola; NYD	Village	B. Hoa Luong	Unknown	c. E-48-80-D 929655	a. 250	-
B. Tang Hoa	NS: Saola; DT 94	Village	B. Tang Hoa	Unknown	c. E-48-80-D 940630	a. 250	-
Ba Cay	DKH	Partly dry stream. Secondary forest. Scrub and open land with banana	None	Ba Cay	17°28.337'N-106°18.736'E	c. 400 <sup>a</sup>	6-8/7
Ban On	RJT, DT, TVC	Village in degraded in-lying valley	None	Ban On	E-48-80-D 024550	250	5, 7, 13, 17, 22/10
Base camp 1	NTN	Degraded valley forest on limestone	None	None	E-48-93-A 17°30.847'N, E 106°12.776'E	180	4-6/7
Base camp 2	NTN	Degraded valley forest on limestone	None	None	E-48-93-A 17°31.607'N, 106°13.411'E	180	11-12/7
Cha Noi (area)	DT	Settlement in degraded valley; surrounded by forested (karstic) limestone to the south and degraded/2° forest on non-limestone hills to the north	None	Cha Noi	E-48-93-A 150-200, 480-540	250-800	3-20/9
Cha Noi (settlement)	DT	Settlement	None	Cha Noi	E-48-93-A 175505	250	3-20/9
Cha Ra	DKH	Cave. Open land, scrub	None	Cha Ra	17°46.074'N-105°53.713'E	c. 450 <sup>a</sup>	19-20/8
Da Nui	Gaur; NYD	?	None	Da Nui	E-48-80-D 17°44.45'N, 105°50.58'E	400	13/8
Dan Hoa	NS	Village in cultivated lowlands	Dan Hoa	Dan Hoa	E-48-80-D 825693	150	-
Dia Chat campsite	RJT, TVC	Campsite in forested valley	None	Dia Chat	E-48-92-B 973512	550	17-21/10
Dui Mui	DKH	Dry stream and small pool in open land, scrub and coffee fields	None	Dui Mui	17°34.994'N-106°18.592'E	c. 50 <sup>a</sup>	19-20/7
Duong Cau	DKH	Primary riverine forest	None	Duong Cau	17°49.57'N-105°44.5'E*	c. 800 <sup>a</sup>	14-15/8
Eo Cap	NTN	Forest on (karstic) limestone	None	Eo Cap	E-48-93-A 17°32.638'N, 106°12.687'E	?	7/7
Hang Ca Tuc	RJT, DT	Rock shelter used as a camp; flat valley habitat mosaic	None	Hang Ca Tuc	E-48-93-A 068462	350	2-5/10
Hang Ca Tuc, area of	RJT, DT	Forested limestone (karstic) hill area	None	Hang Ca Tuc	E-48-92-B 057449 - E-48-93-A 062-085. 450-470	350-500	27, 29/9 and 2-5/10
Hang Cop Tang	RJT, DT	Rock shelter used as a camp; flat valley habitat mosaic	None	Hang Cop Tang	E-48-92-B 048505	300	26/9-2/10

Name in text	Surveyed by	Type of location/habitat	Name on maps	Name in local use	Location	Altitude	Survey dates
Hang Cop Tang, area of	RJT, DT	In-lying valley; flat valley habitat mosaic (with tall forest)	None	Hang Cop Tang	E-48-92-B 045-055, 495-515	300-350	26/9-2/10
Hang En cave	DKH, Tiger, NXD	Cave with stream running through. Valley. Open land	Rau Thuong	Hang En/Lam Hang On.	E-48-93-D 17°26.53'N, 106°17.52'E	c. 200 <sup>a</sup>	8-10/7
Hang Ruc Pha	DKH	Small cave in primary riverine forest.	None	Hang Ruc Pha	17°45.559'N-105°50'920'E	c. 500 <sup>a</sup>	12/8
Hoa Luong	DKH	Stream in open agricultural land, scrub	B. Hoa Luong	Hoa Luong	17°46.538'N-105°52.133'E	c. 250 <sup>a</sup>	17-18/8
Hoa Son village	DKH	Village	Hoa Son	Hoa Son	17°45.846'N-105°53.013'E	c. 250 <sup>a</sup>	19-20/8
Hung Ba Dau	NTN	Degraded forest on limestone hills	None	Hung Ba Dau	E-48-93-B 17°36'N, 106°17'E	?	15-16/7
Hung Lao	NTN	Forest on (karstic) limestone	None	Hung Lao	E-48-93-A 17°32.827'N, 106°12.809'E	?	7-8, 13/7
Khe Da Nui	DKH	Tall, riverine forest	None	Khe Da Nui	17°45.206'N-106°50.840'E	c. 750 <sup>a</sup>	13-14/8
Khe Dap Tro	DKH	Stream. Agricultural land, scrub and secondary forest	None	Khe Dap Tro	17°35.207'N-106°19.266'E	c. 50 <sup>a</sup>	17-19/7
Khe Lan	DT	Valley with degraded habitat mosaic (mostly 2° forest)	None	(also known as Khe Hut)	E-48-93-A 120-150, 515-535	350-500	?
Khe Mu Hon	DKH	Tall, riverine forest	None	Khe Mu Hon	17°42.06'N-105°53.75'E	c. 450 <sup>a</sup>	7-8/8
Khe Nhai	DKH	Dry stream bed. Secondary forest	None	Khe Nhai	17°38.047'N-105°59.297'E	c. 300 <sup>a</sup>	4-5/8
Khe Pha	DKH	Tall, riverine forest	None	Khe Pha	17°45.718'N-105°50.953'E	c. 500 <sup>a</sup>	12-13/8
Khe Sat Day	DKH	Secondary riverine forest	None	Khe Sat Day	17°29.006'N-106°18.129'E	c. 300 <sup>a</sup>	4-6/8
Khe So Dua	DKH	Small stream, open land, banana and scrub	None	Khe So Dua	17°31.361'N-106°16.934'E	c. 100 <sup>a</sup>	13-14/7
Khe Tra An	DKH	Large stream. Secondary forest.	None	Khe Tra An	17°30-17°32'N-106°15-106°17'E	0-100 <sup>a</sup>	20-24/7
Len A	DKH	Stream. Secondary forest and open, agricultural land	Len A	Len A	17°34-17°35'N-106°18-106°19'E	c. 50 <sup>a</sup>	17-20/7
Lo Do campsite	DKH	Small stream. Scrub	None	Khe Lo Do	17°33.5'N-106°18'E	c. 100 <sup>a</sup>	24-25/7
Hang Lon	DKH	Dry stream bed. Secondary forest	None	Hang Lon	17°38.686'N-105°58.689'E	c. 350 <sup>a</sup>	3-4/8
Hang Lon cave	DKH	Cave. Secondary forest	None	Hang Lon	17°38.686'N-105°58.689'E	c. 350 <sup>a</sup>	3-4/8
Lo Do cave	DKH	Cave. Secondary forest	None	None	17°33.266'N-106°17.535'E	c. 100 <sup>a</sup>	24-25/7
Ma Da	DKH	Large stream. Secondary forest	None	Ma Da	17°30.988'N-106°16.332'E	c. 60 <sup>a</sup>	20-22/7
Ma Rinh	DKH	Primary riverine forest	None	Ma Rinh	17°43.68'N-105°50.97'E	c. 750 <sup>a</sup>	15-16/8
Minh Hoa (town)	NS	Town in cultivated lowlands	Minh Hoa	Minh Hoa	E-48-80-D 030700	c. 150	-
Mo O	RJT, DT, TVC	Village	None	Mo O	E-48-80-D 996551	270	7-8, 13, 17, 21-22/10
Mo O valley	RJT, DT, TVC	In-lying valley; mainly heavily degraded	None	Unknown	E-48-80-D 955-020, 545-573	c. 270	7-8, 13, 17, 21-22/10
Nga Ba Hung Thoc	DKH	Large stream. Secondary forest	None	Khe Tra An (Nga Ba Hung Thoc)	17°31.523'N-106°16.649'E	c. 50 <sup>a</sup>	23-24/7
Nuoc Moc	DKH	Large stream. Secondary forest	None	Nuoc Moc Khe Tra An	17°30.075'N-106°15.845'E	c. 50 <sup>a</sup>	22-23/7
Pu Ru cave	DKH	Cave. Secondary forest and open, burned land	None	Pu Ru	17°38.949'N-105°59.063'E	c. 400 <sup>a</sup>	5-6/8

Name in text	Surveyed by	Type of location/habitat	Name on maps	Name in local use	Location	Altitude	Survey dates
Ranger station	DKH	Village. Open agricultural land, scrub	None		17°45'N-106°18.5'E	c. 50 <sup>1</sup>	
Ruc Ma Rinh	DKH	Tall, riverine forest	None	Ruc Ma Rinh	17°43.309'N-105°50.336'E	c. 750 <sup>1</sup>	16-17/8
Ruc Muoi	DKH	Cave with stream running through. Open land. Fields and scrub	None	Hang Ruc Muoi	17°44.753'N-106°54.031'E	c. 250 <sup>1</sup>	11-12/8
Ruc Pha cave	DKH	Cave with stream running through. Tall forest	None	Hang Ruc Pha	17°45.559'N-105°50.920'E	c. 550 <sup>1</sup>	12-13/8
So Dua cave	DKH	Cave. Secondary forest and open land	None	Hang So Dua (Hang Voi)	17°31.N-106°17'E*	c. 200 <sup>1</sup>	13-14/7
Suoi Cat valley	RJT, TVC	Series of forested valleys	None	Suoi Cat	E-48-92-B 967-980, 530-507	520-700	17-21/10
Suoi Cat, south of	RJT, TVC	Forested limestone (karstic) hill area	None	Unknown	E-48-92-B 980-987, 499-508	650-700	18, 20/10
Suoi Chan Loong valley	RJT, DT	In-lying valley; flat valley habitat mosaic (with tall forest)	None	Suoi Chan Loong	E-48-92-B 042518- E-48-93-A 470065	300-450	26/9-2/10
Suoi Chay valley	NTN	Valley with degraded habitat mosaic	Suoi Chay	Suoi Chay	E-48-93-A 285-322, 370-440	150-350	4-8, 11-13/7
Suoi Ken survey area	RJT, TVC	Forested slopes on non-calcareous bedrock	Suoi Ken	Suoi Ken	E-48-80-D 800-810, 577-567	300-600	26-28/10
Suoi May	DKH	Secondary riverine forest	Rau Thuong	Suoi May	17°27.295'N 106°19.069'E	250 <sup>1</sup>	10-12/7
Suoi Mo Sang valley	RJT, DT	Forested valley partly on non-calcareous bedrock	None	Suoi Mo Sang	E-48-80-D 930-950, 583-603	450-550	8-13/10
Suoi On	RJT, DT	Degraded in-lying valley	None	Suoi On	E-48-80-D 024550 - E-48-92-B 043525	250	5/10
Suoi Tagiang	RJT	Forested valley partly on non-calcareous bedrock	None	Suoi Tagiang	E-48-80-D 920-930, 603-620	400-650	12/10
Ta Ty area	RJT, TVC	Forested limestone (karstic) hill area	None	Ta Ty	E-48-80-D 820-840, 590-610	350-600 (-700)	24-26/10
Th. Da Nang	Saola; NXD	Village	Th. Da Nang	Th. Da Nang	E-48-80-D 965680	200	-
Th. Phong Nha	NS	Village in cultivated lowlands	Th. Phong Nha	Th. Phong Nha	E-48-93-B 370470	150	-
Th. Phu Nhieu	RJT, DT	Village in cultivated lowlands	Th. Phu Nhieu	Th. Phu Nhieu	E-48-81-C 085568	250	20-26/9
Th. Phu Nhieu survey area	RJT, DT	Survey area; flat valley forests amongst forested limestone hills	None	Unknown	E-48-81-C 065-110, 540-565	250-450	20-26/9
Th. Yen Hop	RJT, DT, TVC	Village; in-lying degraded valley	Th. Yen Hop	Th. Yen Hop	E-48-80-D 013550	270	7, 13, 17, 22/10
Thuong Hoa	RJT, DT, TVC	Village in cultivated lowlands	Thuong Hoa	Thuong Hoa	E-48-80-D 025597	c. 150	-
Tra An forest	DKH				17°29'-17°34'N, 106°15'-106°18'E	0-200	13, 20-24/7
Yen Hop forest	DKH				17°37'-17°41'N, 105°58'-106°00'E	250-400	2-6/8
Valley between Thuong Hoa and Ban On	RJT, DT, TVC	Forested flat valley	None	Unknown	E-48-80-D 019-024, 553-575	c. 250	5, 7, 13, 17, 22/10

<sup>1</sup> Approximate altitudes based on the maps.

\* No GPS reading at the actual site. Approximate co-ordinates from map.

For district and commune areas see Figure 2.

Surveyed by: initials of researchers are given; NXD = record from Nguyen Xuan Dang *et al.* (1998); NS = area not surveyed.

## ANNEX 2: BIRD SPECIES RECORDED DURING THE SURVEY

Bird status was assessed subjectively using the overall encounter frequency (the number of records). Status of each species was categorised as follows:

Common -- recorded daily, often in large numbers

Frequent -- recorded on over half of days

Occasional -- recorded on fewer than half of days

Present -- not possible to assess abundance

In assessing abundance consideration was given to weather conditions, and the behaviour and ecology of species, which may have affected their observability. The list is far from complete, and can only be used as an indication of the bird communities present.

Table 5. Bird species recorded during the survey.

Species	Vocal	Status		Habitat & localities
pond-heron sp. 1		P	So, W	<i>Ardeola</i>
Bittern		P	So, W	<i>Ixobrychus</i>
Black Baza		P	So	<i>Aviceda leuphotes</i>
Crested Serpent-eagle	V	P		<i>Spilornis cheela</i>
Japanese Sparrowhawk		P		<i>Accipiter gularis</i>
Crested Goshawk		P		<i>Accipiter trivirgatus</i>
Black Eagle		P	S	<i>Ictinaetus malayensis</i>
Rufous-bellied Eagle		P		<i>Hieraeetus kienerii</i>
Pied Falconet		P	F?	<i>Microhierax melanoleucos</i>
Bar-backed Partridge	V	C		<i>Arborophila brunneopectus</i>
Chestnut-necklaced Partridge	V	C	\$	<i>Arborophila charltonii</i>
Silver Pheasant		C	\$	<i>Lophura nycthemera</i>
Red Junglefowl	V	P	\$o	<i>Gallus gallus</i>
Grey Peacock-Pheasant	V	P		<i>Polyplectron bicalcaratum</i>
Crested Argus	V	P	\$	<i>Rheinardia ocellata</i>
Pin-tailed Pigeon		P	S	<i>Treron apicauda</i>
Yellow-vented Pigeon		P		<i>Treron seimundi</i>
Wedge-tailed Pigeon		P		<i>Treron sphenura</i>
Thick-billed Pigeon		P		<i>Treron curvirostra</i>
green-pigeon sp. 1	V	C		<i>Treron</i>
imperial pigeon sp. 1		O?		<i>Ducula</i>
Barred Cuckoo-Dove	V	P	\$o	<i>Macropygia unchall</i>
Spotted Dove	V	C	So	<i>Streptopelia chinensis</i>
Emerald Dove	V	C	\$	<i>Chalcophaps indica</i>
parakeet sp. ?	V	P	So	<i>Psittacula</i>
Vernal Hanging-Parrot	V	(P)	\$	<i>Loriculus vernalis</i>
Banded Bay Cuckoo	V	P		<i>Cacomantis sonneratii</i>
Green-billed Malkoha	V	C/F		<i>Phaenicophaeus tristis</i>
Greater Coucal	V	C	So	<i>Centropus sinensis</i>



Species	Vocal	Status	Habitat & localities	
Lesser Coucal		C	So	<i>Centropus bengalensis</i>
Mountain Scops-Owl	V	C?		<i>Otus spilocephalus</i>
Collared Owlet	V	C		<i>Glaucidium brodiei</i>
Asian Barred Owlet	V	C	\$	<i>Glaucidium cuculoides</i>
Pacific Swift		P	S	<i>Apus pacificus</i>
Red-headed Trogon	V	C		<i>Harpactes erythrocephalus</i>
White-throated Kingfisher		C	So,W	<i>Halcyon smyrnensis</i>
Brown Hornbill	V	O-F	\$	<i>Ptilolaemus tickelli</i>
Wreathed Hornbill		O	(\$)	<i>Rhyticeros undulatus</i>
Great Hornbill		O		<i>Buceros bicornis</i>
Red-vented Barbet	V	C	\$	<i>Megalaima lagrandieri</i>
Green-eared Barbet	V	P		<i>Megalaima faiostriata</i>
White-browed Piculet		P		<i>Sasia ochracea</i>
Red-collared Woodpecker		O		<i>Picus rabieri</i>
Greater Yellownape		P	S	<i>Picus flavinucha</i>
Lesser Yellownape		P		<i>Picus chlorolophus</i>
yellownape sp. 1	V	C		<i>P. flavinucha / P. chlorolophus</i>
Grey-capped Woodpecker		P	S	<i>Picoides canicapillus</i>
Bay Woodpecker	V	C	\$	<i>Blythipicus pyrrhotis</i>
Silver-breasted Broadbill		C/F		<i>Serilophus lunatus</i>
Long-tailed Broadbill	V	P		<i>Psarisomus dalhousiae</i>
Blue-rumped Pitta		C?	\$	<i>Pitta soror</i>
Bar-bellied Pitta		C		<i>Pitta ellioti</i>
Blue/Eared Pitta	V	P	\$	<i>P. cyanea / P. phayrei</i>
Nepal House-Martin		(P)	R	<i>Delichon nipalensis</i>
Bar-winged Flycatcher-shrike		P		<i>Hemipus picatus</i>
Large Wood-shrike		P		<i>Tephrodornis virgatus</i>
Black-winged Cuckoo-shrike		P		<i>Coracina melaschista</i>
Grey-chinned Minivet		(P)		<i>Pericrocotus solaris</i>
Scarlet Minivet	V	C	S,\$	<i>Pericrocotus flammeus</i>
Great Iora	V	P	S	<i>Aegithina lafresnayei</i>
Blue-winged Leafbird		P	S,\$	<i>Chloropsis cochinchinensis</i>
Orange-bellied Leafbird		P	\$	<i>Chloropsis hardwickii</i>
Red-whiskered Bulbul	V	C	So	<i>Pycnonotus jocosus</i>
Sooty-headed Bulbul	V	C	So	<i>Pycnonotus aurigaster</i>
Puff-throated Bulbul	V	C	\$	<i>Criniger pallidus</i>
Grey-eyed Bulbul	V	P	\$	<i>Hypsipetes propinquus</i>
Black Bulbul 2	V	P		<i>Hypsipetes madagascariensis</i>
Ashy Drongo		P		<i>Dicrurus leucophaeus</i>
Bronzed Drongo		C?	S	<i>Dicrurus aeneus</i>
Lesser Racket-tailed Drongo		C		<i>Dicrurus remifer</i>
Hair-crested Drongo		P		<i>Dicrurus hottentottus</i>
Greater Racket-tailed Drongo		C	S	<i>Dicrurus paradiseus</i>
Black-headed Oriole		P	S	<i>Oriolus xanthornus</i>
Asian Fairy-Bluebird	V	C	S,\$	<i>Irena puella</i>
Eastern Green Magpie		P		<i>Cissa hypoleuca</i>
Green magpie sp. 1	V	C?		<i>Cissa</i>
White-winged Magpie	V	F-(C)	(S),\$	<i>Urocissa whiteheadi</i>

Species	Vocal	Status		Habitat & localities
Racket-tailed Treepie		P	So	<i>Crypsirina temia</i>
Ratchet-tailed Treepie	V	C		<i>Temnurus temnurus</i>
Large-billed Crow	V	P	So	<i>Corvus macrorhynchus</i>
Sultan Tit	V	C	§	<i>Melanochlora sultanea</i>
nuthatch sp. 1		O		<i>Sitta</i>
Puff-throated Babbler	V	P		<i>Pellorneum ruficeps</i>
Buff-breasted Babbler	V	LC	§	<i>Trichastoma tickelli</i>
Scaly-crowned Babbler	V	(F)-C		<i>Malacopteron cinereum</i>
Large Scimitar-Babbler	V	C	S, §	<i>Pomatorhinus hypoleucos</i>
Short-tailed Scimitar-Babbler		C	R	<i>Jabouillea danjoui</i>
Streaked Wren-Babbler		C	R, §	<i>Napothera brevicaudata</i>
Eyebrowed Wren-Babbler	V	C	R, D	<i>Napothera epilepidota</i>
Rufous-fronted Babbler		P	So	<i>Stachris rufifrons</i>
Sooty Babbler		C	R	<i>Stachyris herberti</i>
Grey-throated Babbler	V	C	D	<i>Stachyris nigriceps</i>
Spot-necked Babbler		P	D	<i>Stachyris striolata</i>
Striped Tit-Babbler	V	C	S, §	<i>Macronous gularis</i>
White-crested Laughingthrush		LC		<i>Garrulax leucolophus</i>
laughingthrush sp. 3	V	C		<i>Garrulax</i>
Lesser Necklaced Laughingthrush		LC		<i>Garrulax monileger</i>
Grey Laughingthrush		LC?		<i>Garrulax maesi</i>
Black-throated Laughingthrush		P		<i>Garrulax chinensis</i>
Hwamei		P	So	<i>Garrulax canorus</i>
Mountain Fulvetta		LC		<i>Alcippe peracensis grotei</i>
Grey-cheeked Fulvetta	V	C		<i>A. morissonia</i>
Striated Yuhina		P	§	<i>Yuhina castaniceps</i>
White-bellied Yuhina	V	C	§	<i>Yuhina zantholeuca</i>
Rufous-tailed Robin		P		<i>Luscinia sibilans</i>
Siberian Blue Robin		P		<i>Luscinia cyane</i>
Oriental Magpie Robin	V	C	So	<i>Copsychus saularis</i>
Slaty-backed Forktail		P	W, S, §	<i>Enicurus schistaceus</i>
White-crowned Forktail		P	W	<i>Enicurus leschenaulti</i>
Blue Rock Thrush		P	So, §o	<i>Monticola solitarius</i>
Blue Whistling Thrush	V	C	D, R, §	<i>Myiophoneus caeruleus</i>
Orange-headed Thrush		P	§	<i>Zoothera citrina</i>
Siberian Thrush		P	§o	<i>Zoothera sibirica</i>
Scaly Thrush		P		<i>Zoothera dauma</i>
Grey-cheeked Warbler		P		<i>Seicercus poliogenys</i>
Golden-spectacled Warbler		P	§	<i>Seicercus burkii</i>
Inornate Warbler	V	C	§	<i>Phylloscopus inornatus</i>
Blyth's Leaf-Warbler		P		<i>Phylloscopus reguloides</i>
Leaf-Warbler 4		C	§	<i>Phylloscopus cf. P. ricketti</i>
Lanceolated Warbler		P		<i>Locustella lanceolata</i>
Striated Warbler		P	So	<i>Megalurus palustris</i>
Dark-necked Tailorbird	V	C	S, §	<i>Orthotomus atrogularis</i>
Plain Prinia		P	So	<i>Prinia inornata</i>
Slaty-bellied Tesia	V	P	D	<i>Tesia olivea</i>
Stub-tailed Bush-Warbler	V	P		<i>Cettia squameiceps</i>

Species	Vocal	Status	Habitat & localities	
White-tailed Flycatcher	V	C?	D, \$	<i>Cyornis concreta</i>
Pale Blue Flycatcher		P		<i>Cyornis unicolor</i>
Grey-headed Flycatcher	V	C	\$	<i>Culicicapa ceylonensis</i>
Black-naped Monarch		C	\$	<i>Hypothymis azurea</i>
Japanese Paradise-flycatcher		[P]		<i>Terpsiphone atrocaudata</i>
Asian Paradise-flycatcher		C?	F?	<i>Terpsiphone paradisi</i>
White Wagtail		P	So, \$	<i>Motacilla alba</i>
Grey Wagtail	V	C	S, \$	<i>Motacilla cinerea</i>
Ashy Wood-swallow		C	So	<i>Artamus fuscus</i>
Long-tailed Shrike		C	So	<i>Lanius schach</i>
starling sp. 1		P	So	<i>Sturnus</i>
Common Myna		P	So	<i>Acridotheres tristis</i>
Crested Myna		C	So	<i>Acridotheres cristatellus</i>
Hill Myna	V	LF	S	<i>Gracula religiosa</i>
Purple-naped Sunbird	V	P	\$	<i>Hypogramma hypogrammicum</i>
Fork-tailed Sunbird	V	C?	\$	<i>Aethopyga christinae</i>
Crimson Sunbird	V	P		<i>Aethopyga siparaja</i>
Streaked Spiderhunter	V	C	S, \$	<i>Arachnothera magna</i>
Thick-billed Flowerpecker		P		<i>Dicaeum agile</i>
Eurasian Tree-Sparrow		LC	So	<i>Passer montanus</i>

Species limits and nomenclature follow Lekagul and Round (1991), order that of King *et al.* (1975).

Species notes:

1. Excludes birds identified to species.
2. All birds seen were an all black form.
3. Calls of either White-crested or Grey Laughingthrush
4. A distinctive leaf-warbler taxon similar to Sulphur-breasted Warbler

Key:

Abundance codes: C = common; F = frequent; O = occasional; L (prefix) = local; P = present abundance unknown; [ ] = provisional or unconfirmed identification.

Vocal: V = knowledge of the species's vocalisations greatly helped status assessment.

Habitat and locality: habitat association of a species is with forest unless otherwise stated; S = also found in heavily degraded non forest habitats; So = only found in heavily degraded non forest habitats; R = associated with rocky microhabitats; D = associated with damper 'enclosed' microhabitats; F = associated with flat valleys; W = associated with water; \$ = found in the Suoi Ken area to the west of the road south of B. Cha Lo; So = found only to the west of the road south of B. Cha Lo.

**ANNEX 3: MAMMAL SPECIES RECORDED DURING THE SURVEY**

Mammal abundance was assessed in the same way as for birds (see Annex 2), except that the numbers of signs seen were also taken into account.

**Table 6. Mammal species recorded from Phong Nha-Ke Bang during the survey.**

Species	Abundance	Method of detection	Level of identification	
Northern Treeshrew	C	A	confirmed (1)	<i>Tupaia belangeri</i>
Pig-tailed Macaque	O	A	confirmed	<i>Macaca nemestrina</i>
Assamese Macaque	O	A	confirmed	<i>Macaca assamensis</i>
Stump-tailed Macaque	O-F	A	confirmed	<i>Macaca arctoides</i>
Francois's Langur	O	A	confirmed	<i>Semnopithecus francoisi</i>
White/Buff-cheeked Gibbon	O	A	confirmed	<i>Hylobates (Nomascus) leucogenys/gabriellae</i>
Bear	P	S	confirmed	<i>Ursus</i>
Yellow-throated Marten	P	A	confirmed	<i>Martes flavigula</i>
Hog Badger	P	A	confirmed	<i>Arctonyx collaris</i>
Marbled Cat	P	T	confirmed	<i>Pardofelis marmorata</i>
wild pig spp.	LC	S	confirmed	<i>Sus</i>
Indian Muntjac	P	T, [S]	confirmed	<i>Muntiacus muntjak</i>
Southern Serow	P	[S]	provisional	<i>Naemorhedus sumatraensis</i>
Black Giant Squirrel	O-F	A	confirmed	<i>Ratufa bicolor</i>
Pallas's Squirrel	C	A	confirmed	<i>Callosciurus erythraeus</i>
Inornate Squirrel	O	A	confirmed	<i>Callosciurus inornatus</i>
Cambodian Striped Squirrel	P	A	confirmed	<i>Tamiops rodolphii</i>
Striped Squirrel (2)	P	A	confirmed	<i>Tamiops</i>
striped squirrel spp. (3)	C	A	confirmed	<i>Tamiops</i>
Red-cheeked Long-nosed Squirrel	C	A	confirmed	<i>Dremomys rufigenis</i>
Asiatic Brush-tailed Porcupine	C?	T	confirmed	<i>Atherurus macrourus</i>

Order and scientific nomenclature follow Corbet and Hill (1992). Identification of tracks followed van Strien (1983) and the personal experience of observers. The list is far from complete, and can only be used as an indication of the species present. Only species of known provenance from within Phong Nha-Ke Bang are included; for other species of unknown provenance or found outside of Phong Nha-Ke Bang see text Sections 3.4.2.3. and 3.4.2.4., and Annex 4.

**Abbreviations:**

Abundance codes: C = common; F = frequent; O = occasional; P = present, abundance not assessed; [ ] = record unconfirmed.

Method of detection: A = sighting or vocal records; T = trapped animal of known provenance; S = signs.

**Notes**

1. Identified as this species solely on basis of range.
2. A unidentifiable morph certainly not *T. rodolphii*.
3. Animals not identified to species.

ANNEX 4: OBSERVATIONS OF OR EVIDENCE FOUND FOR HUNTING AND TRADE OF WILDLIFE DURING THE SURVEY

Nguyen Xuan Dang *et al.* (1998) also report evidence of heavy snaring pressure in areas covered during the project, as well as evidence for use of guns.

Table 7. Observations of or evidence for hunting and trade of wildlife during the survey.

Survey Area	Location	Type of hunting	Circumstances	Number of people	Animals captured	Destination of animals	Observers
Suoi Chay valley	Suoi Chay valley (1)	Snare	Three short? snare lines (single cable) seen	?	?	?	NTN
Cha Noi	Cha Noi area	Snare	Snarelines visited with hunters on two days; c. 200 snares	Two	Pig Asian Brush-tailed Porcupine <i>Atherurus macrourus</i>	?	DT
	Cha Noi area	Snare	Snarelines visited with hunters on two days c. 70 snares	Two	Asian Brush-tailed Porcupine	?	DT
Th. Phu Nhieu	Th. Phu Nhieu village (2)	Snare	Interviews and forest visits with hunters between 14 and 21 September; reportedly 200 snares, checked four times	Two	palm civet Asian Brush-tailed Porcupine	?	DT
	Th. Phu Nhieu village	Snare	Interviews and forest visits with hunters between 14 and 21 September; reportedly 560 snares, checked four times	Two	palm civet pig 2 Asian Brush-tailed Porcupine	?	DT
	Th. Phu Nhieu village	Snare	Interviews and forest visits with hunters between 14 and 21 September; reportedly 60 snares, checked two times	Three	4 young pigs (A) Asian Brush-tailed Porcupine	Local consumption	DT
	South of Th. Phu Nhieu (3)	Snare	People met in forest	Three	2 Asian Brush-tailed Porcupine (1A) young Stump-tailed Macaque (A)	?	RJT, DT
	South of Th. Phu Nhieu	Snare	Person met in forest	One	Pheasant	?	RJT, DT
	Th. Phu Nhieu village	Gun Snare	People returning to village from forest	Three	Black Giant squirrel Asian Brush-tailed Porcupine (A)	Local consumption Collection by motorbike taxi driver	RJT, DT
	Suoi Chan Loong valley	Suoi Chan Loong valley	Snare	Two old snare lines each several hundred m long seen (4)	?	?	?
	Limestone hills to south and east of Hang Ca Tuc	Snare	Several old snare lines seen	?	?	?	RJT, DT
Suoi Cat valley and Mo O village	Mo O village	Snare	Village meal	?	Pig	Local consumption	RJT, DT

Area	Location	Type of hunting	Circumstances	Number of people	Animals captured	Destination of animals	Observers
	Suoi Cat valley	Snare	People in forest reportedly 70 single cable snares and 10 large mammal snares (5)	Two	Female Silver Pheasant (A) Indian Muntjac Asian Brush-tailed Porcupine Red-checked Long-nosed Squirrel	? ? Local consumption Local consumption	RJT, TVC
	Suoi Cat valley	Snare	Survey guides checking reportedly 40-50 snares	?	Asian Brush-tailed Porcupine	Local consumption	RJT, TVC
Suoi Mo Sang valley	Suoi Mo Sang valley (6)	Snare	Snare line seen (single cable; reportedly 50 snares) and campsite visited	Two	2 Asian Brush-tailed Porcupine (1A)	?	RJT, DT
	Suoi Mo Sang valley	Snare	Campsite visited; two groups of people using same camp; reportedly 300 snares in total	Two groups of two	Binurong <i>Arctictis binturong</i> Asian Brush-tailed Porcupine	?	DT
B. Cha Lo	Ta Ty	Snare	Five long active, snare lines (single cable) and several opportunistic snares seen in forest over a c. 4 km walk (7)	?	Red-checked Long-nosed Squirrel	Local consumption	RJT, TVC
	Suoi Ken area	Snare	One active, snare line (single cable) seen; reported total of 110 snares (8)	One hunter and family camped in forest	<i>Nesolagus</i> (A)	Collection by motorbike taxi drivers	RJT, TVC
	Suoi Ken area	Snare	Two old snare lines (each over several hundred m long) seen	?	?	?	RJT
	Road south B. Cha Lo	Snare	Older man and woman returning from forest	Two	Stump-tailed Macaque (A)*	Collection point in B. Cha Lo village	RJT, TVC
	Road south B. Cha Lo	Snare	Man and boy returning from forest	Two	[ <i>Viverra</i> ] carcass 2 [ <i>Melogale</i> ] sized carcasses	Local consumption?	RJT, TVC
	Road south B. Cha Lo	Snare	Young man returning from forest	One	Baby Stump-tailed Macaque (A) Owston's Palm Civet (A)* part of [Southern Scrow] carcass	? Collection point in B. Cha Lo village For sale?	RJT, TVC
	B. Cha Lo village (9)	Snare?	Collection point	One	4 Common Palm Civet (A) 2 Masked Palm Civet (A) 2 Owston's Palm Civet (A)* 2 Stump-tailed Macaque (A)* [Rhesus Macaque] (A)	Collection by motorbike taxi drivers and sale to passing Vietnamese lorry from Laos	RJT, TVC
	Border post at B. Cha Lo	?	Motorbike from Laos	One	2 Sunda Pangolin (A) 2 Snakes (A) 2 other containers	? Border post gratuity ?	RJT, TVC

\* = the same individual(s) recorded in the possession of different people.

Note inactive but well used campsites are ubiquitous in the survey areas, the motivation for their use is undoubtedly hunting and collection of NTFPs in the case of the latter opportunistic hunting without doubt goes hand-in-hand.

The notes below are further evidence for active or very recent hunting activity:

1. Suoi Chay valley: people, some with fishing equipment, were frequently encountered (NTN).
2. Th. Phu Nhieu village: a further group of hunters were interviewed who had reportedly 200 snares, but had yet to catch anything (DT).
3. South of Th. Phu Nhieu: eight people seen apparently off in search of valuable timber (RJT, DT).

Saola *Pseudoryx nghetinhensis*

Tracks and droppings likely to be confusable with Serow and perhaps deer and pigs.

Southern Serow *Neomohedus sumatraensis*

Tracks confusable with pigs and Saola, while droppings confusable with deer and maybe Saola. Notes on situation should be provided.

Wild cattle *Bos, Bubalus*

Tracks in many cases identifiable to species, weighting of the certainty of identification is advisable based on the full range of tracks observed. Details of measurements and sketches should be given. The situation of prints is also an important factor. No distinction can be made between domestic and Wild Water Buffalo *Bubalus arnee*. See also the discussion in Duckworth and Hedges (1998).

Porcupines *Hystrix, Atherurus*

Tracks and droppings probably identifiable to species but careful research is needed, possibility of confusion with several other mammals.



## **ANNEX 6: TURTLES AND TORTOISES**

A single species, Keeled Box Turtle *Pyxidea mouhotii*, was recorded as follows:

*Survey records:* One individual was found in flat valley forest of the Suoi Chan Loong valley just north of Hang Cop Tang on the 2 October (found DT, identified RJT).

## ANNEX 7: SUMMARY OF BAT RECORDS IN SURVEY AREAS AND CAVES

Table 8. Summary of bat records, survey areas.

Species	English name	Scientific name	No. of bats caught in survey areas					
			Suoi May forest	Len A	Trn Au	Yen Hop forest	Hoa Son forest	Hoa Son village
[Leschenault' Roussette]	[Leschenault' Roussette]	[ <i>Rousettus leschenaultii</i> ]			[7]			[1]
[Short-nosed Fruit Bat]	[Short-nosed Fruit Bat]	[ <i>Cynopterus sphinx</i> ]		[10]	[5]			
[Ratanworabhan's Fruit Bat]	[Ratanworabhan's Fruit Bat]	[ <i>Megarops niphanae</i> ]		[1]	[1]		[4]	[1]
[Dawn Fruit Bat]	[Dawn Fruit Bat]	[ <i>Eonycteris spelaea</i> ]	[2]					
[Hill Long-tongued Fruit Bat]	[Hill Long-tongued Fruit Bat]	[ <i>Macroglossus sobrinus</i> ]	3		1			
Lesser False Vampire Bat	Lesser False Vampire Bat	[ <i>Megaderma spasma</i> ]		1				1
Greater False Vampire Bat	Greater False Vampire Bat	[ <i>Megaderma lyra</i> ]	3	4		4	1	1
Woolly Horseshoe Bat	Woolly Horseshoe Bat	[ <i>Rhinolophus luctus</i> ]				3		
Bourret's Horseshoe Bat	Bourret's Horseshoe Bat	[ <i>Rhinolophus paradoxolophus</i> ]				1		
Pearson's Horseshoe Bat	Pearson's Horseshoe Bat	[ <i>Rhinolophus pearsonii</i> ]	3	6		1	1	
[Little Nepalese Horseshoe Bat]	[Little Nepalese Horseshoe Bat]	[ <i>Rhinolophus subbadius</i> ]				[1]		
[Malayan Horseshoe Bat]	[Malayan Horseshoe Bat]	[ <i>Rhinolophus malayanus</i> ]		[3]	[1]	[5]	[2]	
[Rufous Horseshoe Bat/ Intermediate Horseshoe Bat]	[Rufous Horseshoe Bat/ Intermediate Horseshoe Bat]	[ <i>Rhinolophus rouxi/affinis</i> ]		[9]		1		[1]
[Andersen's Leaf-nosed Bat]	[Andersen's Leaf-nosed Bat]	[ <i>Hipposideros pomona</i> ]					[1]	
[Pratt's Leaf-nosed Bat/ Shield-faced Leaf-nosed Bat]	[Pratt's Leaf-nosed Bat/ Shield-faced Leaf-nosed Bat]	[ <i>Hipposideros pratti/lylei</i> ]	[2]			[2]		
Himalayan Leaf-nosed Bat	Himalayan Leaf-nosed Bat	[ <i>Hipposideros armiger</i> ]	7	2	14	9	1	9
Horsfield's Leaf-nosed Bat	Horsfield's Leaf-nosed Bat	[ <i>Hipposideros larvatus</i> ]	1	3		26	6	1
Stoliczka's Trident Bat	Stoliczka's Trident Bat	[ <i>Aselliscus stoliczkanus</i> ]				3		
Large Myotis	Large Myotis	[ <i>Myotis chinensis</i> ]	6					
[Himalayan Whiskered Bat]	[Himalayan Whiskered Bat]	[ <i>Myotis siligorensis</i> ]	[1]		[9]		[1]	[1]
[Whiskered Bat/ Nepalese Whiskered Bat]	[Whiskered Bat/ Nepalese Whiskered Bat]	[ <i>Myotis mystacinus/muricola</i> ]	[2]		[1]	[4]	[2]	[1]
[Daubenton's Bat/ Horsfield's Bat]	[Daubenton's Bat/ Horsfield's Bat]	[ <i>Myotis daubentonii/ horsfieldii</i> ]						[2]
[Rickett's Big-footed Bat]	[Rickett's Big-footed Bat]	[ <i>Myotis ricketti</i> ]	[2]		[2]			[1]
Harlequin Bat	Harlequin Bat	[ <i>Scotomanes ornatus</i> ]			1	3	1	
Great Evening Bat	Great Evening Bat	[ <i>Idia io</i> ]	17					6
[Kelaart's Pipistrelle/ Chinese Pipistrelle]	[Kelaart's Pipistrelle/ Chinese Pipistrelle]	[ <i>Pipistrellus ceylonicus/ pulveratus</i> ]						[7]
[Schreibers' Bent-winged Bat]	[Schreibers' Bent-winged Bat]	[ <i>Miniopterus schreibersii</i> ]					[2]	
[Greater Tube-nosed Bat]	[Greater Tube-nosed Bat]	[ <i>Murina leucogaster</i> ]					[1]	
[Round-eared Tube-nosed Bat]	[Round-eared Tube-nosed Bat]	[ <i>Murina cyclotis</i> ]			[1]	[1]		
Tube-nosed Bat	Tube-nosed Bat	[ <i>Murina</i> sp. 3]	2					
[Hairy-winged Bat]	[Hairy-winged Bat]	[ <i>Harpiocephalus harpia/mordax</i> ]		[1]			[1]	

Table 9. Summary of bat records, caves.

Species		No. of bats caught in each cave						
English name	Scientific name	Lam Hang On Cave	Hang So Dun (Hang Vol) Cave	Cave near Khe Lo Do	Hang Lon Cave	Pu Ru Cave	Hang Ruc Mol Cave	Hang Chu Rn Cave
[Leschenault's Rousette]	[ <i>Rousettus leschenaulti</i> ]		[2]					[1]
[Hill Long-tongued Fruit Bat]	<i>Macroglossus sobrinus</i>							1
Greater False Vampire Bat	<i>Megaderma lyra</i>	1			2			1
Woolly Horseshoe Bat	<i>Rhinolophus luctus</i>				2			
Bourret's Horseshoe Bat	<i>Rhinolophus paradoxolophus</i>					1		
[Little Nepalese Horseshoe Bat]	[ <i>Rhinolophus subbadius</i> ]					[1]		
[Malayan Horseshoe Bat]	[ <i>Rhinolophus malayanus</i> ]				[2]	[3]		
[Pratt's Leaf-nosed Bat/Shield-faced Leaf-nosed]	[ <i>Hipposideros pratti/lylei</i> ]	[2]			[2]			
Himalayan Leaf-nosed Bat	<i>Hipposideros armiger</i>	1		4	8			9
Horsfield's Leaf-nosed Bat	<i>Hipposideros larvatus</i>					26		1
Stoliczka's Trident Bat	<i>Aselliscus stoliczkanus</i>					3		
Large Myotis	<i>Myotis chinensis</i>	6						
[Himalayan Whiskered Bat]	[ <i>Myotis siligorensis</i> ]	[1]					[1]	
Whiskered Bat/Nepalese Whiskered Bat]	[ <i>Myotis mystacinus/muricola</i> ]					[4]		
[Rickett's Big-footed Bat]	[ <i>Myotis ricketti</i> ]	[2]					[1]	
Harlequin Bat	<i>Scotomanes ornatus</i>							
Great Evening Bat	<i>la la</i>	17						
[Kelaart's Pipistrelle/Chinese Pipistrelle]	[ <i>Pipistrellus ceylonicus/pulveratus</i> ]							6 [7]

## ANNEX 8: LIST OF BAT SPECIMENS

Table 10. List of all bat specimens taken during the survey.

Specimen no.	Identification	Sex	Date	Net/trap site	Survey area	Kept at Harrison Zoological Museum, England	Kept at Xuan Mai, Hanoi University, Vietnam	Notes
PN-01-01	<i>Rhinolophus pearsonii</i>	M	4-5/7	1	Suoi Mai forest	X		
PN-01-02	<i>Hipposideros armiger</i>	M	4-5/7	1	Suoi Mai forest		X	
PN-01-03	<i>Hipposideros armiger</i>	M	4-5/7	1	Suoi Mai forest		X	
PN-01-04	[ <i>Myotis mystacinus/muricola</i> ]	F	5-6/7	1	Suoi Mai forest	X		
PN-01-05	<i>Megaderma lyra</i>	M	5-6/7	1	Suoi Mai forest	X		
PN-02-01	[ <i>Eonycteris spelaea</i> ]	M	6-7/7	2	Suoi Mai forest	X		
PN-02-02	<i>Murina sp. 3</i>	F	6-7/7	2	Suoi Mai forest	X		
PN-02-03	<i>Macroglossus sobrinus</i>	M	6-7/7	2	Suoi Mai forest		X	
PN-03-01	<i>Macroglossus sobrinus</i>	F	7-8/7	3	Suoi Mai forest	X		
PN-04-01	<i>Myotis chinensis</i>	F	8-9/7	4	Suoi Mai forest		X	
PN-04-02	<i>Myotis siligorensis</i>	M	8-9/7	4	Suoi Mai forest	X		
PN-04-03	<i>Myotis chinensis</i>	M	8-9/7	4	Suoi Mai forest	X		
PN-04-04	[ <i>Hipposideros pratti</i> ]	M	8-9/7	4	Suoi Mai forest	X		
PN-04-05	<i>Megaderma lyra</i>	M	8-9/7	4	Suoi Mai forest		X	
PN-04-06	<i>Ia io</i>	M	8-9/7	4	Suoi Mai forest	X		
PN-04-07	<i>Ia io</i>	M	8-9/7	4	Suoi Mai forest		X	
PN-04-08	<i>Hipposideros armiger</i>	M	8-9/7	4	Suoi Mai forest	X		
PN-04-09	<i>Ia io</i>	F	8-9/7	4	Suoi Mai forest	X		
PN-04-10	<i>Myotis chinensis</i>	F	8-9/7	4	Suoi Mai forest	X		
PN-04-11	[ <i>Hipposideros pratti/lylei</i> ]	F	8-9/7	4	Suoi Mai forest	X		
PN-04-12	[ <i>Myotis ricketti</i> ]	M	9-10/7	4	Suoi Mai forest	X		
PN-04-13	[ <i>Myotis ricketti</i> ]	M	9-10/7	4	Suoi Mai forest	X		
PN-05-01	<i>Rhinolophus pearsonii</i>	M	10-11/7	5	Suoi Mai forest		X	
PN-05-02	<i>Rhinolophus pearsonii</i>	F	10-11/7	5	Suoi Mai forest		X	
PN-05-03	<i>Murina sp. 3</i>	M	11-12/7	5	Suoi Mai forest	X		
PN-05-04	<i>Hipposideros larvatus</i>	M	11-12/7	5	Suoi Mai forest	X		
PN-05-05	<i>Macroglossus sobrinus</i>	M	11-12/7	5	Suoi Mai forest		X	Juvenile
PN-05-06	[ <i>Eonycteris spelaea</i> ]	M	11-12/7	5	Suoi Mai forest	X		
PN-05-07	<i>Hipposideros armiger</i>	F	11-12/7	5	Suoi Mai forest		X	
PN-05-08	[ <i>Myotis mystacinus/muricola</i> ]	M	11-12/7	5	Suoi Mai forest	X		
PN-06-01	[ <i>Rousettus leschenaultii</i> ]	?	13/7	6	Tra An		X	Found dead
PN-06-02	[ <i>Rousettus leschenaultii</i> ]	F	13/7	6	Tra An	X		Found dead. Pregnant
PN-08-01	[ <i>Rhinolophus rouxi/affinis</i> ]	M	17-18/7	8	Len A		X	
PN-08-02	[ <i>Rhinolophus rouxi/affinis</i> ]	F	17-18/7	8	Len A		X	
PN-08-03	[ <i>Cynopterus sphinx</i> ]	F	17-18/7	8	Len A		X	Juvenile
PN-08-04	<i>Megaderma lyra</i>	F	17-18/7	8	Len A		X	
PN-08-05	<i>Rhinolophus pearsonii</i>	F	17-18/7	8	Len A	X		
PN-08-06	<i>Hipposideros larvatus</i>	F	17-18/7	8	Len A	X		
PN-08-07	<i>Rhinolophus pearsonii</i>	M	17-18/7	8	Len A		X	
PN-08-08	<i>Rhinolophus pearsonii</i>	M	17-18/7	8	Len A	X		
PN-08-09	[ <i>Rhinolophus rouxi/affinis</i> ]	F	17-18/7	8	Len A	X		
PN-08-10	[ <i>Rhinolophus rouxi/affinis</i> ]	F	17-18/7	8	Len A		X	
PN-08-11	[ <i>Rhinolophus malayanus</i> ]	F	17-18/7	8	Len A		X	
PN-09-01	[ <i>Rhinolophus rouxi/affinis</i> ]	F	18-19/7	9	Len A	X		
PN-09-02	<i>Rhinolophus pearsonii</i>	M	18-19/7	9	Len A		X	
PN-09-03	<i>Rhinolophus pearsonii</i>	M	18-19/7	9	Len A	X		

(different from the former groups) (RJT).

5. Suoi Cat valley: these two people came in on 17 and left on 18 October and came back in again on 21 October (RJT, TVC). Two other groups of two and one people seen (RJT). One group of four people with a gun and reportedly about 100 snares seen (TVC).
6. Suoi Mo Sang valley area: a further five groups of two, three, two, one and two people seen. Gun shots heard on a couple of occasions (RJT, DT).
7. B. Cha Lo, Ta Ty area: two active campsites, one with two people; well constructed recently used shelter with several animal remains (RJT, TVC).
8. Suoi Ken hunters camp: prices quoted for different species: pangolin 250,000 dong/kg; civet 60,000 dong/kg; monkey 20,000 dong/kg; pig 15,000 dong/kg; muntjac 12,000 dong/kg; porcupine 80,000 per animal; *Nesolagus* 40,000 per animal (TVC).
9. B. Cha Lo village: recent remains reportedly of a Binturong shown to TVC and RJT.

## ANNEX 5: A PROVISIONAL ANNOTATED LIST OF THE LEVEL OF JUSTIFIABLE IDENTIFICATION FOR MAMMAL SIGNS IN INDOCHINA

The list is a first attempt at systematically giving applicability of signs for mammal identification. It is hoped that it will encourage discussion and further research into identification of signs. The list possibly includes instances of over caution and cases of overlap unaware to the authors; these should be elucidated upon by future field workers at the earliest opportunity. Uncertainty over the distinctiveness of some signs could be cleared up with the collection of validated series of measurements, from known individuals of known species in Indochina. Note that several extralimital northern species have not been taken into account (i.e. musk deer *Moschus*, Red Panda *Ailurus fulgens*, Eurasian Badger *Meles meles*, Raccoon Dog *Nyctereutes procyonoides*, Goral *Neomorphedus goral*, Red Fox *Vulpes vulpes*).

Factors, which undoubtedly affect track characteristics of a given taxon and need to be taken into consideration, include age, sex, gait and substrate. Factors, which undoubtedly affect faeces characteristics of a given taxon and need to be taken into consideration, include age, sex, food availability and health. It is probably unwise to identify faeces of carnivores, as there may be considerable overlap in characters even between the major groups (i.e. dogs, cats, civets, badgers and weasels, and mongooses).

### Pangolins *Manis*

Clear pangolin tracks are identifiable, but not to species.

### Dhole *Cuon alpinus*

Tracks probably generally identifiable to species (over 7.5 cm long; size should be given). The situation and numeracy of prints is also an important factor to consider.

### Asiatic Jackal *Canis aureus*

Doubtfully identifiable from domestic dogs, and perhaps also some overlap with Dhole.

### Bears *Ursus*

Tracks, claw marks and damage to trees are all unequivocal evidence of bears, but certainly at the present individual signs should not be identified to species. Prints from adult Asian Black Bears *Ursus thibetanus* may be identifiable on size but more data need to be made available.

### Weasels *Mustela*

Tracks probably identifiable as weasels, but certainly not to species, also a possibly for confusion with rodents and insectivores.

### Ferret badgers *Melogale* and Yellow-throated Marten *Martes flavigula*

Possibly distinguishable between ferret badgers and martens but only after careful study, also probably confusion possible with civets.

### Hog Badger *Arctonyx collaris*

Clear tracks should be identifiable to species. Rooting signs are probably not clearly distinguishable from those of pigs.

### Otters *Lutra*, *Lutrogale*. *Aonyx*

Tracks seem to be identifiable between Asian Small-clawed Otter *Aonyx cinerea* and other species but not within the larger *Lutra/Lutrogale* species (note Smooth-coated *Lutrogale perspicillata* may be identifiable by print size but more data are required). Spraints are probably identifiable as spraints on

the basis of situation as much as from content, identification to species is perhaps inadvisable, and possible confusion could come from a number of other species including Fishing Cat *Prionailurus viverrinus*, Crab-eating Mongoose *Herpestes urva*, Indochinese Otter Civet *Cynogale lowei* (and even possibly fish-owls *Kettupa*). Data on spraint size, contents and situation would usefully be recorded.

#### *Viverra* and *Viverricula* Civets

Tracks probably not identifiable to species, and probably in some instances possibility for confusion with dogs.

Masked Palm Civet *Paguma larvata*, Small-toothed Palm Civet *Arctogalidia trivirgata*, Common Palm Civet *Paradoxurus hermaphroditus*, Binturong *Arctictis binturong*, Indochinese Otter Civet *Cynogale lowei*, Spotted Linsang *Prionodon pardicolor*, Owston's Palm Civet *Hemigalus owstoni*  
Prints of some possibly identifiable to species but only after careful study, also probably confusion possible with ferret badgers and Yellow-throated Marten.

#### Mongoose *Herpestes*

Tracks possibly identifiable to species, but a possibility for confusion with porcupines and maybe even some civets and ferret badgers.

#### Cats several genera

Tracks not identifiable to species, with the exception of Tiger (over 10 cm; size should be given) and perhaps Fishing Cat *Prionailurus viverrinus* (presence of claws). Other cat tracks are worth recording, sketching and including with measurements. The likelihood of sympatric species varying in size from Leopard Cat *Prionailurus bengalensis* to Tiger *Panthera tigris* in many areas and taking into account age related variation suggests that it is highly likely that there is a continuum of track sizes with considerable overlap in track sizes between similar sized congers.

#### Elephant *Elephas maximus*

Tracks, dung and feeding signs all unequivocal (except possibly in the presence of rhinoceros), but not distinguishable from domestic animals.

#### Pigs *Sus*

Tracks are not identifiable to species, but are in the large unequivocal of the presence of pigs. Heavy rooting signs are probably a clear indication of pigs, although Hog Badger probably make similar rootings. Farrowing nests also appear to be a clear sign for the presence of pigs.

#### Mousedeer *Tragulus*

Tracks and droppings should be identifiable, but not to species.

#### Larger deer *Cervus*, *Axis*

There is likely to be overlap in the characters of tracks and droppings between the species present, although there appears to be grounds for separating Sambar *Cervus unicolor* and Eld's Deer *Cervus eldi* (see Round 1998; none of the current authors have experience with the latter species); more data would be invaluable. There may be some potential for confusion between the largest muntjac and smallest Sambar tracks. A note to the effect of identification of signs of Sambar on the basis of location, range and habitat is essential.

#### Muntjacs *Muntiacus*, *Megamuntiacus*

Tracks and droppings are not identifiable to species, but are in the majority of areas unequivocal of the presence of muntjac. In certain habitats the presence of Eld's Deer *Cervus eldi* and Hog Deer *Axis porcinus* may be potential causes for confusion (the danger being overlooking these species rather than miss-identifying the presence of muntjac on the basis of signs from these species).

A PRELIMINARY ASSESSMENT OF THE CONSERVATION IMPORTANCE AND CONSERVATION PRIORITIES OF THE PHONG NHA-KE BANG PROPOSED NATIONAL PARK, QUANG BINH PROVINCE, VIETNAM

Specimen no.	Identification	Sex	Date	Net/trap site	Survey area	Kept at Harrison Zoological Museum, England	Kept at Xuan Mai, Hanoi University, Vietnam	Notes
PN-09-04	[ <i>Myotis formosus</i> ]	M	18-19/7	9	Len A	X		
PN-09-05	[ <i>Megarops niphanae</i> ]	F	18-19/7	9	Len A	X		
PN-09-06	[ <i>Rhinolophus rouxi/affinis</i> ]	M	18-19/7	9	Len A		X	
PN-09-07	[ <i>Rhinolophus rouxi/affinis</i> ]	F	18-19/7	9	Len A	X		
PN-09-08	<i>Rhinolophus pearsonii</i>	F	18-19/7	9	Len A		X	
PN-09-09	[ <i>Rhinolophus malayanus</i> ]	M	18-19/7	9	Len A	X		
PN-09-10	[ <i>Rhinolophus malayanus</i> ]	F	18-19/7	9	Len A	X		
PN-10-01	<i>Hipposideros larvatus</i>	F	19-20/7	10	Len A		X	
PN-10-02	<i>Hipposideros larvatus</i>	M	19-20/7	10	Len A		X	
PN-10-03	[ <i>Cynopterus sphinx</i> ]	F	19-20/7	10	Len A		X	Juvenile
PN-10-04	[ <i>Cynopterus sphinx</i> ]	F	19-20/7	10	Len A		X	Juvenile
PN-10-05	[ <i>Cynopterus sphinx</i> ]	F	19-20/7	10	Len A		X	Juvenile
PN-10-06	[ <i>Cynopterus sphinx</i> ]	F	19-20/7	10	Len A		X	Juvenile
PN-10-07	[ <i>Cynopterus sphinx</i> ]	M	19-20/7	10	Len A	X		
PN-10-08	<i>Megaderma spasma</i>	M	19-20/7	10	Len A	X		
PN-10-09	<i>Hipposideros armiger</i>		19-20/7	10	Len A	X		
PN-11-01	[ <i>Cynopterus sphinx</i> ]	F	20-21/7	11	Tra An		X	
PN-11-02	[ <i>Murina cyclotis</i> ]	M	20-21/7	11	Tra An	X		
PN-11-03	[ <i>Myotis silgorensis</i> ]	M	20-21/7	11	Tra An		X	
PN-11-04	[ <i>Myotis silgorensis</i> ]	M	20-21/7	11	Tra An	X		
PN-11-05	[ <i>Myotis ricketti</i> ]	M	20-21/7	11	Tra An	X		
PN-11-06	[ <i>Myotis silgorensis</i> ]	F	21-22/7	11	Tra An		X	
PN-12-01	<i>Scotomanes ornatus</i>	F	22-23/7	12	Tra An		X	
PN-12-02	[ <i>Cynopterus sphinx</i> ]	M	22-23/7	12	Tra An	X		
PN-12-03	[ <i>Megarops niphanae</i> ]	F	22-23/7	12	Tra An	X		Juvenile
PN-12-04	<i>Macroglossus sobrimus</i>	F	22-23/7	12	Tra An	X		
PN-13-01	[ <i>Myotis mystacinus/muricola</i> ]	M	23-24/7	13	Tra An	X		
KB-15-01	[ <i>Murina cyclotis</i> ]	M	2-3/8	15	Yen Hop forest	X		
KB-16-01	[ <i>Hipposideros lylei</i> ]	M	3-4/8	16	Yen Hop forest	X		
KB-16-02	<i>Rhinolophus luctus</i>	F	3-4/8	16	Yen Hop forest	X		
KB-16-03	[ <i>Hipposideros pratti lylei</i> ]	F	3-4/8	16	Yen Hop forest	X		
KB-17-01	<i>Rhinolophus pearsonii</i>	M	3-4/8	17	Yen Hop forest		X	
KB-17-02	<i>Rhinolophus luctus</i>	M	3-4/8	17	Yen Hop forest	X		
KB-18-01	<i>Scotomanes ornatus</i>	F	4-5/8	18	Yen Hop forest		X	
KB-19-01	[ <i>Myotis mystacinus/muricola</i> ]	M	5-6/8	19	Yen Hop forest		X	
KB-19-02	<i>Aselliscus stoliczkanus</i>	M	5-6/8	19	Yen Hop forest	X		
KB-19-03	<i>Aselliscus stoliczkanus</i>	M	5-6/8	19	Yen Hop forest	X		
KB-19-04	<i>Aselliscus stoliczkanus</i>	M	5-6/8	19	Yen Hop forest		X	
KB-19-05	[ <i>Rhinolophus subbadus</i> ]	M	5-6/8	19	Yen Hop forest	X		
KB-19-06	<i>Rhinolophus paradoxolophus</i>	M	5-6/8	19	Yen Hop forest	X		
KB-20-01	[ <i>Murina leucogaster</i> ]	F	7-8/8	20	Hoa Son forest	X		
KB-20-02	[ <i>Harpiocephalus harpia/mordax</i> ]	F	7-8/8	20	Hoa Son forest	X		
KB-23-01	<i>Scotomanes ornatus</i>	M	13-14/8	23	Hoa Son forest	X		
KB-23-02	[ <i>Rhinolophus malayanus</i> ]	M	13-14/8	23	Hoa Son forest	X		
KB-24-01	[ <i>Myotis mystacinus/muricola</i> ]	F	14-15/8	24	Hoa Son forest		X	
KB-24-02	[ <i>Miniopterus schreibersii</i> ]	F	14-15/8	24	Hoa Son forest		X	
KB-24-03	[ <i>Miniopterus schreibersii</i> ]	M	14-15/8	24	Hoa Son forest	X		
KB-24-04	<i>Rhinolophus pearsonii</i>	M	14-15/8	24	Hoa Son forest		X	
KB-25-01	[ <i>Myotis mystacinus/muricola</i> ]	M	15-16/8	25	Hoa Son forest	X		
KB-26-01	[ <i>Hipposideros pomona</i> ]	M	16-17/8	26	Hoa Son forest	X		



Specimen no.	Identification	Sex	Date	Net/trap site	Survey area	Kept at Harrison Zoological Museum, England	Kept at Xuan Mai, Hanoi University, Vietnam	Notes
B-27-01	[ <i>Myotis daubentonii/horsfieldii</i> ]	M	17-18/8	27	Hoa Son village	X		
B-27-02	[ <i>Myotis daubentonii/horsfieldii</i> ]	M	17-18/8	27	Hoa Son village	X		
B-27-03	[ <i>Rhinolophus rouxii/affinis</i> ]	M	17-18/8	27	Hoa Son village	X		
B-29-01	[ <i>Pipistrellus pulveratus/ceylonicus</i> ]	M	19-20/8	29	Hoa Son village Hoa Son village		X	
B-29-02	[ <i>Pipistrellus pulveratus/ceylonicus</i> ]	M	19-20/8	29	Hoa Son village		X	
B-29-03	[ <i>Rousettus leschenaultii</i> ]	M	19-20/8	29	Hoa Son village		X	
B-29-04	[ <i>Pipistrellus pulveratus/ceylonicus</i> ]	M	19-20/8	29	Hoa Son village	X		
B-29-05	[ <i>Pipistrellus pulveratus/ceylonicus</i> ]	F	19-20/8	29	Hoa Son village	X		
B-29-06	<i>Hipposideros armiger</i>	F	19-20/8	29	Hoa Son village		X	

# ANNEX 9: SUMMARY OF MEASUREMENTS OF BATS

Table 11. Summary of main measurements of bats captured during the survey.

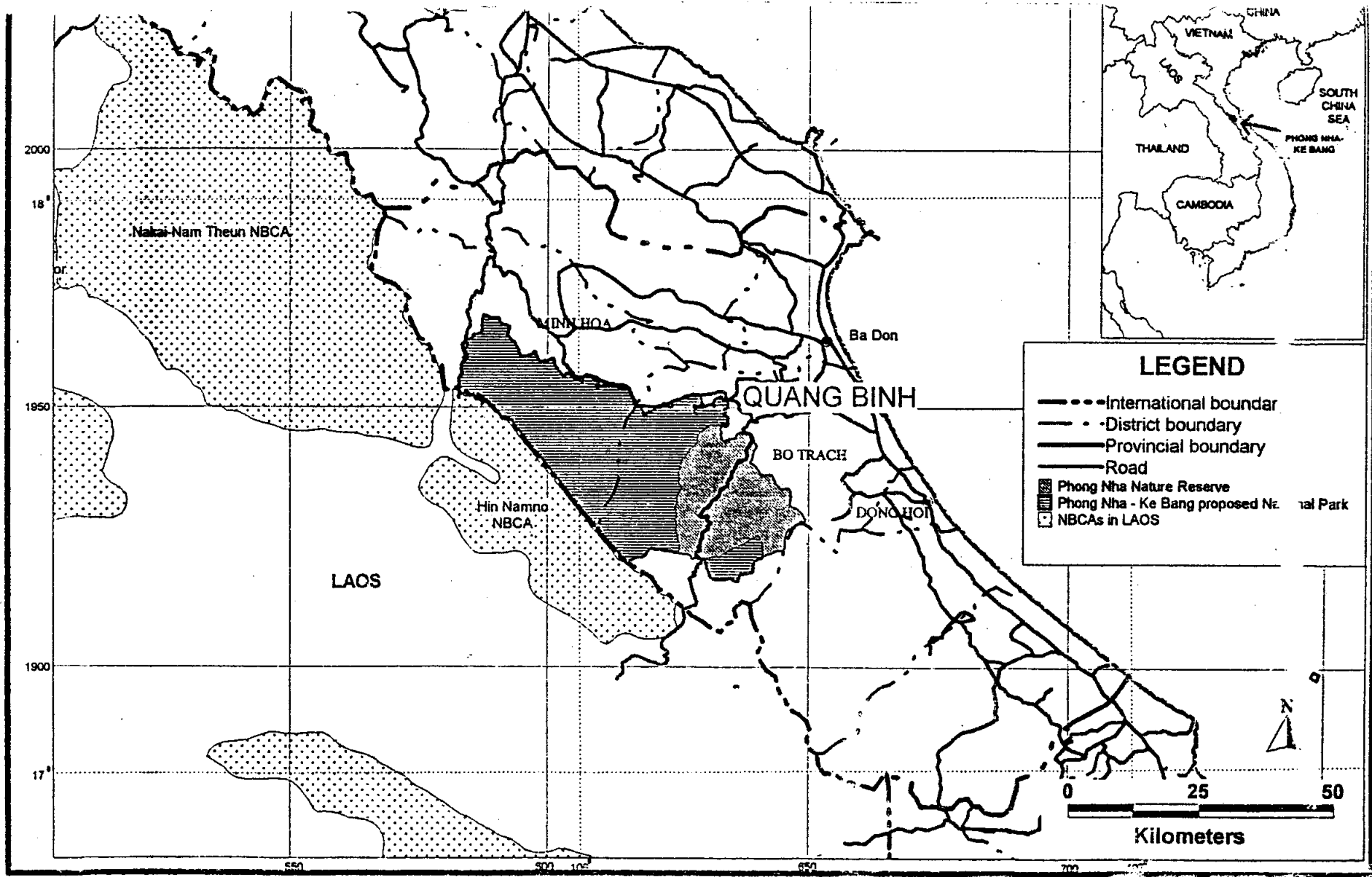
The means are based on both specimens and on individuals released after measuring.

Species	Sex	Mean (mm)	Forearm SD	Range (mm)	N	Mean (mm)	Weight SD	Range (mm)	N	
Pteropodidae	[ <i>Rousettus leschenaulti</i> ]	M	73.5							
		F	81.00	1.12	(73.5)	1	53*			
	[ <i>Cynopterus sphinx</i> ]	M	71.72	1.94	(79.8-82.6)	6		(53)	1	
		F	70.17	2.09	(68.9-73.9)	5	45.40*	8.73	(35-57)	5
		F(Preg.)			(67.3-74.2)	9	36.80*	4.60	(31-42)	5
	[ <i>Megarops niphanae</i> ]	F(Juv.)	68.28	4.29	(63.1-74.4)	6	57.00*	3.46	(53-59)	3
		F	56.9		(56.9)	1	32.37*	6.44	(25.6-38)	6
	[ <i>Eonycteris spelaea</i> ]	F(Juv.)	55.1		(55.1)	1				1
	[ <i>Macroglossus sobrinus</i> ]	M	67.20	7.07	(62.2-72.2)	2	20.40		(20.40)	2
		M	47.15	1.63	(46.0-48.3)	2	41.50*	17.68	(29-54)	2
		M(Juv.)	43.0		(43.0)	1	22.20*	7.35	(17-27.4)	3
		F	48.50	2.12	(47.0-50.0)	2	13.8		(13.8)	1
						26.70	1.84	(25.4-28.0)	2	
Megadermatidae	<i>Megaderma spasma</i>	M	60.0		(60.00)	1	13.0		(13.0)	1
	<i>Megaderma lyra</i>	M	67.83	1.90	(65.4-70.4)	8	38.33*	7.84	(31-51)	6
		F	68.42	1.68	(66.8-70.3)	5	42.75*	0.50	(42-43)	4
Rhinolophidae	<i>Rhinolophus luctus</i>	M	74.60	0.71	(74.1-75.1)	2	32*			
		F	77.4		(77.4)	1	36*		(32)	1
	<i>Rhinolophus paradoxolophus</i>	M	63.0		(63.0)	1			(36)	1
	<i>Rhinolophus pearsonii</i>	M	51.66	1.17	(49.4-53.1)	8	8.6		(8.6)	1
		F	52.30	1.77	(50.7-54.2)	3	10.80	1.47	(9.1-12.6)	8
	[ <i>Rhinolophus subbadius</i> ]	M	34.3		(34.3)	1	13.07	0.70	(12.4-13.8)	3
	[ <i>Rhinolophus malayanus</i> ]	M	44.75	0.82	(43.3-45.6)	8	3.0		(3.0)	1
		F	44.00	0.44	(43.5-44.3)	3	7.70	1.06	(6.8-9.0)	5
	[ <i>Rhinolophus rouxii/affinis</i> ]	M	51.20	0.50	(50.7-51.8)	4	7.95	0.49	(7.6-8.3)	2
		F	50.01	1.22	(47.9-51.8)	7	13.65	1.48	(12.6-14.7)	2
						13.08	1.49	(11.6-15.0)	5	
Hipposideridae	[ <i>Hipposideros pomona</i> ]	M	42.9		(42.9)	1	5.7		(5.7)	1
	[ <i>Hipposideros pratti</i> ]	M	84.1		(84.1)	1	30*		(30)	1
	[ <i>Hipposideros lylei</i> ]	M	79.6		(79.6)	1	45*		(45)	1
	[ <i>Hipposideros pratti/lylei</i> ]	F	79.60	1.27	(78.7-80.5)	2	42*		(42)	1

Species	Sex	Mean (mm)	SD	Range (mm)	N	Mean (mm)	SD	Range (mm)	N
<i>Hipposideros armiger</i>	M	91.88	2.86	(85.5-99.8)	29	46.87*	9.78	(31-62)	23
	F	57.19	1.57	(53.2-60.1)	20	14.75*	3.07	(11-22)	20
<i>Aselliscus stoliczkanus</i>	M	43.20	0.82	(42.3-43.9)	3	4.70	0.56	(4.2-5.3)	3
<b>Vespertilionidae</b>									
<i>Myotis chinensis</i>	M	67.55	1.58	(65.3-69.0)	4	30.50*	6.45	(21.0-35)	4
	F	70.55	1.63	(69.4-71.7)	2				
[ <i>Myotis siligorensis</i> ]	M	31.47	0.90	(30.2-32.7)	9	3.13	0.22	(3.0-3.4)	5
	F	32.00	0.87	(31.4-33.0)	3	4.05	0.49	(3.7-4.4)	2
[ <i>Myotis mystacinus/muricola</i> ]	M	34.43	1.83	(32.7-38.0)	6	3.22	0.99	(2.0-4.4)	6
	F	34.55	1.77	(32.6-36.8)	4	3.40	0.57	(3.0-4.4)	3
[ <i>Myotis daubentonii/horsfieldii</i> ]	M	35.75	1.48	(34.7-36.8)	2	6.70	0.81	(6.2-7.2)	2
[ <i>Myotis ricketti</i> ]	M	54.08	1.38	(52.5-56.0)	5	16.27	0.81	(15.4-17.0)	3
<i>Scotomanes ornatus</i>	M	55.4		(55.4)	1				
	F	58.18	1.52	(56.1-59.7)	4	26.50*	0.58	(26-27)	4
<i>Ia io</i>	M	77.40	1.75	(74.4-80.3)	12	50.18*	8.73	(41-66)	11
	F								
[ <i>Pipistrellus ceylonicus/pulveratus</i> ]	M	34.30	1.43	(32.5-35.8)	4	4.40	1.15	(3.0-5.8)	4
	F	34.73	1.07	(33.8-35.9)	3	5.70	0.62	(5.4-6.0)	3
[ <i>Miniopterus schreibersii</i> ]	M	48.8		(48.8)	1	13.1		(13.1)	1
	F	50.2		(50.2)	1	13.1		(13.1)	1
[ <i>Murina leucogaster</i> ]	F	38.3		(38.3)	1	9.0		(9.0)	1
[ <i>Murina cyclotis</i> ]	M	31.90	2.83	(29.9-33.9)	2	5.10	0.71	(4.6-5.6)	2
[ <i>Harpiocephalus mordax</i> ]	F	53.9		(53.9)	1	23.8		(23.8)	1
[ <i>Harpiocephalus harpia</i> ]	M	48.5		(48.5)	1				

<sup>1</sup> The weight of the pregnant *Cynopterus sphinx* are included separately. Their forearm measurements are included together with the non-pregnant females.

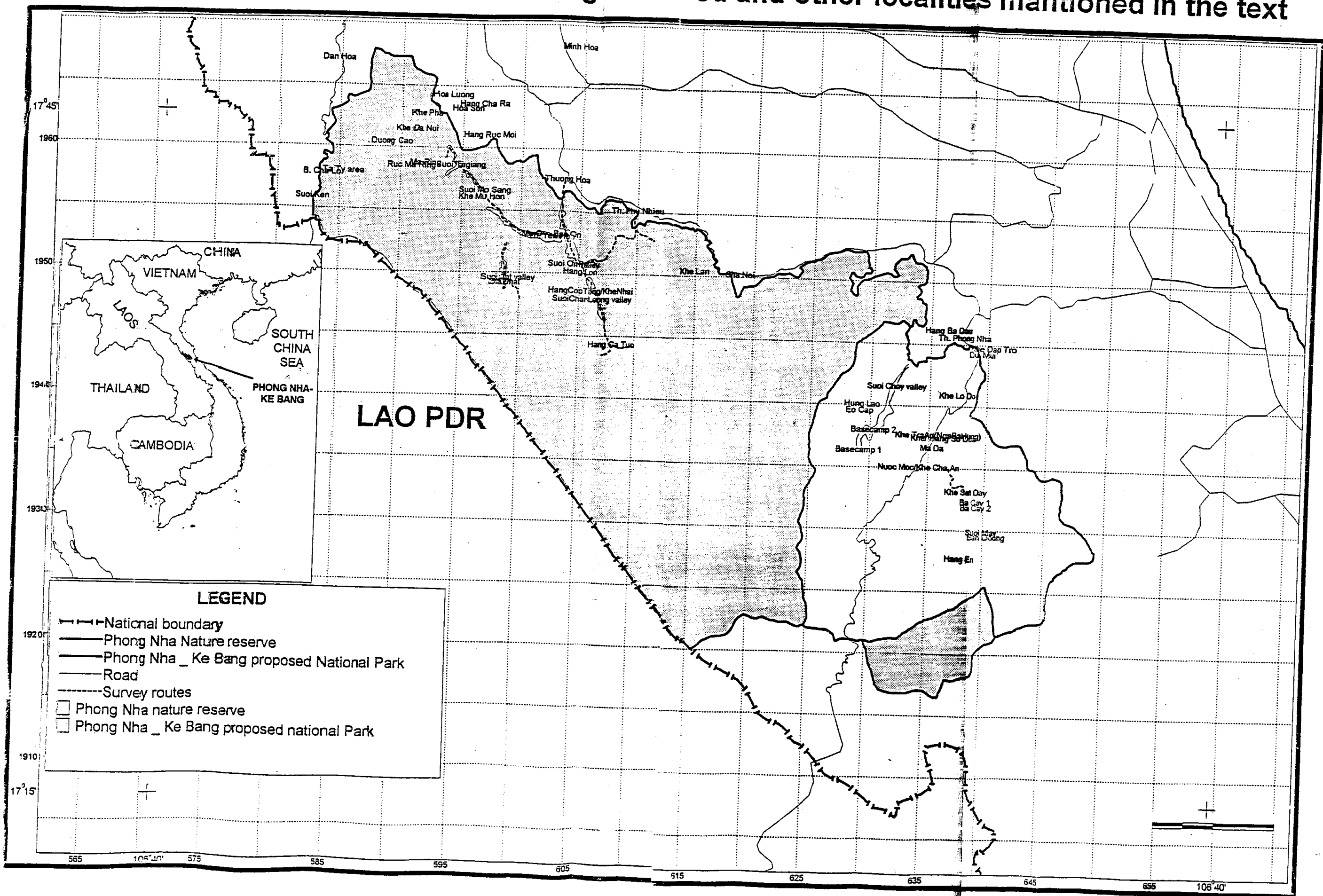
\* Means based on approximate measurements.



Map projection: UTM, Unit: km, Spheroid: Everest

Scale: 1:1,000,000

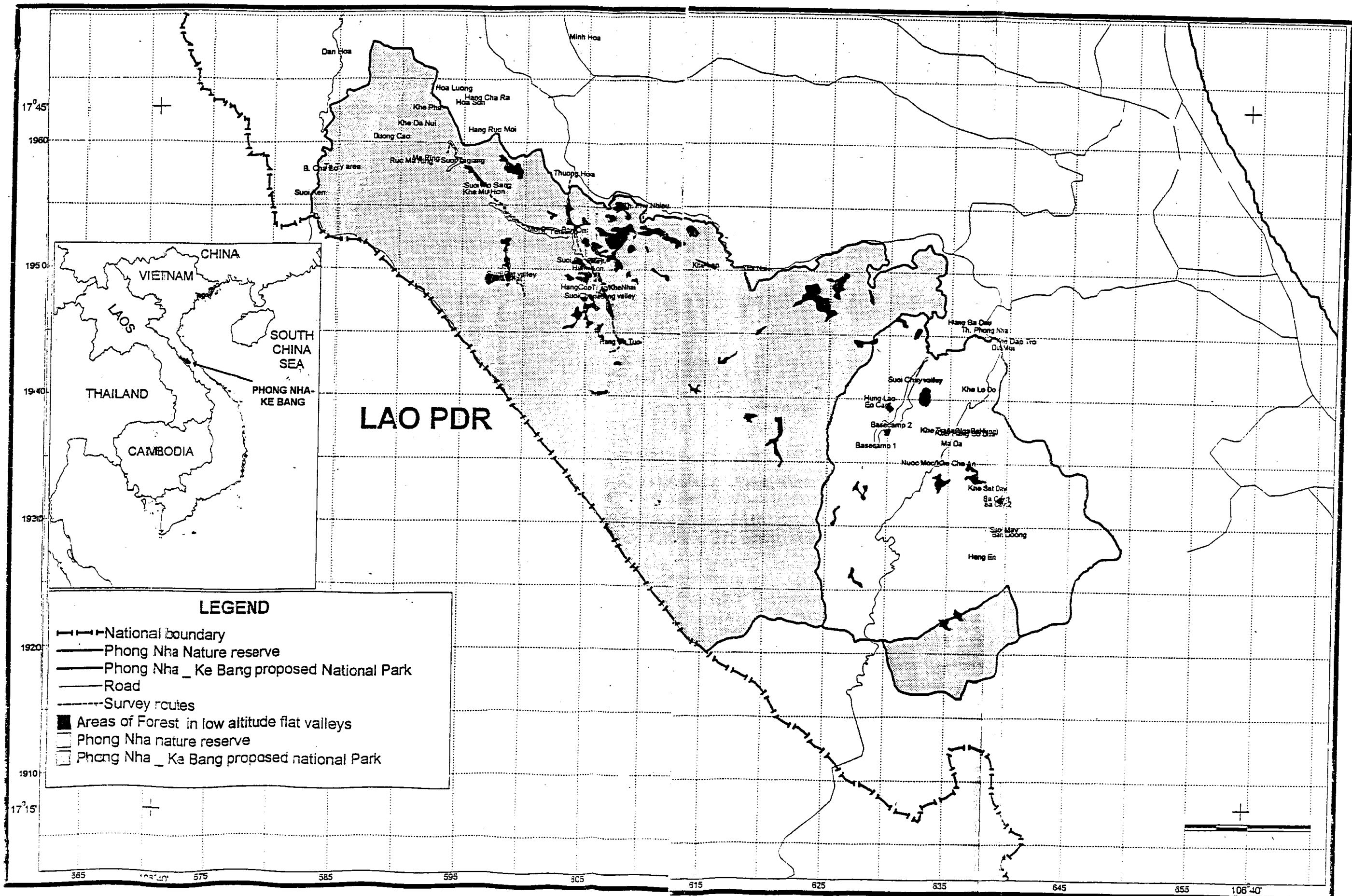
Figure 2: Area of Phong Nha - Ke Bang surveyed and other localities mentioned in the text



Map projection: UTM, Unit: km, Spheroid: Everest

Scale: 1 : 280,000

Figure 3: Known and probable areas of forest in low altitude flat valleys



**LEGEND**

- +—+— National boundary
- Phong Nha Nature reserve
- Phong Nha - Ke Bang proposed National Park
- Road
- Survey routes
- Areas of Forest in low altitude flat valleys
- Phong Nha nature reserve
- Phong Nha - Ka Bang proposed national Park

Map projection: UTM, Unit: km, Spheroid: Everest

Scale: 1 : 280,000



**VIETNAM-RUSSIAN TROPICAL CENTRE  
WORLD WIDE FUND FOR NATURE  
ACTION GRANT**



**RESULTS OF THE COMPLEX  
ZOOLOGICAL-BOTANICAL EXPEDITION  
TO THE KE BANG AREA**

**FINAL REPORT**

**(Survey March 14 - May 01, 1999)**

**Hanoi  
September 1999**

## INTRODUCTION

It is quite evident that a study of the biological diversity of some region is but the first, though self-dependent, stage of investigations. This stage permits to get the principle knowledge about floristic and faunistic richness of different landscape units. Besides that, to compose the taxonomic list of plants (on specific or, that is more common for tropics, on generic level) implies carrying out the determined volume of researches in fixed terms. Usually work is performed in safe terms for investigators (taking into account danger of malaria, and out of the rainy season etc.). And often namely the time limits prevent to embrace all the information volume of the environment. Mainly common, that is the most frequently met, taxonomic units (species) are revealed and identified. After experience of our work in tropics we know that the ability to get abstracted from background information begins to work after 10-15 days of itinerary investigations of any concrete territory. The higher is the informational volume of the environment, and in the first turn the diversity and mosaic pattern of biotopes, the more long period is demanded for the investigator for his getting used to the situation. It is very important that the periods of researches should coincide with the most significant plants' phenophases. For example, the massive flowering and fruiting of many trees fall on the termination of the dry season and the beginning of the damp one. Some species make an exception to this rule. The spring time is the season of nest for aboriginal species, but at the same time that's the period of migrations of northern species, whose quota in the resulting faunistic list may be quite noticeable. Observing birds in trees canopy is a rather difficult task especially when the height of trees is close to 35-40 m, and visual contact (with the help of binoculars) with observed subjects doesn't last more than 3-20 seconds. More over birds usually move quickly and hide themselves behind tree leaves and branches. On that reason many birds inhabiting tree tops may be observed but once. Certainly its own specificity and difficulties have as well observations of some other groups of living organisms. So small terrestrial mammals (forest rats) are usually not numerous under the cover of the primary tropical forest. Their number may fall up to 1 specimen for 1 ha of the forest area, but rises by 1-2 orders in some other territories as overgrown cleared spaces etc. where species characteristic for those territories and particular forest species may be met.

Knowledge about tropical forests is still very scarce, and often the disappearance of forests occurs ahead of their study (even on the level of primary data). Hence any trustworthy materials gathered in time are extremely important. Especially precious are results represented in the form of species-descriptive articles, that fill up concrete materials on the spe-



cies biology. This kind of works as a rule appear when expedition investigations pass to the plane of the stationary ones. For this purpose it is necessary to work out on the determined territory for 3-4 field seasons of 50-60 days each. In the present time it have been made only on the south of Vietnam in the lowland dipterocarpus forests of massive Ma Da. Ornithological investigations are conducted for many years in Cat Tien during the dry season.

Composition of species-descriptive lists is a somehow diagnostic key for the environment. On materials of these lists a specialist having an experience of work in the given region is capable to apprehend the real state of the territory. As far as among the organisms really exist those inhabiting the narrow limits of environment conditions (stenobionts) the presence in the lists even a few such taxons indicates quite determined conditions peculiar for those habitats. A specialist has to make an attempt to estimate specificity of conditions of plants' and animals' living in forests. It is also evident that the informativity of the list (number of taxons) depends on the total quantity of observation time spent on the given territory as well as on specificity of studied subjects. On the base of our own experience it may be noted that while working in some new uninvestigated regions the first 3-7 days appear to be of low outcome (few background species observed) or, on the contrary, are rich on the meetings with extremely rare species. However in most cases the success is prepared and suddenly a sensation comes of gathering some critical mass of information after which a break-through occurs and new species are as though identified by themselves and their number increases. In methodological way it's interesting what number of birds, mammals, insects or plants are identified by corresponding specialist in a short lapse of time or in what measure a good luck accompanies him. One successful day should permit «to close» a lot of «gaps» in determination of the taxonomic status of the species and solving some other important problems. And together with this a scientific intuition as a derivative of the personal experience has a great significance. An investigator knows what facts ought to be paid attention to in the first turn.

Besides the experience and a good luck a friendly scientific cooperation in an expedition team appears to be as well an important condition of successful work. And so it is for common making up the collections, when an ornithologist does not lose the chance to pick up leaves, flowers and fruits of some unknown plant, and the botanists assiduously register birds' nests and note «strange» birds from their point of view. That's why words of gratitude to the fellow-workers sound as an estimation of their real investment in your own work.

Zoo-botanical investigations aiming to study biodiversity on territories occupied with primary tropical forests are undoubtedly very important and actual. The priority by right belongs to profound researches directed towards studying biological peculiarities of organisms, but which may be conducted only on really protected areas. The most important task – protection of plants' habitats – biotopes as components of a landscape, as well as plants themselves – the main environment-making factor in forestry ecosystems.

We state, that results obtained by qualified specialists even on the stage of data handling of primary basic information on the tropical forests (including publication of primary field materials) is the foundation for proceeding of ultimate profound researches and also for adopting of corresponding organisational decisions, that are extremely needed and important in actual time.

## RESULTS OF BOTANIC INVESTIGATIONS

Conducted by Andrei N. Kouznetsov, Phan Luong

### METHODS OF GEOBOTANIC INVESTIGATIONS

The investigations were carried out on forestry plots around the base camp (in the period from the 17th up to the 31st of March and from the 21st up to the 30th of April) as well as around the temporary forestry camp – from the 1st up to the 21st of April.

The main aim of our works consisted in revealing of species composition in forestry plants and structural organization of different phytocenoses.

Investigations were conducted on the walking routes, mean daily length of which was 4-6 km, maximum – 12 km. Mountain relief impeded and limited significantly any displacement.

Walking routes from the base camp ran along the river valley (including environs of remote villages Ma Ma and Mo) as well as in directions of the road N15, town Minh Hoi and to crests, surrounding the valley, where the river runs, and some neighbor crests and valleys. Description of the plants was executed on temporary sample plots measuring 5 x 5 m (for grasses), 20 x 20 m and 40 x 40 m (for trees), and also on some separate sections of walking routes. Before choosing the plots the territory was thoroughly inspected to reveal the presence of different biotopes. On prolonged walking routes passing along temporary river beds, plane territories of valley forests, hunters' paths, over rocks and crests we revealed and mapped (with the help of GPS) the most representative forestry plots. Long walking routes, as we have found, help to reveal the main species composition in plants and in the first turn that of trees and lianas, existing in conditions peculiar for every landscape. Aims of less prolonged walking routes with more detailed study of biotopes consisted in revealing of typical and rare plant species. After summarizing of picked up general evidences about the landscape, hydrological and edaphic conditions of the territory, species diversity in different forestry plots some parts of the forest were chosen for more thorough geobotanic researches. Then it was estimated in what measure those sampling plots reflect the specificity of tree groups in their species composition (together with lianas and epiphytes), their morphological and structural particularities.

We performed a description of trees in a valley (flooded) forest, on gentle and steep slopes, on interior mountain crests with not predominant heights and on the main ridges. When describing trees we defined the taxonomic characteristics of plants: trees and herbs (including epiphytes) to genus, sometimes to species; lianas - chiefly to family or genus. The list of the plants is mentioned below.

There was defined a height (H) for trees in meters, diameter of trunks on the height of the chest (1.3 m) (D) in centimeters, height of the beginning of crown (H of crown) in meters, radius of crown (R of crown) in meters; also it was sketchily fixed a shape of crown, presence of buttress and their parameters: height in meters, length in meters, thickness in centimeters, indicated phenological phase (falling of old leaves and appearance of new ones, blossoming, fructification), state of a tree, including mechanic injuries, carves in the trunk, dry branches in the crown, fruit bodies of polypores on the trunks and on the buttress. Presence of plants-epiphytes on the trunk and crown was indicated.

When defining of taxonomic characteristic of the trees the following signs were taken into consideration: height of a tree, peculiarities of the basal part of the trunk (presence of stilt roots, their number and degree of their development), color and relief of the surface of bark, shape of the crown, character of branching. With binoculars we discerned leaves, flowers, and fruits in the crown, correlated them with those in the leaf litter measuring parameters of the first ones and marking color of the first ones.

Using a machete or a large knife we would make a section of bark downwards to the beginning of layers of timber, marking color of the fresh section, speed of changing of its color, picture on the section, color and smell of the juice pouring out. Sections on the trunk were performed above or between buttress. The section made on buttress is less informative since it is usually lighter in colors.

The reliable main signs of the bark section are characteristic for the trees of fam. Fagaceae, Rosaceae (*Pygeum*), Lauraceae, Sapotaceae, Ebenaceae, Burseraceae, Annonaceae, Apocynaceae, Myristicaceae, Moraceae, Juglandaceae, Clusiaceae, separate representatives of fam. Euphorbiaceae; lianas of Menispermaceae, Annonaceae, Connaraceae, Apocynaceae, Asclepiadaceae, Moraceae fam. By exterior signs of trunk the trees of the following fam. differ firmly: Dipterocarpaceae, (only gen. *Dipterocarpus*), Sterculiaceae, Sapindaceae, Meliaceae, Elaeocarpaceae, Magnoliaceae, Annonaceae, Clusiaceae, Myrsinaceae, Myristicaceae, Fagaceae, Fabaceae, Rubiaceae and some others; the lianas of fam. Fabaceae (especially of gen. *Entada*, *Bauhinia*), Annonaceae, Gneta-

ceae, Smilacaceae, Loganiaceae, Simaroubaceae, Menispermaceae, Ancistocladaceae, Combretaceae and others.

With the help of binoculars it was marked the presence of the epiphyte vegetation on trunks and crowns of trees. It was marked for herbs height, projective cover, phenological phase.

Collecting of plants for the further herbarization was fulfilled in the limited volume, as their drying in the wood camp, under conditions of a high humidity was extremely difficult and could be possible only when hanging up above the permanently burning camp-fire.

Samples of plants were packed in the thick polyethylene bags, upon the arriving in Hanoi were kept in a refrigerator, then were unpacked and dried under laboratory conditions. Doing herbarium like this have been repeatedly tried, what allows to keep cut branches of trees and lianas in appropriate conditions to make a herbarium within 5-7 days.

The following editions as defining and reference literature were used: (see lower-Reference).

On the routes and trial squares it was carried out a detailed photo and video shooting as well of elements of landscape as of separate plants. Here it should be noted that high humidity of air exert extremely adverse influence on working of photo and video cameras. On rainy days video shooting was impossible. Video shooting was fulfilled with the amateur camera Sony-CCD-TR 730E; the film Sony-P6-120MP3 was usually used. The reliable work of the cameras under the most complex conditions really deserves praising words. Within all the time of the expedition it was shot about 7 hours of the film (duplicates were sent to WWF). Photo works were made with the cameras Canon-N-90 and Ricoh-XR-10. The film Fujicolor - ACE 400, the slide one - Konica-R-100.

To study forest soils in various biotopes there were made soil digging up with depth up to 50-60 cm. Besides it was carried out the analysis of the sides of temporary streams, specially cleaned up. Soil horizons were described in details according to the accepted scheme: color, structure, mechanic composition, presence of implementations, thickness of the root-containing layer.

## RESULTS

The Table 1 comprises a taxonomic list of the higher plants, marked on the territory inspected. It is necessary to stipulate that the results obtained we regard as the preliminary ones. Within that short period of the field works under conditions of the complex relief, se-

were everyday conditions of the forest camp (in particular, lack of water) did not allow to cover completely a species variety of the plant of the Ke Bang limestone massif.

The specific relief of limestone cliff outlets - namely extended ridges of various heights - forms a huge variety of biotopes of different species capacity. On this account, at the same time as a biologic diversity of the Ke Bang tract it is necessary to speak about diversity of habitats there.

The route explorations allowed to discern the following main plant formation:

- Forests that were formed on the relatively smoothed areas of inter-mountain valleys. The relief of such areas is gently wavy, with island outlets of limestone rocks and massive crater-shaped depressions. There is a well-developed hydrologic network, presented basically by temporary streams with the beds of those reaching the width 2-8 m. The square of such valleys (smoothed areas) is extremely various, from tens of square meters to several hectares.

According to our preliminary assessments the valley forest occupied 20-30% of the whole square of the territory:

- Forests formed on the gentle slopes - resembling those of the valley territories and therefore joined with them in the further examination;
- Forests formed on the steep stony slopes. Side by side with those not great in square (20-100 m<sup>2</sup>) smoothed terraced areas with formed argillaceous soils, the main square of slopes is presented by the large (1-3 m<sup>2</sup>) and small (to 0.3 m<sup>2</sup>) disintegrated limestone material, where the soil is absent. Surface of the stones is excavated that facilitate further retention and accumulation of vegetable litter (branches, leaves, flowers) and moisture. The water of an atmospheric precipitation is kept in hollows of the stones for several days (until next rain). On the slopes, especially at the foot of the mountain ranges there is formed a specific microclimate - an air is nearly still with the humidity approximated to 100%.

The enumerated plant formations occupy about 40% of the territory.

- Forests on the ridges of the main mountain ranges with height about 300-500 m and width of ridges from 1 to 20 m. Soil is not formed, the trees grow on rock grounds. Root systems of trees are superficial, some of the roots go down the cracks between the stones. On the surface of stones a vegetable litter is accumulated; in the cracks and depressions poor but well structured black soils are gradually formed. The trunk of the trees are curved with the crowns low bent. The specificity of microclimate: a strong insolation and a wind influence, the considerable temperature overfalls, fogs and an

abundant fall out of dew. The plant formations on the mentioned areas occupy supposedly 20-30% of the territory.

It is important to note that the greatest variety of biotopes is characteristic for slopes. Diverse areas of slopes differ in humidity of air and substratum, thickness of soil, screening ability against the predominant winds and solar rays, in other indices. So, under conditions of the utter screening ability against winds, of a high humidity of air and substratum, of lighting by the sun only for few midday hours there grow the specific species of plants - mainly herbs of fam. Begoniaceae, Balsaminaceae, Piperaceae, Araceae, Orchidaceae.

Basing on the results of the observations carried out, we propose to mark out the following principle landscape subdivisions of the territory Ke Bang with large square and composition of plants:

- valley Yen Khop and valley woods beyond the village Mo (occupy a special (detached) position);
- the smoothed (valley) areas, lifted on different heights, located among the mountain ranges and shielded from the predominant winds respectively, and also the gentle argillaceous slopes at the foot of the mountain ranges, smoothly shifted to the valley forests (30%, possibly 40% of the territory); steep stony slopes, shielded to a different extent with length 200-400 m, with small terraces (supposedly 40-50% of the territory);
- ridges and solitary peaks of the main mountain ranges with heights up to 500 m above sea-level (20-30% of the territory).

## List of plant species

Table 1

Key habitat and key words: lowland primary forest - l.f.; destroyed forest - d.f.; mountain slopes - sl.; roads; paths; river; edges; gaps; living forms - tree(t), herb(h), liana(l), epiphyt(ep), semiepiphyt(sp), parasit(p). Status-rare(r).

N	Name	Living Form	Habitat	Status
1	2	3	4	5
	Aspleniaceae			
1	<i>Asplenium nidus</i>		l.f., sl.	
2	<i>A. tenerum</i>		l.f., sl.	
3	<i>A. cf. ensiforme</i>		l.f., sl.	
	Blechnaceae			
4	<i>Blechnum cf. Orientale</i>		sl.	
5	<i>Woodwardia sp.</i>		sl.	
	Cyatheaceae			
6	<i>Alsophila sp.</i>		l.f.	
7	<i>Cyathea sp.</i>		l.f.	
	Dryopteridaceae			
8	<i>Rumohra diffracta</i>		l.f.	
9	<i>Cyclosorus spp.</i>		s.f.	
	Gymnogrammeaceae			
10	<i>Adiantum sp.</i>		sl., l.f.	
11	<i>Coniogramme sp.</i>		sl., l.f.	
12	<i>Notholaena cf. velutina</i>		sl., l.f.	
	Hymenophyllaceae			
13	<i>Hymenophyllum sp.</i>		l.f.	
	Lycopodiaceae			
14	<i>Lycopodium cf. squarrosum</i>		sl., l.f.	
15	<i>L. cf. squarrosum</i>		p.f.	
	Lygodiaceae			
16	<i>Lygodium microphyllum</i>		sl.	
17	<i>L. auriculatum</i>		sl.	
18	<i>L. conform</i>		sl.	
	Marattiaceae			
19	<i>Angiopteris cf. cochinchinensis</i>		l.f.	
20	<i>Angiopteris sp.</i>			



1	2	3	4	5
	Polypodiaceae			
21	<i>Colysis longisora</i>		l.f.	
22	<i>Drynaria sp.</i>		l.f.	
23	<i>Phymatodas spp.</i>		l.f.	
24	<i>Pyrrosia spp.</i>		l.f., sl	
25	<i>Polypodium cf. argutum</i>		l.f., sl	
	Psilotaceae			
26	<i>Psilotum nudum</i>		sl.	
	Pteridaceae			
27	<i>Histiopteris incisa</i>		sl., l.f.	
28	<i>Pteridium aquilinum</i>		sl., l.f.	
29	<i>Pteris spp.</i>		sl., l.f.	
	Selaginellaceae			
30	<i>Selaginella spp.</i>		sl., l.f.	
	Vittariaceae			
31	<i>Vittaria sp.</i>		sl.,	
	<u>Gymnospermatophyta</u>			
	Gnetaceae			
32	<i>Gnetum sp.</i>		l.f.	
	Podocarpaceae			
33	<i>Dacrydium pierrei</i>		edges	
34	<i>Nageia cf. Fleuryi</i>		edges	
35	<i>Podocarpus imbricatus</i>		edges	
36	<i>P. cf. neriifolius</i>		edges	
37	<i>P. cf. pilgeri</i>		edges	
	Angiospermatophyta			
	Acanthaceae			
38	<i>Justicia spp.</i>		sl., l.f.	
39	<i>Strobilanthes spp.</i>		sl., l.f., roads	
40	<i>Thunbergia sp.</i>		roads	
	Aceraceae			
41	<i>Acer cf. Calcaratum</i>		sl.	
42	<i>Acer cf. Decandrum</i>		sl.	
43	<i>Acer sp.</i>		sl.	
	Anacardiaceae			
44	<i>Dracontomelum sp.</i>		p.f.	
45	<i>Mangifera cf. Foetida</i>		sl., l.f.	

1	2	3	4	5
	Ancistrocladaceae (lian)			
46	<i>Ancistrocladus cf. cochinchinensis</i>		l.f.	
	Annonaceae			
47	<i>Alphonsea sp.</i>		sl., l.f.	
48	<i>Artabotrys sp.</i>		sl., l.f.	
49	<i>Dasymaschalon sp.</i>		sl., l.f.	
50	<i>Desmos chinensis</i>		sl., l.f.	
51	<i>Fissistigma sp.</i>		sl., l.f.	
52	<i>Goniothalamus sp.</i>		sl., l.f.	
53	<i>Mitrephora cf. thorelii</i>		l.f., sl.	
54	<i>Polyalthia spp.</i>		sl., l.f.	
55	<i>Uvaria sp.</i>		sl., l.f.	
	Amaranthaceae			
56	<i>Amaranthus spp.</i>		roads	
	Apocynaceae			
57	<i>Strophantus sp.</i>		sl.	
58	<i>Tabernaemontana cf. laotica</i>		p.f.	
59	<i>Wrightia sp. 1</i>		edges	
60	<i>Wrightia sp. 2</i>		sl., l.f.	
	Araliaceae			
61	<i>Aralia cf. Chinensis</i>		sl., d.f.	
62	<i>Shefflera sp.</i>		epiph, l.f.	
63	<i>Trevesia sp.</i>		sl., l.f.	
	Asclepiodaceae			
64	<i>Hoya spp.</i>		sl., edges	
	Asteraceae			
65	<i>Bidens sp.</i>		roads, d.f.	
66	<i>Blumea sp.</i>		roads, d.f.	
67	<i>Conyza canadensis</i>		roads	
68	<i>Eupatorium sp.</i>		roads, d.f.	
	Balsaminaceae			
69	<i>Impatiens sp. 1</i>		edges	
70	<i>Impatiens sp. 2</i>		sl., stem	
	Begoniaceae			
71	<i>Begonia sp. 1</i>		edges	
72	<i>Begonia spp.</i>		sl.	

1	2	3	4	5
	Burseraceae			
73	<i>Canarium spp.</i>		l.f.	
74	<i>cf. Bursera</i>		sl.	
75	<i>cf. Dacryodes</i>		sl., l.f.	
	Capparaceae			
76	<i>Capparis sp.</i>		l.f.	
77	<i>Crateva sp. (cf. unilocularis)</i>		river	
	Caprifoliaceae			
77	<i>Sambucus cf. Eberhardtii</i>		roads, d.f.	
	Cecropiaceae			
78	<i>Poikilospermum sp.</i>		l.f.	
	Connaraceae			
79	<i>Connarus paniculatus</i>		l.f., sl. (lian)	
80	<i>Rourea spp.</i>		l.f., sl. (lian)	
81	<i>Agelaea sp.</i>		l.f., sl. (lian)	
	Convolvulaceae			
82	<i>Argyreia spp.</i>		l.f., sl.	
	Cucurbitaceae			
83	<i>Hodgsonia sp.</i>		sl.	
84	<i>Trichosantes sp.</i>		sl.	
85	<i>Melothria cf. Heterophylla</i>		gaps	
	Datyscaceae			
86	<i>Tetrameles nudiflora</i>		l.f.	
	Dipterocarpaceae			
87	<i>Dipterocarpus cf. kerry</i>		l.f.	
88	<i>Hopea sp.1</i>		l.f., sl.	
89	<i>Hopea sp.2</i>		l.f., sl.	
	Dilleniaceae			
90	<i>Tetracera cf. Scandens</i>		l.f., sl.	
	Ebenaceae			
91	<i>Diospyros sp. 1</i>		sl.	
92	<i>Diospyros sp. 2</i>		l.f.	
93	<i>Diospyros sp. 3</i>		edges	
	Elaeocarpaceae			
94	<i>Elaeocarpus laoticus</i>		sl., l.f.	
95	<i>E. varunua</i>		l.f.	

1	2	3	4	5
96	<i>Elaeocarpus</i> spp.		sl., l.f.	
97	<i>Elaeocarpus</i> cf. <i>hamandii</i>		sl., l.f.	
98	<i>Sloanea</i> sp.		l.f.	
	Ericaceae			
99	<i>Lyonia</i> sp.		edges	
100	<i>Rhododendron</i> sp.		sl., epiph.	
	Euphorbiaceae			
101	<i>Antidesma</i> spp.		l.f.	
102	<i>Baccaurea</i> spp.		sl., l.f.	
103	<i>Bischofia javanica</i>		l.f.	
104	<i>Breynia</i> sp. 1		edges	
105	<i>Breynia</i> sp. 2		l.f., sl.	
106	<i>Breyniopsis</i> sp.		sl., river	
107	<i>Croton</i> spp.		sl., l.f.	
108	<i>Endospermum</i> sp.		l.f.	
109	<i>Macaranga</i> spp.		roads, d.f.	
110	<i>Mallotus</i> spp.		roads, d.f.	
111	<i>Ostodes paniculata</i>		sl.	
112	<i>Phyllanthus</i> sp. 1		edges	
113	<i>Phyllanthus</i> sp. 2		l.f., sl.	
114	<i>Sapium</i> cf. <i>Sebiferum</i>		roads, d.f.	
115	<i>Vernicia montana</i>		roads	
116	cf. <i>Bridelia</i>		edges	
	Fabaceae			
117	<i>Albizia</i> spp.		p.f.	
118	<i>Bauhinia</i> spp.		l.f., sl., edges	
119	<i>Caesalpinia</i> spp.		sl., l.f.	
120	<i>Dalbergia</i> sp.		lian	
121	<i>Dalbergia</i> sp.		l.f., sl.	
122	<i>Desmodium</i> spp.		roads	
123	<i>Dialium</i> cf. <i>Cochinchinensis</i>		p.f.	
124	<i>Entada</i> cf. <i>Phaseoloides</i>		l.f.	
125	<i>Gleditschia</i> sp.		l.f.	
126	<i>Indigofera</i> spp.		roads	
127	<i>Lasiobema</i> sp.		l.f.	
128	<i>Lourea</i> spp.		roads	
129	<i>Ormosia</i> cf. <i>Balansae</i>		p.f.	
130	<i>Pithecellobium</i> cf. <i>clypearia</i>		p.f., s.f.	
131	<i>Sindora</i> sp.		l.f.	
	Fagaceae			
132	<i>Castanopsis</i> sp.		l.f.	
133	<i>Lithocarpus</i> sp.		l.f., sl.	
134	<i>Quercus</i> spp.		sl., l.f.	

1	2	3	4	5
	Guttiferaceae (Clusiaceae)			
135	<i>Callophyllum sp.</i>		edges	
136	<i>Garcinia spp.</i>		sl., l.f.	
	Hypericaceae			
137	<i>Cratoxylum cf. cochinchinense</i>		l.f.	
138	<i>Hypericum sp.</i>		roads	
	Icacinaceae			
139	<i>Gonocarium sp.</i>		sl., l.f.	
	Illiciaceae			
140	<i>Illicium sp. 1</i>		l.f.	
141	<i>Illicium sp. 2</i>		edges	
	Juglandaceae			
142	<i>Engelhardtia sp.</i>		sl.	
143	<i>cf. Annamocarya</i>		sl.	
144	<i>cf. Platycarya</i>		sl.	
	Kiggelariaceae			
145	<i>Hydnocarpus sp.</i>		l.f.	
	Laminaceae			
146	<i>cf. Salvia</i>		edges	
	Lauraceae			
147	<i>Actinodaphne sp.</i>		sl.	
148	<i>Cinnamomum sp. 1</i>		l.f.	
149	<i>Cinnamomum sp. 2</i>		sl.	
150	<i>Lindera sp.</i>		edges	
151	<i>Litsea spp.</i>		l.f.	
152	<i>L. cubeba</i>		roads	
153	<i>Machilus sp.</i>		sl., l.f.	
154	<i>Neolitsea sp.</i>		sl.	
155	<i>Phoebe sp.</i>		l.f.	
	Leeaceae			
156	<i>Leea sp.</i>		l.f.	
	Lecythidaceae			
157	<i>Barringtonia cf. acutangula</i>		l.f.	
	Loganiaceae			
158	<i>Strychnos sp.</i>		l.f.	
	Loranthaceae			
159	<i>Macrosolen sp.</i>		l.f.	

1	2	4	5
	Lythraceae		
160	<i>Lagerstroemia sp.</i>	l.f.	
	Magnoliaceae		
161	<i>Magnolia sp.</i>	l.f.	
162	<i>Manglietia sp.</i>	l.f.	
163	<i>Michelia sp.</i>	l.f.	
	Malvaceae		
164	<i>Hibiscus sp.</i>	roads	
165	<i>Kydia sp.</i>	l.f.	
166	<i>Malvastrum sp.</i>	roads	
167	<i>Sida acuta</i>	roads	
168	<i>S. rhombifolia</i>	roads	
169	<i>Urena sp.</i>	roads	
	Melastomataceae		
170	<i>Medinilla sp.</i>	l.f., sl.	
171	<i>Melastoma cf. villosum</i>	roads	
172	<i>Osbeckia sp.</i>	roads	
173	<i>Vietsenia sp.</i>	l.f., sl.	
	Meliaceae		
174	<i>Aglaia sp.</i>	l.f.	
175	<i>Amoora sp.</i>	l.f.	
176	<i>Chisocheton sp.</i>	l.f.	
177	<i>Dysoxylum spp.</i>	l.f.	
178	<i>Melia azedarach</i>	roads, d.f.	
179	<i>Sandoricum cf. koetjape</i>	l.f.	
180	<i>Walsura sp.</i>	l.f.	
	Menispermaceae (lians)		
181	<i>Fibraurea sp.</i>	l.f.	
182	<i>Stephania spp.</i>	sl., l.f.	
183	<i>Tinospora sp.</i>	roads	
	Moraceae		
184	<i>Antiaris toxicaria</i>	sl., l.f.	
185	<i>Artocarpus spp.</i>	l.f.	
186	<i>Broussonetia papyrifera</i>	roads	
187	<i>Dimerocarpus sp.</i>	l.f.	
188	<i>Ficus spp.</i>	sl., l.f.	
189	<i>Streblus</i>	l.f., sl.	
190	<i>Taxotrophis macrophylla</i>	sl., l.f.	
	Myristicaceae		
191	<i>Knema linifolia</i>	sl., l.f.	
192	<i>Knema spp.</i>	l.f., sl.	

1	2	3	4	5
	Myrsinaceae			
193	<i>Ardisia gigantifolia</i>		l.f., sl.	
194	<i>A. cf. Mamillata</i>		l.f., sl.	
195	<i>A. sylvestris</i>		l.f., sl.	
196	<i>Ardisia spp.</i>		l.f., sl.	
197	<i>Embelia sp.</i>		sl., edges	
198	<i>Maesa spp.</i>		sl., l.f.	
	Myrtaceae			
199	<i>Syzygium sp.</i>		edges	
200	<i>Syzygium spp.</i>		l.f., sl.	
	Oleaceae			
201	<i>Jasminum spp.</i>		sl., l.f.	
	Passifloraceae			
202	<i>Adenia spp.</i>		l.f.	
203	<i>Passiflora sp.</i>		roads, d.f.	
	Piperaceae			
204	<i>Peperomia sp.</i>		sl., l.f.	
205	<i>Piper spp.</i>		l.f.	
	Polygonaceae			
206	<i>Polygonum spp.</i>		roads, d.f.	
	Proteaceae			
207	<i>Helicia sp.</i>		l.f., sl.	
	Rhamnaceae			
208	<i>Ventilago sp.</i>		l.f., sl.	
209	<i>Ziziphus sp.</i>		l.f., sl.	
	Rhizophoraceae			
210	<i>Carallia sp.</i>		l.f., sl.	
	Rhodoleiaceae			
211	<i>Rhodoleia cf. Parvipetala (?)</i>		edges	
	Rosaceae			
212	<i>Duchesnea indica</i>		roads	
213	<i>Eriobotrya sp.</i>		sl.	
1	2	3	4	5
214	<i>Pygeum (Prunus) sp. 1</i>		l.f.	
215	<i>Pygeum (Prunus) sp. 2</i>		l.f.	
216	<i>Pyros granulosa</i>		l.f., epiph.	
217	<i>Rubus spp.</i>		edges	

1	2	3	4	5
	Rubiaceae			
218	<i>Adina</i> sp.		l.f.	
219	<i>Canthium</i> sp.		sl.	
220	<i>Hedyotis</i> spp.		roads, d.f.	
221	<i>Ixora</i> spp.		sl., l.f.	
222	<i>Lasianthus</i> sp. 1		edges	
223	<i>Lasianthus</i> sp. 2		sl.	
224	<i>Lasianthus</i> sp. 3		sl., l.f.	
225	<i>Mussaenda</i> sp. 1		edges	
226	<i>Mussaenda</i> sp. 2		sl.	
227	<i>Ophyorhiza</i> sp.		l.f.	
228	<i>Psychotria</i> spp.		l.f.	
229	<i>Uncaria</i> spp.		l.f., sl.	
230	cf. <i>Wenlandia</i>		l.f.	
	Rutaceae			
231	<i>Clausena</i> sp.		sl., l.f.	
232	<i>Euodia leptala</i>		sl., l.f.	
233	<i>Glycosmis</i> sp.		sl., l.f.	
234	<i>Luvunga</i> sp.		sl., l.f.	
	Sapindaceae			
235	<i>Allophylus</i> sp.		l.f.	
235	<i>Pometia pinnata</i>		l.f.	
236	cf. <i>Paviesia</i>		l.f.	
	Sapotaceae			
237	<i>Eberhardtia</i> sp.		l.f., sl.	
238	<i>Madhuca</i> spp.		l.f.	
239	cf. <i>Donella</i>		l.f., sl.	
240	<i>Sarcosperma</i>		l.f.	
	Saururaceae			
241	<i>Houttuynia cordata</i>		Mo vil.	
	Scrophulariaceae			
242	<i>Lindernia</i> spp.		roads	
243	<i>Torenia</i> spp.		roads	
	Schizandraceae			
244	cf. <i>Kadsura</i> sp.		sl.	
	Simaroubaceae			
245	<i>Harrisonia perforata</i>		l.f.	
	Solanaceae			
246	<i>Solanum</i> sp.		roads	



1	2	3	4	5
	Sterculiaceae			
247	<i>Pterospermum diversifolium</i>		sl.	
248	<i>Pterospermum sp.</i>		sl., l.f.	
249	<i>Pterospermum cf. truncalobatum</i>		sl.	
250	<i>Sterculia spp.</i>		l.f., sl.	
	Styracaceae			
251	<i>Styrax cf. Benzoin</i>		l.f.	
	Theaceae			
252	<i>Eurya sp.</i>		sl.	
253	<i>Schima sp.</i>		sl.	
254	<i>Temstroemia spp.</i>		l.f., sl., edges	
	Thymelaeaceae			
255	<i>Linostoma scandens</i>		sl., l.f.	
	Tiliaceae			
256	<i>Burretiodendron sp.</i>		sl.	
257	<i>Corchorus sp.</i>		roads	
258	<i>Grewia spp.</i>		roads	
259	<i>Triumfetta tomentosa</i>		roads	
260	<i>cf. Tilia(!) sp.</i>		l.f., sl.	
	Ulmaceae			
261	<i>Gironniera sp.</i>		l.f., sl.	
262	<i>Trema velutina</i>		d.f.	
	Urticaceae			
263	<i>Debregeasia sp.</i>		l.f.	
264	<i>Elatostema surculosum</i>		l.f.	
265	<i>E. cf. cuneatum</i>		l.f.	
266	<i>E. cf. balansae</i>		l.f.	
267	<i>Oxyspora</i>		l.f.	
268	<i>Pellionia spp.</i>		l.f.	
269	<i>Pouzolzia spp.</i>		l.f.	
270	<i>Villebrunea spp.</i>		l.f.	
	Verbenaceae			
271	<i>Callicarpa sp. 1</i>		road, s.f.	
272	<i>Callicarpa sp. 2</i>		edges	
273	<i>Clerodendrum cf. javanicum</i>		l.f.	
274	<i>Clerodendrum sp.</i>		l.f., sl.	
275	<i>Gmelina sp.</i>		l.f., d.f.	
276	<i>Sphenodesma sp.</i>		l.f., sl.	
277	<i>Phyla nodiflora</i>		sl.	
278	<i>Premna herbaceae</i>		l.f.	
279	<i>Vitex sp.</i>		sl.	

1	2	3	4	5
	Violaceae			
280	<i>Viola sp.</i>		roads	
281	<i>cf. Rinorea</i>		l.f.	
	Vitaceae			
282	<i>Ampelopsis spp.</i>		sl., l.f.	
283	<i>Cissus spp.</i>		sl., l.f.	
284	<i>Partenocissus sp.</i>		sl., l.f.	
285	<i>Tetrastigma spp.</i>		sl., l.f.	
	<u>Monocotyledones</u> (Liliopsida)			
	Araceae			
287	<i>Acorus sp.</i>		river	
288	<i>Aglaonema spp.</i>		l.f., sl.	
289	<i>Alocasia sp.</i>		sl., l.f.	
290	<i>Amorphophallus sp. 1</i>		edges	
291	<i>Amorphophallus sp. 2</i>		sl.	
292	<i>Amorphophallus sp. 3</i>		l.f.	
293	<i>Amorphophallus sp. 4</i>		l.f.	
294	<i>Arisaema sp.</i>		l.f.	
295	<i>Colocasia</i>		roads	
296	<i>Epipremnum giganteum</i>		sl.	
297	<i>Homalomena cf. occulta</i>		l.f.	
298	<i>Lasia sp.</i>		l.f., lake	
299	<i>Pothos peniciliger</i>		l.f.	
300	<i>Pothos scandens</i>		l.f.	
301	<i>Pothos sp.</i>		l.f.	
302	<i>Pseudodracontium sp.</i>		sl.	
303	<i>Raphidophora sp. 1</i>		sl., l.f.	
304	<i>Raphidophora sp. 2</i>		l.f., sl.	
305	<i>Thyphonium spp.</i>		sl., l.f.	
306	Asphodelaeaceaea			
307	<i>Chlorophytum sp.</i>		sl.	
	Commelinaceae			
308	<i>Commelina sp.</i>		roads, river, gaps	
309	<i>Cyanotis cf. Burmanniana</i>		gaps	
310	<i>Floscopa sp.</i>		sl.	
311	<i>Forrestia mollissima</i>		river, gaps	
	Convallariaceae			
312	<i>Aspidistra sp. 1</i>		l.f.	
313	<i>Aspidistra sp. 2</i>		sl.	
314	<i>Disporum sp.</i>		sl.	

1	2	3	4	5
315	<i>Liriope sp.</i>		sl., l.f.	
316	<i>Peliosanthes sp.1</i>		sl.	
317	<i>Peliosanthes sp.2</i>		l.f.	
318	<i>Ophiopogon sp.</i>		l.f.	
	Costaceae			
319	<i>Costus speciosus</i>		l.f., gaps	
	Dioscoreaceae			
320	<i>Dioscorea bulbifera</i>		sl., l.f.	
321	<i>Dioscorea spp.</i>		sl.	
	Dracaenaceae			
322	<i>Dracaena cf. Cambodiana</i>		edges, sl.	
	Hypoxidaceae			
323	<i>Curculigo cf. Anpamitica</i>		l.f., sl.	
	Marantaceae			
324	<i>Phrynium cf. Parviflorum</i>		river	
	Orchidaceae			
325	<i>Anoectochilus sp.</i>		sl.	
326	<i>Bulbophyllum spp.</i>		edges, sl., l.f.	
327	<i>Cymbidium spp.</i>		sl.	
328	<i>Dendrobium spp.</i>		sl., l.f.	
329	<i>Eria spp.</i>		edges, sl.	
330	<i>Haemaria sp.</i>		sl.	
331	<i>Pholidota chinensis</i>		l.f.	
332	<i>Paphiopedilum sp.</i>		edges	
333	<i>Phalaenopsis sp.</i>		l.f.	
	Palmae (Arecaceae)			
334	<i>Arenga pinnata</i>		sl.	
335	<i>Caryota mitis</i>		sl., l.f.	
336	<i>C. urens</i>		l.f.	
337	<i>Caryota spp.</i>		sl., l.f.	
338	<i>Calamus spp.</i>		sl., l.f.	
339	<i>Licuala cf. Spinosa</i>		l.f., sl.	
340	<i>Livistona sp.</i>		l.f.	
341	<i>Korthalsea sp.</i>		sl., l.f.	
342	<i>Pinanga sp. 1</i>		l.f.	
343	<i>Pinanga sp. 2</i>		sl., l.f.	
	Pandanaceae			
344	<i>Pandanus sp. 1</i>		edges	
345	<i>Pandanus sp. 2</i>		sl., l.f.	

1	2	3	4	5
	Phormiaceae			
346	<i>Dianella sp.</i>		sl.	
	Smilacaceae			
347	<i>Smilax spp.</i>		edges, l.f., sl.	
	Stemonaceae			
348	<i>Stemona sp.</i>		sl.	
	Taccaceae			
349	<i>Tacca paxiana</i>		l.f.	
350	<i>T. cf. integrifolia</i>		l.f.	
	Trilliaceae			
351	<i>Paris sp.</i>		l.f.	
	Zingiberaceae			
352	<i>Alpinia spp.</i>		sl., l.f.	
353	<i>Amomum sp.</i>		sl., l.f.	
354	<i>Curcuma sp.</i>		l.f.	
355	<i>Globba sp.</i>		sl.	
356	<i>Hedychium sp.</i>		sl.	
357	<i>Zingiber spp.</i>		l.f., sl.	

### Description of vegetation

#### Forests on the smoothed areas and gentle slopes, shielded from strong winds (fig.1)

Soils are thick, well-structured, medium and heavy loam with occlusions of limestone fragments and schists. Water-capacity is good. Argillaceous layers, deposited from depth 1-1.5 m have features of the water proof stratum. Soils are able to accumulate the atmospheric moisture, the capillary hem reaches the upper horizons of the soil mass under certain circumstances. Composition of the soils is homogenous. Supposedly, the mother (soil-forming) rocks - argillaceous schists. During powerful short downpour precipitation as a result of plain drainage, there happens redistribution of water along the surface of soil:

Humus horizon 0-15 (20) cm, weak, dark-gray, gray-yellow, with a little difference in color from the argillaceous layers deposited lower, slightly structured with rare occlusions of limestone. Leaf litter mainly consists of leaves of the current year. Under condition of a high humidity of the close-ground strata of air and soil, leaf plates decompose, as a rule, within a year. Leaf litter is formed on the surface of soil in December-March, supposedly by October-November.

In the structure of forests 3-4 horizontal units - sub-level can be marked out. At the same time, the upper (1) sublevel is thick, the lower one is rarefied but differ here distinctly. The herbs, as a result of a strong shadowing adjoin the forest «windows».

The trees of the upper sublevel reach height 25-30 m; separate one – up to 40 m with the diameter of trunks 60-220 cm. The trunks of the trees are straight, column-like. The bark of many trees is thin, the color of the bark: yellowish, dark-gray, orange-brown, brown. The characteristic peculiarity of those forests - the crowns of the trees are oval or oval-flattened with radius 4-12 m, often touching up. The most of the trees of the upper sublevel have complex leaves. The young leaves appear in April, blossoming can be watched in March-April, at the same time the separate trees begin to form fruits.

In the upper sublevel of forests under conditions of relatively smoothed relief of intermountain valleys and gentle slopes there is predominant *Pometia pinnata* (Sapindaceae), co-dominants are *Magnolia* sp. (cf. *Manglietia*) sp., *Dipterocarpus kerry*, *Burretiodendron* sp.(l), cf. *Canarium*, *Dacryodes* sp., *Endospermum sinensis*, *Artocarpus* sp., *Litsea* sp., cf. *Chisocheton*, cf. *Dysoxylum*, cf. *Aglaia*, *Amoora* sp., *Ficus* sp., *Madhuca* sp., *Elaeocarpus* spp., rarely marked *Mangifera* sp., *Lithocarpus* sp., *Tetrameles nudiflora* (l).

Then second sublevel (height of trees to 20-25 m) is formed by *Knema* cf. *linifolia*, *Garcinia* sp., *Elaeocarpus* spp., *Diospyros* spp., *Cinnamomum* sp., *Quercus* sp., *Lithocarpus* sp., *Barringtonia* cf. *Acutangula*, *Sterculia* spp., *Lagerstroemia* sp., *Machilus* sp., *Phoebe* sp., *Dalbergia* sp., *Sloanea* sp., *Grewia* (*Colona*) sp., *Gironniera* sp., *Manglietia* sp. There are slightly more of trees *Elaeocarpus*, *Quercus*, *Sterculia*, then other species.

The third sublevel (height of trees 8-12 m) is formed by *Baccaurea* spp., *Elaeocarpus* spp., *Polyalthia* spp., *Wrightia* sp., *Helicia* sp., cf. *Tilia*(!)-rare, *Cariota urens*-rare (Palmae), *Capparis* sp., *Pterospermum* sp., *Kydia* sp., *Pygeum* sp., *Syzygium* spp., *Taxotrophis* (*Streblus*) sp., *Helicia*, *Capparis*, *Elaeocarpus*, *Taxotrophis*-prevail.

The fourth level (height up to 2 m) is formed by not great trees of fam. Rubiaceae (*Lasianthus* spp., *Psychotria* sp.), Apocynaceae, Euphorbiaceae (*Antidesma* spp., *Brevnia* sp., *Croton* sp., *Phyllanthus* sp.), Sterculiaceae (*Sterculia* sp.), Araliaceae (*Trevesia* sp.), Palmae (*Caryota* sp., *Pinanga* sp., *Licuala* sp.), Rutaceae (*Euodia lepta*, *Clausena* sp.), Myrsinaceae (*Ardisia* spp., *Maesa* spp.), Violaceae (*Rinorea* sp.), Apocynaceae - with predominant species of fam. Sterculiaceae(!), Myrsinaceae and Rubiaceae.

Underwood - bush layer are fragmentary.

The layer of herbs is formed basically by species of fam. Taccaceae(!) - (*Tacca* cf. *integrifolia*), Urticaceae(!!!)-dominant, Melastomataceae(!!!)-dominant (*Medinilla* sp., *Vietsenia* sp.), Rubiaceae (*Ophyorriza* sp.), Leeaceae (*Leea* sp.), Aristolochaceae (*Asarum* sp.), Orchidaceae, Commelinaceae, Convalariaceae (*Aspidistra* sp., *Peliosanthes* spp., *Ophiopogon* sp., *Liriope* sp.), Hypoxidaceae (*Curculigo annamitica*), Triliaceae (*Paris* sp.), Zingiberaceae (*Curcuma* sp., *Alpinia* spp., *Amomum* sp., *Zingiber* sp.), Araceae(!!!)-dominant (*Aglaonema* spp., *Amorphophallus* sp., *Arisaema* sp., *Homalomena occulta*, *Lasia* sp., *Thyphonium* sp.), Begoniaceae, Verbenaceae (*Clerodendrum* sp., *Phyla nodiflora*), Marattiaceae (*Angiopteris* cf. *cochinchinensis*, *A.* cf. *evecata*), Selaginellaceae(!!!)-dominant (*Selaginella* spp.), Marantaceae (*Phrynium* cf. *parviphlorum*), Costaceae (*Costus speciosus*), Myrsinaceae (*Ardisia* sp.), Cyperaceae(!), Pandanaceae, Poaceae (in gaps), Astera-ceae (in gaps), Balsaminaceae.

The leaf litter: the main mass is supposedly accumulated on the surface of soil within the period from December till March. During our observation in April some species kept shedding foliage (*Mangifera*). Some other trees had already leaves of a new generation being formed.

The layer of leaf litter is 1-2 cm thick. The leaf plates on the surface of soil are moistened by the atmospheric precipitation; therefore they are wet that favors transforming of the leaf

litter. The main transformers of the leaf litter are ground fungi, earthworms and also many of arthropods (chiefly collembolae and crustacea). Branch litter is partially used by termites. Existence of many animals - mammals, amphibians, reptiles and birds, according to our observations, is connected with leaf litter, since they find here forage. It is important for birds at the same time thickness of the leaf litter, its dampness, friability and density as influencing possibility to turn leaves in the litter and abundance of earthworms, various mollusks - shelled and nude in the litter.

Saturation of the forest space in the valley woods with crowns and trunks of trees that grow in a direct nearness from each other and have different heights, favors growth of numerous powerful lianas.

It is well known that woody trunks of lianas climb up to the level of crowns of the forest canopy and form main ways of transference for the animals inhabiting the crown space of the forest. Many of the forest animals feed on fruits of many liana species. We repeatedly watched the powerful trunks of lianas to hold dead trees.

In the valley woods among the lianas the most often a liana *Entada* sp. (Fabaceae) dominated, preferring well-moistened soils. The trunks of this powerful and one of many years living tropical lianas, reach diameter 30-36 cm. In the south of Vietnam in dipterocarpal woods this species may be met along the banks of temporary streams and rivers and appears to be a background plant in the valley flooded lagerstremial forest of the reservation Nam Kat Tien. The presence of this plant indicates, as a rule, a high moisture of substratum.

Side by side with *Entada* sp. the following lianas occur: *Bauhinia* sp., *Albizia* sp., *Dalbergia* sp., *Caesalpinia* sp., *Lasiobema* sp., *Dialium* sp. (fam. Fabaceae), *Artabotrys* sp., *Uvaria* spp., *Desmos* sp. (Annonaceae), *Ancistrocladus* sp. (Ancistrocladaceae), *Gnetum* sp. (Gnetaceae), *Strychnos* sp. (Loganiaceae), *Jasminum* spp. (Oleaceae), *Ficus* sp. (Moraceae), *Connarus* sp., *Rourea* sp., *Agelaea* sp. (Connaraceae), as well as the lianas of fam. Menispermaceae (*Fibraurea* sp., *Stephania* sp.), Apocynaceae, Convolvulaceae (*Argyrea* sp.), Vitaceae (*Cissus* sp., *Ampelopsis* sp., *Tetrastigma* spp.), Palmae (*Calamus* spp., *Korthalsea* sp.), Dilleniaceae (*Tetracera* sp.), Rubiaceae (*Uncaria* sp.), Rutaceae (*Luvunga* sp.), Passifloraceae (*Adenia* sp.), Piperaceae (*Piper* spp.), Araceae (!!!)-dominant (*Pothos* sp., *P. penicilliger*, *P. scandens*, *Epipremnum* cf. *giganteum*, *Rhaphidophora* spp.), Dioscoreaceae (*Dioscorea* spp.), Rhamnaceae (*Ventilago* sp., *Ziziphus* sp.), Smilacaceae (!!!)-dominant (*Smilax* spp.), Verbenaceae (*Sphenodesma* sp.), cf. Malvaceae and others.

We suppose, that a rich species structure of lianas that frequently have powerful (with a big diameter) trunks indirectly indicates that these forests are of the initial origin and exists for the long time - several thousand years.

The root systems of the most of plants are superficial with net of anchor roots going down into the depths of soil; the central root goes deep down to 1-1.5 m, then begins forking and forms the roots horizontally oriented. Thickness of the root-containing layer is from 1 to 1.5 (2) m; deeper there deposit the argillaceous overdamped strata.

The surface roots of trees can be traced up to the distance of 10-12 m from the trunk. The buttress of the most plank-buttress roots have length 2-4 m from the trunk (some trees – up to 6 m). Height of the buttresses is 1-2.5 m, rarely 4 m. In the course of forming the buttresses fork and form the roots of the 2nd and 3rd order. The presence of closed cells, formed by buttresses, in the basal part of the trunk is the usual occurrence for the trees of the valley forest. Such cells are formed as a result of knitting of two buttresses. We marked such formations on different heights from the surface of soil. There the vegetable litter is accumulated between the walls of the buttresses. Close-ground strata of air and ground have the heightened moisture. After rains in the cells, formed by the buttress roots there occurs stagnation of water.

Thickness of the buttress of many trees attains from 3 to 5-7 cm. The trees with more thick roots are rare. On edges of the buttresses are frequently present fruit bodies of polypores. Examination of the trees (trunks) broken at their base and fallen out from the forest canopy indicates that their ruin was a result of development of rotten stuffs in the buttress.

In our opinion, forming of the superficial root system and the buttress results from over-moistening of soil argillaceous layers, density of build (mechanical barrier) and shortage of oxygen in damp horizons. We can suppose that the trees with a well developed but thin buttresses are relatively short-living and in a considerable extent are subjected to falling out. According to our observations one falling tree injures trunks of 2-3 trees more. Through the injured areas of trunks and especially through buttresses the spores of wood-attacking fungi penetrate, rotten stuffs develop, and in some time (3-5 years) there appear fruit bodies of fungi. In the basal parts of many trees hollows are formed. Supposedly, the trees with injured buttresses fall out in 10-15 years.

The valley forests and the ones formed on gentle slopes, as we should think, are dynamic in replacement of tree species. Even weak rushes of wind cause breaking off of main branches and falling of trees. Sometimes settlement of large epiphytes may often be the cause of breakage of main branches. Squally strikes of wind, accompanying showers are



the most dangerous for trees. Falling of trees results in forest «windows». Later various herbs develop in the forest «windows». Utilization of the fallen trees provide larvae of insects, wood-attacking fungi and, in a small extent, termites. This is connected with a significant humidity substrate and its saturation with fungi metabolic products.

### **Forests on steep slopes of mountain ranges (fig.2)**

The slopes are presented to be cliff outlets of limestone rocks, accumulation of disintegrated rock formations. Sometimes thickness of limestone outcrops reach 2-3 m. Soil is formed only on smoothed small terraces. The surface of limestone plates and fragments is covered with hollows (edges of the hollows are sharp); due to it vegetation and the water of atmospheric precipitation is kept. The main part of water penetrates downwards and is filtered under the action of the gravitational force. At the same time it is moving to the direction of the shale geological plate. The plants as well use directly the water of precipitation as the water, accumulated in hollows and clefts in rocks. Besides they use the water condensed on the surface of the rocks.

The trees that grow on steep slopes upwards to the top of a mountain range are exposed to increasing influence of winds. In direction from the foot to the top of a range the height of trees is gradually decreases, composition of the specific difference is changing; there is a sharp replacement of vegetation at the crest top. In spite of the severe conditions the trees are contiguous by the crowns on slopes. In strong winds the neighboring trees lash each other with branches. It results in breaking and falling of branches of different thickness.

Trunks of the trees are often curved; in a less extent it is characteristic for the trees that grow on terraces. Influence of protection from wind is well seen in appearance of trees; it became evident in their increasing in height. Besides, trunks of the trees are straight, in their basal part there are formed buttresses. The trees that grow on windy slopes practically do not have buttresses.

The surface roots, spreading along the stones as well as the anchor ones as far as possible go down the clefts under the stones. The basal part of trees often looks as though embracing the stony substratum. The forest, formed under these conditions differs from the valley one in species composition and in structure. Here frequently occur large palm trees attaining 15 m in height, especially in saddlebacks and on terraces, protected from winds.

The structure of forests on steep slopes is not very complex. There is a well marked the upper closed wood sublayer with height 12-15 m. The subordinate sublayers are frag-

mentary. There are dominant the following trees: *Diospyros* spp., *Hopea* sp., cf. *Shorea*, *Syzygium* sp., *Quercus* sp., *Elaeocarpus* spp., *Acer* spp., *Garcinia* sp., *Pterospermum* sp., Moraceae, *Knema* sp., *Girroniera* sp., *Wrightia* sp., *Podocarpus imbricatus*, *Trevesia* sp., *Polyalthia* sp., *Lithocarpus* sp., *Castanopsis* sp., *Goniotalamus* sp., *Baccaurea* sp., *Ostodes paniculata*, *Engelhardtia* sp., *Cinnamomum* sp. (and other sp. from Lauraceae), *Arenga pinnata* (Palmae)-dominant.

The layer of herbs is presented with species of genera *Begonia*, *Amorphophallus*, *Pseudodracontium*, *Thyphonium*, *Impatiens*, *Pandanus*, *Globba*, *Alpinia*, *Hedychium*, *Dianella* (!), *Ardisia*, *Curculigo*, *Medinilla*. There are of great interest the plants of families Araceae of genera *Amorphophallus*, *Thiphonium* and, probably, *Pseudodracontium*, since we do not exclude the presence of new species among these tuberous herbs. At the moment of observation many of herbs flowered.

The composition of lianas, epiphytes and semiepiphytes is considerably impoverished due to influence of wind.

#### **Vegetation of mountain crests with height to 500 m above sea-level (fig.3)**

It is obvious that vegetation formed on the tops of crests is specific due as well to absence of soil as to considerable insulation, influence of a strong squally winds, interchange of high temperatures of air and low cloudiness. Due to small height of the ranges above sea level the temperature gradient is not formed. Daily temperatures in the valley at the foot of the range differ in a slight extent from the one on the top. Entry of moisture and wind influence are, apparently, the most important factors of plants growth on mountain ranges. The plants get moisture from atmospheric precipitation and at the expense of drop watering - during falling of low cloudiness. While our staying there we watched rather thick cloudiness to remain for three days. Such condition is especially actual for the epiphytic vegetation. Besides, in certain spells of twenty-four-hours a strong wind blew. At the same time the air mass in the valley actually did not transferred.

The trees on mountain range reach the height of 2-3 m with diameter of trunks 8-14 cm. Trunks of trees are curved. The bark is smooth, dense with thickness 5-10 mm, there frequently occur crust lichens on the surface of trunks. The distance between the trees is 0.2-1 m, the crowns are often closed up. The root systems are superficial, as far as possible they penetrate down the clefts. The diameter of base of skeletal roots is often equal to the one of the trunk on this level.

The crowns of trees are compact, dense, sphere-like in form; the height of the beginning of crowns is 1-1.5 m, the radius of crown is 0.5-1.2 m. The leaves are small, dense, skinny (of xerophitous kind), glossy, with a thick wax coating and short thickened peduncle. The most frequently met trees - the ones with complex leaves; in species relation the situation is quite the reverse - those are the trees with plane leaves.

It is necessary to note that under conditions of even inconsiderable shielding from winds, the trees reach a bigger size than the ones on the ranges, blowed through.

The forest is made up of the following trees: *Dacrydium pierri*, *Podocarpus nervifolium*, *P. pilgeri* (?), *Nageia* cf. *fleuryi*, *Phyllanthus* sp.(!!!)-dominant, *Temstroemia* sp., *Callophyllum* sp.(!!!)- dominant, *Garcinia* sp., *Mussaenda* sp.-rare, *Elaeocarpus* sp., *Brydelia* (*Breynia*) sp., Bignoniaceae, *Quercus* sp., cf. *Lindera*, Fabaceae, *Syzygium* sp., *Lasiantus* sp., *Cinnamomum* sp., *Eurya* sp. cf. *Thea*, *Maesa* sp., *Wrightia* sp., *Ardisia* sp., *Rubus* spp., *Pterospermum* sp., Verbenaceae (*Callicarpa* sp.), *Illicium* sp., *Lyonia* sp., *Diospyros* sp., *Embelia* sp.(liana), *Smilax* sp.(liana), *Rhodoleia* cf. *parvipetala*.

*Phyllanthus*, *Wrightia*, *Garcinia*, *Illicium*, *Elaeocarpus*, *Temstroemia* and *Callophyllum*-dominate and *Mussaenda* occurs rarely.

As far as herbs are concerned we would like to mark: *Paphyopedillum* cf. *concolor* - extremely beautiful and rare orchid; *Begonia* sp. (supposedly a new species) - with dense leaves of succulent kind; *Impatiens* - the plant with a short thickened stem; small in size. fern - supposedly of gen. *Pterys*; *Dracaena* cf. *cambodiana*-up to 4 m.; *Pandanus* sp.-2-3 m. Epiphytes, excluding lichens, chiefly are presented by the plants of family Orchidaceae. Some species show striking examples of adaptation - for instance *Bulbophyllum* - with small bulbs tile-placed and pressed to bark of the trunk. As far as for orchids, on the preliminary estimation, several species in status novo were collected.

## CONCLUSION

In the presented report we, unfortunately, could not expand on all the problems, results and peculiarities of the performed geobotanic and soil works. In this regard we will confine ourselves with the results and proposals the most important, in our view, and that corresponds to the aim of the report.

1. On the basis of my own many years experience of work in tropical forests in different provinces of Vietnam we state that we do not know the territories identical to the one the researches were carried out on.
2. The forests that were formed under conditions of the broken mountain relief of limestone (calcareous) ranges are the initial ones, and that is extremely important that they have not been exposed to the anthropogenic influence.
3. The mountain relief determines a huge mosaic of biotopes – depending on the grade of moistening, shielding from winds, insulation, thickness of soils and their structure and many others. That results in a mosaic of vegetation from the level of forest to the existence in narrow parameters of environment of separate plants.
4. The geographical location of limestone massifs allows co-existence on this territory of the plant species characteristic for the Southern and Northern Vietnam. Supposedly, on the Ke Bang territory there may be a rather high level of endemism. Probability of revealing of new species for Vietnam is also high, especially for herbal plants of fam. Araceae, Orchidaceae, Begoniaceae; also, for trees - new species relating to fam. Dipterocarpaceae, Meliaceae.

All the mentioned above shows uniqueness of Ke Bang forestry massif as well for Vietnam as, possibly, for the South-East Asia on the whole. At present, on our deep conviction, the most important task is to preserve the botanical units by their introduction into botanical gardens as to keep the natural areas of growth of these plants by prohibition of any (except scientific) influence on elements of the landscape.

Due to the fact that many trees have obvious commercial and medical value (that is not regarded in the present report), we believe to be important to take measures to preserve these species, in particular not to inform the natives about their commercial value, to seek for the means to cause interest in the natives to carry out nature-protective arrangements. The obvious example of predatory usage of natural Ke Bang treasures is felling of big ebony trees (*Diospyros*) to obtain the core (central) wood. Such trees, growing in the region of the village Ma Ma are extremely rare, and not only for Vietnam. From trunks of the tree

only beams are taken to be illegally conveyed to the village Phong Nha, and than, by sea - to China.

We will mention once again that even the preliminary explorations (performed for the relatively short period - 45 days) allows to speak about an urgent necessity of reservation of Ke Bang forest massif and the adjacent territories, about foundation of a large biosphere reserve with the adjusted structure including a scientific explorations. Undoubtedly, it will demand solving of complex of various tasks including the ones of the social kind; analysis and discussion of these problems are out of the limits of our report

### RECOMMENDATIONS

On the background of a catastrophically sharp devastation of the forest territories in the South-North, existence of the reservation, like Ke Bang on the territory of Vietnam is to be phenomenal. The forests kept their virginity as a reason of their inaccessibility. So, the trees in the valley of the river Yen Hop are wholly cut on gentle slopes, keep being cut on the adjoining slopes to the valley (with a slight inclination) to clear for growing rice and tobacco.

In our opinion the actual measures are the following:

1. To give Ke Bang the official status on the level of the state or under the aegis UNESCO namely-foundation of a large joint biosphere reservation (possible of the international one Vietnam-Laos), including the territories of the National Park Phong Nha.
2. Effective guarding of the territory - it is necessary to exclude or to hamper a traditional mass hunt of animals: deers, vivveras, hybbons, forest cats, birds (including fledglings) and also of ebony trees and benzoian resin.
3. Ecological education in schools, wide publication of materials, supporting of existing projects and creation of new social ones including the ethnographic ones.
4. Scientific work - building of the forest scientific constant stations (panel sectional houses), attracting scientists to carry out long-term works, creation of constant trial forest areas (with square 5, 10 and 20 ha), arrangement (building) of nurseries for animals.
5. Ecological tourism - creation of training schools and camps to prepare local specialists (guides), as well as creation of international (students') camp-schools on surviving.
6. Popularisation of ecological knowledge - scientific international youth (student) schools, shooting of scientific popular films in the context of nature protection, various polygraphic production.

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## STUDY OF BIODIVERSITY OF BUTTERFLIES (LEPIDOPTERA, RHOPALOCERA)

Conducted by Alexei L. Devyatkin, Vu Van Lien

### INTRODUCTION

Butterflies are one of the most attractive and conspicuous groups of invertebrates which play an important role in natural ecosystems. Among them, a number of species is strictly associated with particular plants and is sensitive to environmental changes, thus being characteristic for particular habitats and their condition.

The aim of the present study was to estimate the species composition and relative abundance of butterflies during the given period of time in order to assess whether they are indicative of the overall biodiversity and state of forest ecosystems of the Ke Bang area. On the other hand, this limestone area could be interesting from the zoogeographical point of view due to its geographical position and unusual relief.

### COLLECTING LOCALITIES AND HABITATS

Butterflies were collected in primary forest, secondary associations, at the forest edge and in the river valley within the day-trip distances in various directions from the villages Yen Hop, O and Mo (Minh Hoa district).

### METHODS

The main methods of the field work were collecting with an entomological net and visual registration. For detailed identification, mounting of specimens and examination of genitalia in laboratory conditions were provided in Moscow.

The categories of abundance (N, C, U, R, S - see below) are cumulative and rather subjective, since no objective counts of butterflies can be provided in the field. The visual abundance of butterflies is strongly dependant upon weather, time of the day, their physiological age etc. Moreover, there were places (such as the river valley) of concentration of males of certain butterfly species, while females could be seen extremely rarely and only in the forest.

## RESULTS

According to the collected material and field observations, the butterfly fauna of the Ke Bang area during the period of study can be estimated as containing around 260 species (several unidentified specimens were not taken). The below list is based upon the examination of all the material and checking all doubtful specimens. Relative abundance of species and their geographical range, as being the main characteristics of the butterfly fauna, were roughly estimated.

## CHECKLIST OF THE BUTTERFLIES OF KE BANG

## Abbreviations (abundance, roughly):

N - numerous (hundreds to thousands)

C - common (50-100 specimens seen)

U - uncommon (10-50 specimens seen)

R - rare (4-10 specimens seen)

S - single (found singly, 1-3 specimens)

## Range of the species (distribution limits, roughly):

1 - Indochina to Indonesia

2 - N-E India (Sikkim, Assam) to Malaysia (and Sumatra)

3 - India and China to the Philippines

4 - Indo-Australian Region (entire or most part)

5 - Wide combined range (part of the Oriental as well as of adjacent regions)

No.	Species	Local abundance	Range
	<b>Papilionidae</b>		
1	<i>Troides aeacus</i> (Felder)	R	2
2	<i>Chilasa slateri</i> (Hewitson)	S	2
3	<i>Chilasa paradoxa telearchus</i> (Hewitson)	S	3
4	<i>Papilio demoleus</i> Linnaeus	S	4
5	<i>Papilio mahadeva</i> Moore	U	1
6	<i>Papilio helenus</i> Linnaeus	C	4
7	<i>Papilio nephelus chaon</i> Westwood	C	2
8	<i>Papilio polytes romulus</i> Cramer	C	2



9	<i>Papilio memnon agenor</i> Linnaeus	C	3
10	<i>Papilio rhetenor</i> Westwood	S	2
11	<i>Papilio protenor</i> Cramer	C	2
12	<i>Papilio dialis doddsi</i> Janet	S	2
13	<i>Papilio polyctor</i> Boisduval	S	2
14	<i>Papilio paris</i> Linnaeus	C	3
15	<i>Graphium agetes</i> (Westwood)	S	1
16	<i>Graphium aristeus</i> (Stoll)	C	4
17	<i>Graphium antiphates</i> (Cramer)	C	2
18	<i>Graphium macareus</i> (Godart)	C	3
19	<i>Graphium xenocles</i> (Doubleday)	C	2
20	<i>Graphium megarus</i> (Westwood)	U	2
21	<i>Graphium sarpedon</i> (Linnaeus)	C	4
22	<i>Graphium doson</i> (Felder)	N	2
23	<i>Graphium euryпилus</i> (Linnaeus)	C	4
24	<i>Graphium chironides</i> (Honrath)	U	2
25	<i>Graphium agamemnon</i> (Linnaeus)	U	4
26	<i>Lamproptera curius</i> (Fabricius)	N	3
27	<i>Lamproptera meges virescens</i> (Butler)	N	3
	<b>Pieridae</b>		
28	<i>Leptosia nina</i> (Fabricius)	S	3
29	<i>Prioneris thestylis</i> (Doubleday)	C	2
30	<i>Prioneris philonome</i> (Boisduval)	U	2
31	<i>Pieris rapae</i> (Linnaeus)	S	5
32	<i>Pieris canidia</i> (Linnaeus)	U	5
33	<i>Cepora nerissa</i> (Fabricius)	U	3
34	<i>Cepora nadina</i> (Lucas)	C	2
35	<i>Appias lycida</i> (Cramer)	N	3
36	<i>Appias olferna</i> Swinhoe	R	3
37	<i>Appias nero</i> (Fabricius)	R	2
38	<i>Appias albina</i> (Boisduval)	N	3
39	<i>Appias indra</i> (Moore)	N	2

40	<i>Appias lalage</i> (Doubleday)	S	2
41	<i>Appias lalassis</i> Grose-Smith	R	1
42	<i>Ixias pyrene</i> (Linnaeus)	C	3
43	<i>Hebomoia glaucippe</i> (Linnaeus)	C	3
44	<i>Dercas verhuelli</i> (van der Hoeven)	U	2
45	<i>Dercas lycorias</i> (Doubleday)	R	2
46	<i>Catopsilia pomona</i> (Fabricius)	C	4
47	<i>Catopsilia scylla</i> (Linnaeus)	S	4
48	<i>Eurema hecabe</i> (Linnaeus)	C	4
49	<i>Eurema blanda</i> (Boisduval)	U	2
50	<i>Eurema andersonii</i> (Moore)	C	2
51	<i>Eurema ?novapallida</i> Yata	R	1
52	<i>Gandaca harina</i> (Horsfield)	C	4
	<b>Danaidae</b>		
53	<i>Danaus chrysippus</i> (Linnaeus)	S	5
54	<i>Danaus genutia</i> (Cramer)	C	4
55	<i>Tirumala septentrionis</i> (Butler)	U	3
56	<i>Parantica aglea</i> (Stoll)	C	2
57	<i>Parantica melaneus</i> (Cramer)	C	3
58	<i>Euploea modesta</i> Butler	R	1
59	<i>Euploea camaralzeman</i> Butler	U	1
60	<i>Euploea core</i> (Cramer)	R	3
61	<i>Euploea algea</i> (Godart)	C	3
62	<i>Euploea sylvester</i> (Fabricius)	U	2
63	<i>Euploea mulciber</i> (Cramer)	N	3
64	<i>Euploea tulliolus</i> (Fabricius)	U	3
65	<i>Euploea klugii</i> Moore	R	2
66	<i>Euploea eunice</i> (Godart)	C	1
67	<i>Euploea radamanthus</i> (Fabricius)	C	2
	<b>Acraeidae</b>		
68	<i>Acraea issoria</i> (Fabricius)	U	3

69	<i>Acraea violae</i> (Fabricius)	R	3
	<b>Nymphalidae</b>		
70	<i>Phalanta phalantha</i> (Drury)	R	3
71	<i>Cupha erymanthis</i> (Drury)	C	3
72	<i>Vagrans egista</i> (Cramer)	C	3
73	<i>Cirrochroa tyche</i> (Felder)	C	3
74	<i>Vindula erota</i> (Fabricius)	C	3
75	<i>Cethosia biblis</i> (Drury)	S	3
76	<i>Junonia iphita</i> (Cramer)	R	2
77	<i>Junonia atlites</i> (Linnaeus)	C	2
78	<i>Junonia almana</i> (Linnaeus)	C	3
79	<i>Junonia lemonias</i> (Linnaeus)	R	4
80	<i>Junonia hierta</i> (Fabricius)	S	3
81	<i>Symbrenthia lilaea</i> (Hewitson)	C	2
82	<i>Hypolimnas bolina</i> (Linnaeus)	U	4
83	<i>Doleschallia bisaltide</i> (Cramer)	U	3
84	<i>Cyrestis themire</i> Honrath	N	1
85	<i>Cyrestis cocles</i> (Fabricius)	R	2
86	<i>Cyrestis thyodamas</i> Boisduval	C	3
87	<i>Chersonesia risa</i> (Doubleday)	C	2
88	<i>Neptis clinia</i> Moore	C	3
89	<i>Neptis sappho astola</i> Moore	S	5
90	<i>Neptis hylas</i> (Linnaeus)	C	4
91	<i>Neptis soma</i> Moore	S	2
92	<i>Neptis nata</i> Moore	C	3
93	<i>Phaedyma columella</i> (Cramer)	U	4
94	<i>Lasippa heliodore</i> (Fabricius)	S	2
95	<i>Lasippa monata</i> (Weyenbergh)	S	1
96	<i>Pantoporia sandaka</i> (Butler)	R	3
97	<i>Athyma selenophora</i> (Kollar)	R	3
98	<i>Athyma cama</i> (Moore)	S	2
99	<i>Athyma nefte</i> (Cramer)	S	3

100	<i>Athyma ranga</i> (Moore)	S	3
101	<i>Cynitia cocytus</i> (Fabricius)	S	2
102	<i>Cynitia telchinia</i> (Menetries)	S	2
103	<i>Euthalia monina</i> (Fabricius)	S	3
104	<i>Lexias dirtea</i> (Fabricius)	S	3
105	<i>Lexias cyanipardus</i> (Butler)	S	2
106	<i>Rohana tonkiniana</i> (Fruhstorfer)	S	1
107	<i>Eulaceura osteria</i> (Westwood)	S	1
108	<i>Herona marathus</i> Doubleday	S	2
109	<i>Euripus nyctelius</i> (Doubleday)	U	3
110	<i>Hestina nama</i> (Doubleday)	U	2
111	<i>Pseudergolis wedah</i> (Kollar)	R	2
112	<i>Stibochiona nicea</i> (C.R. Gray)	R	2
113	<i>Polyura eudamippus</i> (Doubleday) ssp.?	S	1
114	<i>Charaxes bernardus</i> (Fabricius)	S	3
115	<i>Charaxes aristogiton</i> (Felder)	R	2
116	<i>Charaxes marmax</i> Westwood	S	2
117	<i>Charaxes kahruha</i> (Moore)	S	2
	<b>Satyridae</b>		
118	<i>Melanitis leda</i> (Linnaeus)	C	4
119	<i>Melanitis phedima</i> (Cramer)	U	3
120	<i>Elymnias patna</i> (Westwood)	S	2
121	<i>Elymnias hypermnestra</i> (Linnaeus)	S	3
122	<i>Elymnias casiphone</i> (Hubner)	S	2
123	<i>PentHEMA darlisa</i> Moore	S	1
124	<i>Lethe verma</i> (Kollar)	C	2
125	<i>Lethe confusa</i> Aurivillius	C	2
126	<i>Lethe mekara</i> (Moore)	S	2
127	<i>Coelites nothis</i> Westwood	R	2
128	<i>Orsotriaena medus</i> (Fabricius)	R	4
129	<i>Mycalesis inopia</i> Fruhstorfer	S	1
130	<i>Mycalesis deficiens</i> Fruhstorfer	R	1

131	<i>Mycalesis siamica</i> Riley & Godfrey	R	1
132	<i>Mycalesis intermedia</i> (Moore)	C	1
133	<i>Mycalesis annamitica</i> Fruhstorfer	C	1
134	<i>Mycalesis mystes</i> de Niceville	U	1
135	<i>Ragadia crisilda</i> Hewitson	R	2
136	<i>Ypthima baldus</i> (Fabricius)	C	3
137	<i>Ypthima huebneri</i> Kirby	C	2
138	<i>Ypthima imitans</i> Elwes & Edwards	U	2
	<b>Amathusiidae</b>		
139	<i>Faunis canens</i> Hubner	C	2
140	<i>Faunis eumeus</i> (Drury)	C	2
141	<i>Aemona (amathusia) tonkinensis</i> Rothschild	U	1
142	<i>Stichophthalma fruhstorferi</i> Rober	S	1
143	<i>Thaumantis diores</i> Doubleday	R	2
144	<i>Thauria lathyi</i> Fruhstorfer	U	1
	<b>Libytheidae</b>		
145	<i>Libythea myrrha</i> Godart	C	3
146	<i>Libythea geoffroyi</i> Godart	C	2
	<b>Riodinidae</b>		
147	<i>Zemeros flegyas</i> (Cramer)	C	2
148	<i>Abisara fylla</i> (Westwood)	C	2
149	<i>Abisara echerius</i> (Stoll)	S	2
150	<i>Abisara neophron</i> (Hewitson)	R	2
151	<i>Taxila dora</i> Fruhstorfer	R	1
152	<i>Stiboges nymphidia</i> Butler	U	2
	<b>Lycaenidae</b>		
153	<i>Miletus ancon</i> (Doherty)	S	1
154	<i>Allotinus substrigosus</i> (Moore)	S	2
155	<i>Caleta roxus</i> (Godart)	S	3

156	<i>Caleta elna</i> (Hewitson)	R	3
157	<i>Pithecopus fulgens</i> Doherty	S	2
158	<i>Udara dilecta</i> (Moore)	N	3
159	<i>Udara placidula</i> (H. Druce)	U	2
160	<i>Acytolepis puspa</i> (Horsfield)	C	3
161	<i>Celastrina lavendularis</i>	U	3
162	<i>Neopithecopus zalmora</i> (Butler)	C	3
163	<i>Megisba malaya</i> (Horsfield)	C	3
164	<i>Zizeeria maha</i> (Kollar)	R	2
165	<i>Catochrysops panormus</i> (Felder)	S	4
166	<i>Jamides bochus</i> (Stoll)	U	4
167	<i>Jamides celeno</i> (Cramer)	U	4
168	<i>Jamides elpis</i> (Godart)	R	1
169	<i>Jamides alecto</i> (Felder)	R	3
170	<i>Nacaduba kurava</i> Moore	U	3
171	<i>Nacaduba beroe</i> (Felder)	C	3
172	<i>Nacaduba berenice</i> (Herrich-Scheffer)	U	4
173	<i>Nacaduba hermus</i> (Felder)	U	3
174	<i>Prosotas nora</i> (Felder)	C	4
175	<i>Prosotas pia</i> Toxopeus	U	3
176	<i>Petrelaea dana</i> (de Niceville)	U	4
177	<i>Anthene lycaenina</i> (Felder)	U	3
178	<i>Anthene emolus</i> (Godart)	R	4
179	<i>Heliophorus kohimensis</i> Tytler	N	2
180	<i>Arhopala khamti</i> Doherty	S	2
181	<i>Arhopala ammonides</i> Doherty	S	2
182	<i>Arhopala aida</i> de Niceville	S	2
183	<i>Thaduka multicaudata</i> Moore	S	2
184	<i>Mahathala ameria</i> (Hewitson)	S	2
185	<i>Surendra quercetorum</i> (Moore)	S	3
186	<i>Amblypodia anita</i> Hewitson	S	3
187	<i>Spindasis syama</i> (Horsfield)	R	2
188	<i>Spindasis lohita</i> (Horsfield)	S	2

189	<i>Yasoda tripunctata</i> (Hewitson)	C	2
190	<i>Ticherra acte</i> (Moore)	S	2
191	<i>Tajuria maculata</i> (Hewitson)	S	2
192	<i>Zeltus amasa</i> (Hewitson)	U	2
193	<i>Sinthusa nasaka</i> (Horsfield)	C	2
194	<i>Rapala</i> sp. (? <i>manea</i> Hew.)	S	2 ?
195	<i>Curetis bulis</i> (Westwood)	U	2
	<b>Hesperiidae</b>		
196	<i>Bibasis jaina margana</i> (Fruhstorfer)	S	3
197	<i>Hasora chromus chromus</i> (Cramer)	C	4
198	<i>Hasora taminatus bhavara</i> Fruhstorfer	U	2
199	<i>Hasora malayana</i> (C. & R. Felder)	U	1
200	<i>Hasora vitta indica</i> Evans	C	3
201	<i>Badamia exclamationis</i> (Fabricius)	C	4
202	<i>Choaspes plateni stigmata</i> Evans	S	2
203	<i>Celaenorrhinus ? major</i> Hsu	U	2
204	<i>Celaenorrhinus</i> sp. (? Sp.n.) near <i>oscula</i> Evans	S	1
205	<i>Celaenorrhinus putra putra</i> (Moore)	C	2
206	<i>Celaenorrhinus nigricans nigricans</i> (de Niceville)	S	2
207	<i>Celaenorrhinus vietnamicus</i> Devyatkin	C	2
208	<i>Darpa pteria dealbata</i> (Distant)	S	3
209	<i>Darpa striata striata</i> (H. Druce)	S	2
210	<i>Pseudocoladenia dan fabia</i> (Evans)	U	2
211	<i>Coladenia agni agni</i> (de Niceville)	R	2
212	<i>Seseria</i> sp. (near <i>sambara indosinica</i> Fruhst.) (female)	S	2 ?
213	<i>Tagiades menaka menaka</i> (Moore)	U	3
214	<i>Tagiades litigiosa litigiosa</i> (Moschler)	U	3
215	<i>Abraximorpha davidii elfina</i> Evans	U	2
216	<i>Mooreana trichoneura pralaya</i> (Moore)	U	2

217	<i>Odontoptilum angulata angulata</i> (Felder)	S	3
218	<i>Pintara pinwilli pinwilli</i> (Butler)	S	1
219	<i>Astictopterus jama olivascens</i> Moore	C	2
220	<i>Ochus subvittatus subvittatus</i> (Moore)	R	2
221	<i>Ametta atkinsoni</i> (Moore)	C	2
222	<i>Halpe porus</i> (Mabille)	S	2
223	<i>Halpe pelethronix pagaia</i> Evans	S	1
224	<i>Pithauria murdava</i> (Moore)	S	2
225	<i>Iambrix salsala salsala</i> (Moore)	U	3
226	<i>Koruthaialos rubecula hector</i> Watson	C	3
227	<i>Koruthaialos sindu sindu</i> (C. & R. Felder)	U	3
228	<i>Koruthaialos butleri</i> de Niceville	S	2
229	<i>Stimula swinhoei swinhoei</i> (Elwes & Edwards)	S	2
230	<i>Ancistroides nigrita</i> (Latreille)	S	3
231	<i>Notocrypta clavata theba</i> Evans	S	1
232	<i>Notocrypta curvifascia curvifascia</i> (C. & R. Felder)	R	3
233	<i>Notocrypta feisthamelii alysos</i> (Moore)	U	3
234	<i>Scobura cephaloides kinka</i> Evans	R	2
235	<i>Suastus minuta aditia</i> Evans	R	3
236	<i>Cupitha purreea</i> (Moore)	S	3
237	<i>Zographetus satwa</i> (de Niceville)	R	2
238	<i>Zographetus doxus</i> Eliot	R	1
239	<i>Hyarotis adrastus praba</i> (Moore)	S	3
240	<i>Isma bononia idyalis</i> (de Niceville)	S	1
241	<i>Pyroneura margherita miriam</i> (Evans)	R	2
242	<i>Lotongus sarala</i> (de Niceville)	S	2
243	<i>Erionota torus</i> Evans	S	2
244	<i>Erionota thrax thrax</i> (Linnaeus)	S	3
245	<i>Pirdana hyela rudolphii</i> Elwes & de Niceville	S	3
246	<i>Potanthus trachala tytleri</i> (Evans)	R	2
247	<i>Potanthus mingo ajax</i> (Evans)	U	3
248	<i>Potanthus pava pava</i> (Fruhstorfer)	S	3



249	<i>Potanthus ganda ganda</i> (Fruhstorfer)	R	2
250	<i>Potanthus palnia palnia</i> (Evans)	U	3
251	<i>Telicota besta</i> Evans	S	2
252	<i>Telicota ohara jix</i> Evans	R	4
253	<i>Pamara bada bada</i> (Moore)	R	4
254	<i>Borbo cinnara</i> (Wallace)	S	4
255	<i>Pelopidas agna agna</i> (Moore)	C	4
256	<i>Pelopidas assamensis</i> (de Niceville)	S	2
257	<i>Polytremis lubricans lubricans</i> (Herrich-Scheffer)	C	2
258	<i>Baoris penicillata chapmani</i> Evans	S	2
259	<i>Caltoris cormasa</i> (Hewitson)	S	3

#### DISCUSSION

The species found are distributed between 11 families, which represent all groups of butterflies inhabiting Vietnam: Papilionidae - 27; Pieridae - 25; Danaidae - 15; Acraeidae - 2; Nymphalidae - 48; Satyridae - 21; Amathusiidae - 6; Libytheidae - 2; Riodinidae - 6; Lycaenidae - 43; Hesperidae - 64. The relative number of species revealed in each family generally reflects that registered for Vietnam as a whole, the total number comprising about 1/4-1/5 of the butterfly fauna of Vietnam.

A few female specimens (mostly from Lycaenidae and Hesperidae) could not be identified to species with certainty, since no reliable keys for females have been created till now.

At least one species of Hesperidae (No. 204) may prove to be new to science; in this family, two species (Nos. 203 and 223) also represent new records for Vietnam, *C. major* (if confirmed) most probably being a new subspecies.

As for the zoogeographical point of view, the majority of butterflies found in the Ke Bang area belong to the groups 2-3 of the "Range", i.e. they are more or less widely distributed in the Oriental Region, especially in its continental part. These can be regarded as "northern" species groups associated with primary and secondary forests of Sino-Himalayan origin.

The largest part of species belonging to group 1 ("southern" species) can be found in Satyridae, Amathusiidae and Riodinidae; of these, some species (for example, Nos. 131, 133,

## RESULTS

On the whole there were gathered about 70 specimens of anuran amphibians and reptiles of following species:

Nos.	Group, species	Number of specimens	Biotop
	<b>AMPHIBIA</b>		
	Bufonidae		
1	<i>Bufo melanostictus</i>	6	meadow
2	<i>Bufo galeatus</i>	2	meadow
	Microhylidae		
3	<i>Microhyla berdmorei</i>	2	river bank
4	<i>Microhyla heymonsi</i>	4	meadow
	Ranidae		
5	<i>Amolops</i> sp.	7	meadow
6	<i>Limnonectes limnocharis</i>	5	river bank
7	<i>Rana cuhlii</i>	2	meadow
8	<i>Rana macrodactyla</i>	1	seen in a pool
9	<i>Rana nigrovittata</i> (?)	1	seen in a pool
	Rhacophoridae		
10	<i>Polypedates leucomystax</i>	1	primary forest
	<b>REPTILIA</b>		
	Agamidae		
11	<i>Acanthosaura crucigera</i>	5	primary forest
12	<i>Calotes versicolor</i>	4	primary forest
13	<i>Draco</i> sp.	2	seen in primary forest
14	<i>Physignathus cocincinus</i>	2	Yen Hop river
	Gekkonidae		
15	<i>Cyrtodactylus pulchellus</i>	1	primary forest
16	<i>Gekko gecko</i>	many	heard everywhere
17	<i>Hemidactylus frenatus</i>	many	towns, villages
	Scincidae		
18	<i>Mabuya longicaudata</i>	2	seen, clearings
19	<i>Scincella melanosticta</i> (?)	4	primary forest

20	<i>Sphenomorphus</i> sp.	2	primary forest
	Serpentes		
	Colubridae		
21	<i>Dendrelaphis pictus</i>	1	primary forest
22	<i>Dinodon septentrionalis</i>	1	primary forest
23	<i>Elaphe</i> sp.	1	primary forest
24	<i>Oligodon taeniatus</i>	1	primary forest
25	<i>Pareas margaritafolius</i>	1	meadow
	Crotalidae		
26	<i>Trimeresurus albolabris</i>	1	seen, primary forest
27	<i>Trimeresurus cornutus</i> (?) or <i>Daboia</i> sp. (?)	1	primary forest
	Elapidae		
28	<i>Calliophis maclelandi</i>	1	primary forest

Some collected specimens are not yet determined because of lack of necessary literature. It is especially difficult task when it concerns amphibians.

It ought to be said that the herpetofauna of the region did not appeared to be too rich and abundant. But it seemed not to be the result of enormous agricultural or hunting pressure from the part of aboriginal peoples, what was quite evident for example in relation to some big mammals. More probable reason of relative scarcity of the herpetological diversity in vicinity of Yen Hop was inadequate season of observations, because for the moment there was no any obvious signs of active reproduction behaviour among local amphibians and reptiles and their juvenil stages of development were seen extremely rarely. Even ordinary potential resources of usual food for these animals (mainly orthoptera and slugs) just began to proliferate. Only once foam clutches of *Polypedates* sp. were seen hanging over a small stream in the primary forest, but tadpoles were not present yet in the water. Even frogs choruses in the river Yen Hop were not as deafening as it usually occurs in tropical humid biotops. It seems probable that the main reason for low activity of amphibians and reptiles was rather low temperatures at nights and especially in morning hours, when temperature sometimes did not exceed +18°C. In other words a high overfall of temperatures between day and night levels could be responsible for postponing of the reproductive season, and consequently for low number of herpetological subjects, in the period of our work in Ke Bang area. Finally, it is necessary to note, that almost in all the captured animals, as

well in amphibians as in reptiles gonads were not too developed and were rather on the stage of starting growth and the most part of stomachs in dissected animals was empty demonstrating a really low activity of animals even in their food-seeking occupations. But even on the background of low activity and number of herpetological subjects it is quite evident that the most rich herpetofauna is characteristic for primary tropical forest at least in relation to species diversity. Surely if only the terms of expedition work were prolonged up to the last decade of May the final results of herpetological revelations in Phong Ngha - Ke Bang area would be much more impressive.

#### **ACKNOWLEDGMENTS**

In conclusion I would like to express my gratitude and deep sincere feelings to all those who accompanied our work and favoured it to accomplish successfully and first of all to the staff of the Tropical Center and to my colleagues on the expedition team.

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## ORNITHOLOGICAL STUDIES

Conducted by Mikhail V. Kalyakin

### PURPOSES OF STUDY

Our work was a part of complex research of biodiversity in Ke Bang area. This lowland region of limestone forest lays in 30-40 kms to the north from Phong Nha Nature Reserve. It is planned to include it in territory of the Reserve for increasing its total area. If this plan would be realised a huge net of Nature Reserves alongside the border between Laos and Vietnam including Pu Mat, Vu Quang and Phong Nha-Ke Bang Reserves in Vietnam territory would be more complex.

The main aim of recent survey is to ascertain the List of bird species for territories of Yen Hop valley and some areas around it covered by primary and secondary forest habitats as well as secondary grass and bush vegetation in valleys inhabited by local villagers. I also have tried to identify status of breeding species and to collect any data on biology of all found bird species. Final conclusions about appropriateness and availability of protection of studied area must be based on mentioned materials.

### BACKGROUND INFORMATION

Decreasing of the area of Vietnam forests under the influence of logging, cutting and establishing of new rice fields or other plantations is recently more and more quick. On the other hand, some Projects are ongoing on study and protection of forest massifs, mainly alongside of the country's borders, under the Government and some International Foundations patronage. Recent work is a result of co-operation between Tropical Centre, WWF and local administration in study of Ke Bang flora and fauna diversity. Birds, as well as butterflies, present main components of biodiversity studies because they are very diverse and visible.

The Ke Bang area (c. 17°40'-50'N, 105°50'-106°E) is situated near the Laos-Vietnam border in Quang Binh Province, in west of north part of former Central Annam. The data on bird fauna of mentioned big region were collected before 1940 during some expeditions of J. Delacour and his colleagues and were summarised in a series of faunistic reviews (Delacour and Jabouille 1931, Delacour and Greenway 1940, 1941, Delacour and Jabouille 1940, Delacour 1951, King *et al.* 1975).

After than a long «gap» in ornithological works included a time of the war, and since expeditions were renewed only in the 1979, when co-operative team of Soviet-Vietnamese zoologists visited south part of Central Annam. Their work was continued with some pauses before 1990, final review of bird fauna of the studied area (mainly central and north parts of Tay Nguyen Plateau) was published in 1995 and included some information on bird species new for Central Annam (Stepanyan 1995). Active field studies in forests of Vietnam started in the late 1980-s by English-Vietnamese team, three their publications appeared with some new information on birds of Central Annam (Robson *et al.* 1989, 1993, 1994). They were collected mainly in Bach Ma National Park, more southern than Ke Bang and Phong Nha. Member of mentioned team, J.C. Eames and his colleagues Nguyen Cu and Chuong Van La continue to research of forest birds of Vietnam and elaborate questions of their protection. As a part of this work special survey of threatened Pheasants was made in June-July 1994 in some forest locations, including two in the north part of Central Annam - Bach Ma and Phong Nha. Some data on threatened lowland forest birds were included in final publication of this project (Eames *et al.* 1994) as well as list of recorded bird species, it was the first published information on birds of the Reserve. This study led to fine discovery: Globally Threatened species Sooty Babbler *Stachyris herberti* was found in the first time for Vietnam and secondary after its describing in 1920 (Eames *et al.* 1995). During last decade investigations of bird fauna were actively developed in Laos. As a result, a lot of new data on distribution of Lao birds were collected and published (Thewlis *et al.* 1996, Duckworth *et al.* 1998, Evans and Timmins 1998). Thus, many new data have been got from areas located closely to the territory of Phong Nha and Ke Bang in Laos. There is Hin Namno Nature Reserve in Laos alongside the border of country which represents one of a series of protection areas in Central Laos (Tobias *et al.* 1998).

## METHODS

The composition of the List was made by usual bird-watching methods of bird registration. They were used during slow walk excursions or observation from points carried out on different habitats. Visual records made by binocular (8 x 35) and visual-tube (30-60 x) was the main work method.

Using of type-recording of bird calls was the second main method of collecting data about bird community composition. In the beginning of survey we used the hand-recorder "Sony" for collecting records of birds voices and further stimulation of singers by taping of their calls. This method allowed to identify some shy species, but the recorder was destroyed

on 4 of April. After that we also paid our attention to calls of birds, because the main part of registration in closed tall forest were made by this way. For example, collecting only 15-20 visual records of birds was common situation for one-day excursion in dense closed forest on a range's slopes. As a result I am sure that some local species were omitted during the survey, but I also believe that majority of common or typical species were discovered. We also have got some notes on birds recorded by our colleagues German V. Kouznetsov, Sergei V. Krouskop, Boris D. Vassil'ev and Alexei L. Devyatkin, but mainly from Andrey N. Kouznetsov, who also have found some nests.

Some records were additionally confirmed by catching birds using mist nets (length 10 m, height 3 m, size of mesh 14 mm) which were arranged in all study sites in number from 1-4 per day, and 10 species were included in the List by this way. Totally 61 specimens were caught by me and additionally 32 specimens were got from S.V. Krouskop who used mist nets for catching bats.

Records of two species were made only on base of finding their feathers and one died bird found on a forest path has added one species for the List. Finally, one species was discovered in hands of local man who tried to trade it.

Catching birds were released after getting up measurements and descriptions, or collected: in agreement with contract we collected not more than 2-3 specimens of one species. The scheme of description of caught birds includes such data as a date and place of catching, species, weight, measurements of wing, tail, bill (three parameters) and tarsus, conditions of fat deposition, gonads, brood patch and skull, presence and degree of moult. The taxonomy of Inskipp *et al.* (1990) is followed throughout, English names of birds also can be found here and Vietnamese names of birds are accessible in Vo Quy and Nguyen Cu (1995).

### STUDY DATES AND SITES

The field work was carried out from 16 of March to 30 of April 1999. Two areas were visited, both on lowland landscape on elevations not more than 450-500 m:

1. **The Yen Hop valley between Yen Hop and O Mo villages** was under investigation from 17-31 of March and from 21-30 of April including two days of marches with the back from and to Thuyen Hoa village, as well as 7 days of rains when only some observations were made in the base camp. One day, 21 of March, was used for far-off excursion to the south-west (see below 2.). Secondary shrub and grass vegetation habitats are presented here mixed in different proportions with separate trees or small groups of them. Borders of

the valley are formed by limestone slopes and covered by secondary forest. Both mentioned types of habitats were investigated in equal proportion. Additionally, one excursion was made in the primary forest on a limestone hills in 2-3 kms to the north from the base camp (20 of March).

2. Some dry valleys and limestone ranges located in 12-18 kms to the south-west from the Yen Hop village were investigated during 1-20 of April with pauses on 2 days due to rains. This time also includes two days of marches from and to base camp.

Besides that, 16 of March was spend in small village "Fort 585", or Thuong Hoa, located near the road in 12-14 kms to the north-east from Yen Hop village. In total, 46 field days are included 17 days of observations in primary forest habitats, 13 days - in secondary vegetation habitats, 1 - in a small village, 9 days were almost fully omitted because of rains, 2 days were devoted to camp preparation, and 4 days of long-distance marches with a luggage where observations on birds were accidentally.

## RESULTS

Totally 146 bird species were found during the expedition including three questionnaire species (juveniles of *Hierococcyx* sp.; *Garrulax monileger* or *pectoralis* and *Phylloscopus coronatus*, or *davisoni*, or *reguloides*) as well as three unidentified representatives of genera *Accipiter*, *Arborophila* and *Abroscopus*. It is only in small instance lower than in the same period in Vu Quang Reserve where high elevations (1200-1400 m a.s.l.) was also visited. The majority of found species are represented by lowland birds with only small addition of low mountains fauna.

Eight forms are new for North Annam including four evidently breeding, and two other may be stated as new for this region - unidentified young Cuckoo and possibly found Laughingthrush *Garrulax pectoralis*.

Studied area represents the territory where 3 globally threatened and 5 globally near-threatened (Collar *et al.* 1994) species were discovered during our visit, including Crested Argus *Rheinardia ocellata*, Red-collared Woodpecker *Picus rabieri* (presumably breeding), Sooty Babbler *Stachyris herberti* (breeding) as well as Brown Hornbill *Anorrhinus tickelli* (presumably breeding), Blue-rumped and Bar-bellied Pittas *Pitta soror* and *P. elliotii* (both are breeding), White-winged Magpie *Urocissa whiteheadi* (breeding) and Fujian Niltava *Niltava davidi*.

Totally, the breeding was evidenced for 32 species by nests or fledglings observations, or catching females with developed brood patch. All data on breeding are included in the Ta-



ble. Probably many other bird species were breeding also in studied area and only small numbers of recorded species were migrants - near 13 or 14 ones, status of many other still rests unclear.

Abundance of birds was estimated roughly by using three categories: common species ( $n=29$ ), rare species ( $n=40$ ) and occasional species ( $n=77$ ).

**List of bird species recorded in Ke Bang studied area  
from 16 of March to 1 of May 1999**

No.	Species	Abundance	Breeding	Number of caught birds	Additions
1	2	3	4	5	6
1	<i>Arborophila</i> sp.	occasional			
2	<i>Lophura nycthemera</i>	feathers			only from hunters
3	<i>Rheinardia ocellata</i>	occasional			
4	<i>Tumix suscitator</i>	rare			
5	<i>Sasia ochracea</i>	occasional		1	
6	<i>Dendrocopos canicapillus</i>	occasional			
7	<i>Picus chlorophus</i>	occasional			
8	<i>Picus flavinucha</i>	occasional			
9	<i>Picus rabieri</i>	rare		2	
10	<i>Blythipicus pyrrhotis</i>	rare			
11	<i>Megalaima lagrandieri</i>	rare			
12	<i>Megalaima faiostricta</i>	common			
13	<i>Megalaima franklinii</i>	rare			
14	<i>Buceros bicornis</i>	occasional			
15	<i>Anorrhinus tickelli</i>	rare			
16	<i>Aceros undulatus</i>	occasional			
17	<i>Harpactes erythrocephalus</i>	common	3 nests	1	
18	<i>Eurystomus orientalis</i>	rare			
19	<i>Alcedo atthis</i>	rare		3	

20	<i>Alcedo meninting</i>	occasional		2	
21	<i>Ceyx erithacus</i>	occasional		1	
22	<i>Halcyon smymensis</i>	occasional			
23	<i>Lacedo pulchella</i>	occasional			
24	<i>Clamator coromandus</i>	occasional			
25	<i>Hierococcyx sp.</i>	occasional			
26	<i>Cuculus canorus</i>	occasional			
27	( <i>Cuculus saturatus</i> )	rare			
28	<i>Cacomantis merulinus</i>	rare			
29	<i>Sumiculus lugubris</i>	common			
30	<i>Phaenicophaeus tristis</i>	occasional			
31	<i>Centropus sinensis</i>	common			
32	<i>Centropus bengalensis</i>	common			
33	<i>Loriculus vernalis</i>	occasional			
34	<i>Collocalia brevirostris</i>	common			
35	<i>Apus affinis</i>	occasional			
36	<i>Hemiprocne coronata</i>	occasional			
37	<i>Otus spilocephalus</i>	occasional			
38	<i>Otus sunia</i>	rare			
39	<i>Otus bakkamoena</i>	occasional			
40	<i>Glaucidium cuculoides</i>	rare			
41	<i>Ninox scutulata</i>	rare			
42	<i>Caprimulgus macrurus</i>	rare			
43	<i>Streptopelia chinensis</i>	common			
44	<i>Chalcophaps indica</i>	rare		1	
45	<i>Treron curvirostra</i>	occasional			
46	<i>Treron apicauda</i>	common			
47	<i>Ducula badia</i>	rare			
48	<i>Amauromis phoenicurus</i>	occasional			
49	<i>Actitis hypoleucos</i>	occasional			
50	<i>Pernis ptilorhincus</i>	occasional			
51	<i>Elanus caeruleus</i>	occasional			

52	<i>Spilomis cheela</i>	rare			
53	<i>Accipiter trivirgatus</i>	rare	nest		
54	<i>Accipiter sp.</i>	occasional			
55	<i>Butorides striatus</i>	occasional			
56	<i>Ixobrychus cinna- momeus</i>	occasional		2	
57	<i>Pitta soror</i>	occasional	fledglings	2	
58	<i>Pitta elliotii</i>	occasional	fledglings	1	
59	<i>Pitta cyanea</i>	rare	2 nests	1	
60	<i>Serilophus lunatus</i>	occasional			
61	<i>Psarisomus dalhousiae</i>	occasional	developed brood patch	1	died was found
62	<i>Irena puella</i>	common	building of nest		
63	<i>Chloropsis cochinchinensis</i>	occasional			
64	<i>Chloropsis aurifrons</i>	occasional			
65	<i>Chloropsis hardwicki</i>	occasional			
66	<i>Lanius cristatus</i>	occasional			
67	<i>Lanius tephronotus</i>	rare	feeding of chicks		
68	<i>Urocissa erythrorhyn- cha</i>	occasional			
69	<i>Urocissa whiteheadi</i>	rare	nest		
70	<i>Crypsirina temia</i>	rare			
71	<i>Temnurus temnurus</i>	rare			
72	<i>Artamus fuscus</i>	rare			
73	<i>Oriolus xanthornus</i>	occasional			
74	<i>Coracina macei</i>	occasional			
75	<i>Coracina melashista</i>	occasional			
76	<i>Pericrocotus solaris</i>	occasional			
77	<i>Pericrocotus flammeus</i>	rare	building of nest		
78	<i>Hemipus picatus</i>	occasional			
79	<i>Dicrurus leucophaeus</i>	rare			
80	<i>Dicrurus annectans</i>	common			
81	<i>Dicrurus aeneus</i>	common	building of nest, fledg-		

			ling		
82	<i>Dicrurus remifer</i>	occasional			
83	<i>Dicrurus paradiseus</i>	occasional			
84	<i>Hypothymis azurea</i>	occasional			
85	<i>Terpsiphone paradisi</i>	rare	nest	2	
86	<i>Aegithina tiphia</i>	occasional			
87	<i>Tephrodomis gularis</i>	occasional			
88	<i>Monticola solitarius</i>	occasional			
89	<i>Myophonus caeruleus</i>	rare			
90	<i>Turdus boulboul</i>	occasional			
91	<i>Muscicapa dauurica</i>	occasional			
92	<i>Ficedula parva</i>	rare		2	
93	<i>Niltava davidi</i>	occasional		1	
94	<i>Cyornis concretus</i>	occasional	brood patch	1+?N 27	
95	<i>Cyornis hainanus</i>	common	nest, fledgling	9+?N 27	
96	<i>Culicicapa ceylonensis</i>	rare			
97	<i>Luscinia cyane</i>	occasional			
98	<i>Copsychus saularis</i>	common		2	
99	<i>Copsychus malabaricus</i>	occasional			
100	<i>Enicurus schistaceus</i>	rare			
101	<i>Enicurus leschenaulti</i>	occasional			
102	<i>Acriditheres cristatellus</i>	common		4	
103	<i>Gracula religiosa</i>	occasional			
104	<i>Melanochlora sultanea</i>	rare			
105	<i>Pycnonotus jocosus</i>	common	developed brood patch	5	
106	<i>Pycnonotus finlaysoni</i>	rare			
107	<i>Alophoixus pallidus</i>	common			
108	<i>Hypsipetes leucocephalus</i>	occasional			
109	<i>Prinia atrogularis</i>	rare			
110	<i>Prinia hodgsonii</i>	common			
111	<i>Prinia flaviventris</i>	common	nest		

112	<i>Locustella lanceolata</i>	occasional			
113	<i>Orthotomus sutorius</i>	common	feeding of chicks		
114	<i>Orthotomus atrogularis</i>	occasional			
115	<i>Phylloscopus schwarzi</i>	occasional		1	
116	<i>Phylloscopus inornatus</i>	occasional			
117	<i>Phylloscopus trochiloides</i>	occasional			
118	<i>Phylloscopus coronatus/ reguloides/ davisoni</i>	occasional			
119	<i>Phylloscopus ricketti</i>	common			
120	( <i>Abroscopus</i> sp.)	occasional			
121	<i>Garrulax leucolophus</i>	rare			
122	<i>Garrulax monileger/pectoralis</i>	occasional			
123	<i>Garrulax chinensis</i>	occasional	developed brood patch	1	
124	<i>Garrulax canorus</i>	occasional	fledglings		
125	<i>Pellorneum tickelli</i>	common	developed brood patch	4	
126	<i>Malacopteron cinereum</i>	common	2 nests	5	
127	<i>Pomatorhinus hypoleucos</i>	common	developed brood patch	4	
128	<i>Pomatorhinus ruficollis</i>	occasional	fledglings		
129	<i>Napothera brevicaudata</i>	rare	2 nests		
130	<i>Napothera epilepidota</i>	rare	nest	1	
131	<i>Stachyris herberti</i>	occasional	??? fledglings		
132	<i>Stachyris nigriceps</i>	common	fledglings	9	
133	<i>Stachyris striolata</i>	occasional			
134	<i>Macronous gularis</i>	common	fledglings	1	
135	<i>Alcippe poiocephalus</i>	occasional			
136	<i>Alcippe peracensis/grotei</i>	rare	nest	1	

137	<i>Yuhina zantholeuca</i>	common	fledglings	3	
138	<i>Dicaeum concolor</i>	rare			
139	<i>Aethopyga christinae</i>	common	building of nest		
140	<i>Aethopyga siparaja</i>	occasional			
141	<i>Arachnothera magna</i>	common		2	
142	<i>Passer montanus</i>	occasional			
143	<i>Motacilla cinerea</i>	occasional			
144	<i>Anthus hodgsoni</i>	rare			
145	<i>Lonchura striata</i>	occasional	building of nest	1	
146	<i>Lonchura punctulata</i>	common		8	

### LIST OF SPECIES OF PARTICULAR INTEREST

This part of text included data on Threatened and Near-threatened bird species as well as birds presumably new for Central Annam.

#### **Crested Argus *Rheinardia ocellata***

The only one calling bird was heard on a slope of the Yen Hop River valley not far from Yen Hop village on 19 of March. Besides that, some feathers were found in house of aboriginal hunters or near their small field camps.

#### **Red-collared Woodpecker *Picus rabieri***

Presumably breeding species. It was more common than other woodpeckers in primary forest studied area 12-14 kms to the south-west from Yen Hop village. Four localities of regular meetings were determined on a 4 kms transect. Two males used big trees for bill-pointing almost everyday, caught female had developed brood patch.

#### **Brown Hornbill *Anorrhinus tickelli***

Common species in primary forest 12-16 kms to the south-west from Yen Hop village. Some small flocks or pairs were recorded every day, biggest flock included 7 birds.

#### **Cuckoo *Hierococcyx* sp.**

Juveniles was found in the nest of Hainan Blue Flycatcher *Cyornis hainanus* on 19 of April by A.N. Kouznetsov. It was kept in captivity before 8 of May, when it died on unclear rea-

son. Recently we can not identify it, available literature show us that more features say about its belonging to genera *Hierococcyx*.

**Crested Treeswift *Hemiprocne coronata***

One bird was seen in Yen Hop valley on an area of secondary tree-shrub vegetation with big gaps covered by bush and grass on 23 of April.

Previously the species was firstly discovered for Central Annam in Buen Luoi, south part of the region (Robson *et al.* 1989), recent record is far more northern.

**Bar-bellied *Pitta elliotii***

Male, and some days later - pare with two or more fledglings, were recorded during more than 10 days on a some area in primary forest on elevation near 400 m a.s.l.

**Blue Pitta *Pitta cyanea***

Pare with nest containing three chicks of age from 1-3 days was found on 26 of March in secondary forest area near the base camp on a foothill (c. 100 m a.s.l.). One bird and another pare with the nest containing four eggs were recorded in primary forest on 14 of April.

It is the first registration of the species in Central Annam, and the first breeding record, of cause.

**Blue-rumped Pitta *Pitta soror***

Brood including three or four fledglings was seen on 26 of April in secondary forest mixed with an old banana plantation on a foothill near base camp. Female and one fledgling both were caught here by mist net 29 of April, and female has laid one egg in a net.

**Grey-backed Shrike *Lanius tephronotus***

Species was not rare in grasslands with groups of bushes and trees in Yen Hop valley. Two birds with food for chicks were seen in two different places on 28 of March. It is presumably second record of species in North Annam after our own registration on 30 of April 1992 near Kon Ha Nung village (c. 60 kms to the north from Ankhe, Tay Nguyen Plateau, 600-700 m a.s.l.) where one adult female was collected. It had developed brood patch and enlarged follicles.

**Fujian Niltava *Niltava davidi***

The only one bird, presumably young (with dull yellow corners of the gape) was caught by mist net on 2 of April in closed primary forest.

**Grey-winged Blackbird *Turdus bouboul***

Male was twice seen on the same place in the evening on 18 and in the early morning on 19 of April. Bird was under watch in a distance near 3-4 m, dull patch on wing and red-orange (more red than orange) bill were seen clearly. It is first record for Central Annam.

***Abroscopus* sp.**

One bird was recorded in understory of closed primary forest at elevation 400-450 m a.s.l. on 10 of April. Its identification is not clear, because not all seen features were conformed with descriptions of any Warblers in King *et al.* (1975) or some other Asian guides. The bird has greenish back, wings and rump, almost white breast and belly, dull rufous head with pale crown stripe and without black stripes above eyes and blackish or black throat. Call can be described as a ringing, clear-cut short signal «*trrsee*». Small bird quickly jumped on crown of small trees in 3-6 m above land and was under watch during 20-30 seconds. Its movements were likely to ones of tailorbirds (but with shot bill!) or small warblers from genera *Abroscopus* and *Seicercus*.

**White-winged Magpie *Urocissa whiteheadi***

Breeding species. Records were done in four primary and secondary forest areas. They were regular in one place in primary forest from 21 of March to 19 of April, where building of nest was seen in the morning of 8 of April. Tree birds intensively brought small branches of trees to the crown of a high tall tree in the centre of a small gap during almost two hours.

**Lesser or Greater Necklaced Laughingthrushes *Garrulax monileger/pectoralis***

Groups of Laughingthrushes were not rare in study area, but I could see it only in some sauces. Thus, one big group of 7-10 birds was recorded on 7 of April in closed primary forest on elevation 400-450 m a.s.l., but birds were not under good watch, so identification was not full. Greater Necklaced Laughingthrush was not registered in Central Annam previously.



**Hwamei *Garrulax canorus***

Two fledglings were bough by one our Vietnamese colleague on 23 of April. Birds were collected not far from Yen Hop village, but there is small possibility of their origin from the territory of Laos. If they were found in the territory of Vietnam it is possibly the first record of species from Central Annam.

**Sooty Babbler *Stachyris herberti***

Two birds were seen near the base of high limestone wall in small village "Fort 585", or Thuong Hoa, located near the road in 12-14 kms to the north-east from Yen Hop village. Pare with fledgling(s) was seen by Andrei Kouznetsov on 26 of April about 5 kms to the north from Yen Hop village.

This quite rare species was rediscovered in Vietnam by J. Eames with colleagues (Eames *et al.* 1995) at 1994 to limestone territory of Phong Nha Nature Reserve. Their record was first for Vietnam and second after description of species from Laos in 1920. Our discovery is the second registration for Vietnam and first for evidently breeding species.

**Streak-breasted Scimitar Babbler *Pomatorhinus ruficollis***

One bird was caught by mist net and another one was seen near it with three fledglings on area of secondary forest near Yen Hop village on 29 of April.

Previously this species was found in Cat Binh, not far to the north from studied area, but in North Annam (Robson *et al.* 1989). So our record is presumably the first one for Central Annam.

**Brown-cheeked Fulvetta *Alcippe poiocephalus***

Two birds were seen in a small mixed flock with Striped Tit-babbler *Macronous gularis* and White-bellied Yuhina *Yuhina zantholeuca* in primary forest on 10 of April. It is presumably the first record of the species in Central Annam.

**HUMAN ACTIVITY AND PROTECTION OF BIRDS**

Note: that lowland forest of Vietnam is a mostly rare type of habitats, because its total area decreases more and more quickly throughout all the country. On the other hand, its flora and fauna are richest, so degradation of lowland forests leads to lost of biodiversity in disproportional degree. Lowland forest on limestone has very small area in Vietnam, so terri-

tory of Phong Nha-Ke Bang proposed as a National Park can be treated as a unique Natural region for the country. But ...

Our own observations and information collected by our Vietnamese colleagues, mainly by Phan Luong, show that very active hunting is a main negative influence of human activity on birds in the studied area. Farming is located only in some wide river valleys, logging has low activity and cutting is limited too. But catching of birds (and mammals) and trading of natural productions are very active and keep in practice not only of local people but of many visitors too.

Thus, we have found a lot of aboriginal snares of different constructions in all visited forest territories including ones in a distance near 10 and more kilometres from villages. Mostly common model is a low (40-50 cm) and very long (up to 1 km) fence built of branches and palm leaves and usually oriented a cross tiny valleys from one steep limestone slope to another one. There are a lot of gates with a loops or primitive traps for small mammals and birds. As we could understand, each aboriginal family has its own hunting territory and common everyday practice is to exam traps by children. Some feathers of pheasants and Crested Argus were found near such fences or near small forest camps of hunters, and the same method could be used for catching other terrestrial birds.

Small birds are also a common object of hunting. We have got to know only one variant of such practice. It consists of using of tree branch as a perch for small birds in combination with loop laid on it. Small red fruits of some Aroid plants are used as a bait. Presumably some other methods are used too, because we could see that local people are very nicely familiar with birds, their behaviour and voices. Thus, one villager has demonstrated good imitation of some bird calls which he has heard around in a moment. On the other hand, there is a practice of trading of fledglings of some common singing birds. This trade is based on a good field experience in finding out nests, of cause. We also believe, that one Long-tailed Broadbill found by us on a forest path on 10 of April also was loosed by hunters.

Collecting of wild birds has two main directions. It is a common food for local «ruk» people, because this people traditionally (historically) used forest productions but not rice. But presumably more active affairs are directed on export of «animal food» to Minh Hoa and may be to Dong Hoi and Hanoi. This way is common for trading of wild mammals, but we believe that birds, for example - pheasants, may be included too. Scale of this activity was estimated by us during work in primary forest in 12-14 kms to the south-west from Yen Hop village. From 3-4 to 12-15 persons per day were account on a small forest path di-

rected to the west, to the Laos-Vietnamese border. Rice and presumably some other foods were transported to the west, and alive or died animals or short-prepared meat were moved to the east direction. So this small path really works as a street or a highway for poachers.

Another feature issued from an active hunting is a very low density of pheasants and other Phasianidae. We collected only five or six records for all our colleagues who actively walked to different types of forests and savannah habitats during near one month and half. Our previous experience in working in different parts of Vietnam shows that it may be connected with high level of human press on birds. We can say that Ke Bang was a first from more than 10-12 places characterised by such low density of Phasianidae species. We can only hope that part of Ke Bang area not visited by us and that rises southward has low density of people and keeps its native conditions due to rarity of water sources.

### CONCLUSION

The main conclusion of the ornithological survey consists of an idea that bird fauna of studied part of the Ke Bang area is rich, diverse, includes some Threatened and Near-threatened species and have clear lowland character with some specifically limestone elements. Only low elevations were visited during research, but more than 140 bird species were registered, mainly residents. Pilot character of work allows to hope on future discovery of some relatively common species which were omitted by us as well as some migrants. Specific landscape of Ke Bang area, its rich flora and fauna, general rarity of not-destroyed lowland forests in Vietnam, general low density of local human population, a neighbourhood with protected area in Laos - all are the reasons for establishment of any form of protection on this territory additionally to Phong Nha Reserve. High level of hunting activity makes this purpose more actual and necessary.

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and have done many works on study of local hunters practice. My greatest debt is to all participants of the expedition who have shared with me all troubles and joys of our travel and work. Special thanks to Sergei V. Krouskop for his direct help in bird catching and to Andrei N. Kouznetsov for finding out some nests, including nest with Cuckoo chick, and some important additions to the List of bird species, including new for Central Annam. Finally I am happy to acknowledge our «camp team» - our cock and his assistant for their fine activity in regular food preparation, camp preparation and establishing good contact with local guides and carriers.

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## INVESTIGATIONS OF BIOLOGICAL DIVERSITY IN MAMMALS (EXCEPT THE BATS)

Conducted by German V. Kouznetsov , Pham Hong Phuong

### REGION OF INVESTIGATIONS

Theriological investigations were conducted under the frame of complex expedition of the Tropical Center with the aim of estimation of the present condition of natural environments and animal populations in environs of villages Yen Hop and Ban On, as well as near villages Mo, O, in mountain massifs of Ma Ma and Dalat 2. All the coordinates are indicated on the map applied. Possession of such data permits to elaborate a row of recommendations and measures on preservation of the studied region in proper time and to help in organization of a natural reserve. It's necessary to note that this region (Ke Bang) was earlier visited and investigated by Vietnamese zoologists in March of 1997 (Le Xuan Canh, Truong Van La, Dang Thi Dap, Ho Thu Cuc, Ngo Anh Dao, Pham Nhat *et al.*) and in July-September of 1998 (Nguyen Xuan Dang, Pham Nhat, Pham Trong Ahn with participation of Ditte Hendrichsen from Denmark). Their materials are of some interest for us and were properly used.

### METHODS

While observing different biotops for finding out species composition and relative number of mammals (preferably rodents and insectivores) we used net traps and in some limited number killing traps. The main kind of capturing animals was carried out on the lines (transects), where traps were positioned after each 5 meters of distance. The captured rodents were determined in place and then released, but some of difficulty determining species were collected with the perspective of their ultimate precise determination in museums. Method of picking up excrements of animals was also commonly used especially for carnivores and ungulates. Registration of footprints of these animals also facilitated gathering of information on the meetings and distribution of the representatives of these groups. The same aim was implied while visual watching for sciurids, daily carnivores, ungulates and primates. Additive material was obtained from local hunters of the tribe Rock. While questioning them we used the help of interpreters knowing local languages. It make us capable to ask local hunters in folk dialects. Besides in difficult situations we showed them photo-prints or drawing of animals. Great help in contacts with native people rendered us Phan Luong.

## RESULTS

The index of biodiversity of any taxonomic group reacts the most promptly on the anthropogenic pressure and changement of habitats. Lower we give the taxonomic list of mammals (without Chiroptera) for the studied region, the animals being obtained by us ourselves or by local hunters as well as registered by us visually.

Table 1

Taxonomic list of mammal species (without Chiroptera) of the region (1- specimen investigated; 2- visual registration; 3- footprints; 4- excrements)

Nos	Order Insectivora	
	Fam. Erinaceidae	
1.	<i>Hylomys suillus</i> Miller, 1839	1
	Fam. Soricidae	
2.	<i>Crocidura</i> sp.	1
	Order Scandentia	
3.	<i>Tupaia glis</i> (Diard, 1820)	2
	Order Primates	
4.	<i>Macaca cf. mulatta</i> (Zimmermann, 1870)	2
	Order Carnivora	
	Fam. Mustelidae	
5.	<i>Melogale moschata</i> (Gray, 1831)	1
6.	<i>Lutra lutra</i> (Linnaeus, 1758)	3
	Fam. Viverridae	
7.	<i>Paradoxurus hermaphroditus</i> (Pallas, 1777)	1
8.	<i>Arctictis binturong</i> (Raffles, 1821)	3
	Fam. Felidae	
9.	<i>Prionailurus bengalensis</i> (Kerr, 1792)	4
10.	<i>Catopuma temminckii</i> (Vigors&Horsfield, 1827)	1
	Order Artiodactyla	
	Fam. Suidae	
11.	<i>Sus scrofa</i> Linnaeus, 1758	1
	Fam. Cervidae	

12.	<i>Muntiacus muntjak</i> (Zimmermann, 1780)	1, 3
	Fam. Bovidae	
13.	<i>Naemoraedus sumatraensis</i> (Bechstein, 1799)	1, 3
	Order Pholidota	
14.	<i>Manis javanica</i> Desmarest, 1822	1
	Order Rodentia	
	Fam. Sciuridae	
15.	<i>Petaurista petaurista</i> (Pallas, 1766)	2
16.	<i>Callosciurus erythraeus</i> (Pallas, 1779)	2
17.	<i>Callosciurus flavimanus</i> (I. Geoffroi, 1831)	2
18.	<i>Dremomys rufigenis</i> (Blanford, 1878)	2
19.	<i>Tamiops</i> sp. (cf. <i>rodolphi</i> Milne-Edwards, 1867)	2
20.	<i>Ratufa bicolor</i> (Blanford, 1878)	2
	Fam. Muridae	
21.	<i>Mus musculus</i> Linnaeus, 1758	1
22.	<i>Mus caroli</i> Bonhote, 1902	1
23.	<i>Mus cervicolor</i> Hodgson, 1845	1
24.	<i>Rattus</i> cf. <i>rattus</i> (Linnaeus, 1758)	1
25.	<i>Rattus flavipectus</i> (Milne-Edwards, 1872)	1
26.	<i>Rattus koratensis</i> Kloss, 1919	1
27.	<i>Rattus molliculus</i> Robinson&Kloss, 1922	1
28.	<i>Niviventer bukit</i> (Bonhote, 1903)	1
29.	<i>Niviventer fulvescens</i> (Gray, 1847)	1
30.	<i>Niviventer tenaster</i> (Thomas, 1887)	1
31.	<i>Leopoldamys sabanus</i> (Thomas, 1887)	1
32.	<i>Maxomys sunifer</i> (Miller, 1900)	1
33.	<i>Maxomys</i> (f.) <i>moi</i> (Robinson et Kloss, 1922)	1
	Fam. Hystricidae	
34.	<i>Atherurus macrourus</i> (Linnaeus, 1758)	1
	Order Lagomorpha	
	Fam. Leporidae	
35.	<i>Lepus peguensis</i> Blyth, 1855	1



This list of mammal species doesn't reflect completely the group's biodiversity known for the given region (see Dang Huy Huynh *et al.*, 1994; Corbet and Hill, 1992), that indicates the evident actual «defectness» of the fauna. In the first order it is noticeable for some great beasts of prey, ungulates and primates. One of the main factors lowering number of these groups is agricultural activity of man including direct persecution of animals for the sake of meat and raw materials for medicinal preparation.

As an example the condition of the local population of *Sus scrofa* may be considered. Constant use of capturing loops for wild-boars by local hunters from Rock and Sach tribes has led to evident reduction in sizes of animals in local populations. For example, in environs of Yen Hop for the period from November 1999 up to May 1999 9 adult specimens *Sus scrofa* were captured, but only 2 of them had weight about 140-150 kg and the weight of the rest 7 animals (77.8%) didn't exceed 40 kg. Similar quantitative indices were as well stated in some game ungulates, and great beasts of prey and primates have disappeared entirely from the territory

The taxonomic list cited above is based on numerous lengthy itineraries and utilization of great number of traps (more than 1000 trap-days and 216 cylinder-days were worked out) used in all the accessible habitats. So trustworthiness of this account doesn't evoke any doubts. At the same time the questionnaire proposed to some local hunters from different villages makes it evident that the real list of wild species of the region is more rich and in the first turn it concerns beasts of prey and ungulates. But to tell the truth, these data sometimes are too contradictive and can't be considered as trustworthy ones (see Table 2).

Table 2

Composition of the fauna in Yen Hop valley and some adjacent territories issued from interrogation of aboriginal people from different villages

Nos	Species	Villages		
		Yen Hop	O	Mo
1.	<i>Nycticebus coucang</i>	+	+	+
2.	<i>Nycticebus pygmaeus</i>	-	+	+
3.	<i>Macaca arctoides</i>	+	+	+
4.	<i>Macaca assamensis</i>	-	+	-
5.	<i>Macaca mulatta</i>	+	+?	-
6.	<i>Macaca nemestrina</i>	+	+	-

7.	<i>Tachypithecus francoisi</i>	-	+	-
8.	<i>Pygathrix nemaeus</i>	-	-	+
9.	<i>Hylobates concolor leucogenys</i>	+	+	+
10.	<i>Canis aureus</i>	-	+	-
11.	<i>Cuon alpinus</i>	-	+	+
12.	<i>Ursus malayanus</i>	+	+	+
13.	<i>Ursus thibetanus</i>	+	+	+
14.	<i>Aonyx cinerea</i>	-	-	+
15.	<i>Lutra lutra</i>	+	+	+
16.	<i>Martes flavigula</i>	+	-	-
17.	<i>Melogale moschata</i>	+	+	+
18.	<i>Arctictis binturong</i>	+	+	+
19.	<i>Chrotogale owstoni</i>	+	+?	+
20.	<i>Paguma larvata</i>	+	+	+
21.	<i>Paradoxurus hermaphroditus</i>	+	+	+
22.	<i>Prionodon pardicolor</i>	+	+	+
23.	<i>Viverra megaspila</i>	-	-	+
24.	<i>Prionailirus bengalensis</i>	+	+	+
25.	<i>Catopuma temminckii</i>	+	+	+
26.	<i>Neofelis nebulosa</i>	+	+	+
27.	<i>Panthera pardus</i>	+	+	-
28.	<i>Panthera tigris</i>	+	+	+
29.	<i>Sus scrofa</i>	+	+	+
30.	<i>Tragulus javanicus</i>	+	+	+
31.	<i>Cervus unicolor</i>	+	-	-
32.	<i>Muntiacus muntjac</i>	+	+	+
33.	<i>Muntiacus vuquangensis</i>	+	+	+
34.	<i>Bos gaurus</i>	-	+	+
35.	<i>Naemorhaedus sumatraensis</i>	+	+	+
36.	<i>Manis javanica</i>	-	+	+
37.	<i>Petaurista petaurista</i>	+	+	+
38.	<i>Callosciurus erythraeus</i>	+	+	-
39.	<i>Callosciurus flavimanus</i>	+	+	+

40.	<i>Ratufa bicolor</i>	+	+	+
41.	<i>Tamiops</i> sp.	+	+	+
42.	<i>Rhizomys pruinosus</i>	+	+	-
43.	<i>Atheurus macrourus</i>	-	+	+
44.	<i>Lepus pequensis</i>	-	-	+

One ought to believe that the evidences listed in Table 2 don't reflect the situation characteristic for the actual moment but compile the data for rather long period of time.

Situation with small mammals (in the first turn – with rats) represents some peculiar ecological interest because their number sustains on relatively stable level but only in those biotopes where conditions exist close to optimum ones: with water springs and sufficient food resources (Table 3). Usually these biotopes belong to the secondary floristic formations with some fragments of the primary forests. On the contrary, in valley primary forests with complex structure the lowest number of rats from genera *Leopoldamys* and *Niviventer* is registered. It's worthy to note that some isolated representatives of genus *Leopoldamys* were captured only with the traps of local hunters from the tribe Roch. It witnesses specific conditions in the given forest associations that consist of impossibility for the animals to arrange their shelters because of the great permeability of the soil together with the absence of permanent water springs that is characteristic for those territories (Andrei N. Kouznetzov, personal report). On the whole, there exists the necessity of thorough investigation of this phenomenon registered in the primary tropical forests for the first time. Even in spring time (March-April) under heavy rainfalls on the steep slopes of mountains there exists deficiency of moisture that becomes more pronounced in the dry period of the year.

As to the arboreal squirrels-representatives of genera *Tamiops*, *Dremomys*, *Callosciurus* and *Ratufa* their number was relatively stable (3-2 specimens for 1 km of the route) and depended on the structure complexity of any given forest association and presence of fruits. So, the more complex was the structure of the tropical forest the more numerous were Sciuridae species.

Table 3

Number indices of some representatives of Muridae in a row of biotopes in the vicinity of Yen Hop village

Biotop	Species	Indices of number (animals for 100 trap/days)
Village, houses of Yen Hop	rats of genus <i>Rattus</i>	14.3
Fragments of tropical forest (1.2 ha) near village O surrounded with secondary formations	<i>Niviventer fulvescens</i>	16.6
	<i>Maxomys surifer</i>	6.6
	<i>Rattus koratensis</i>	1.6
Primary tropical forest with palms, lianas and bushes in intermountain valley (900 m a.s.l.)	<i>Niviventer bukit</i>	0.23
Primary tropical forest in upper reaches of Yen Hop river		0.0
High grasses in the valley of Yen Hop river	<i>Rattus koratensis</i>	14.0
	<i>Niviventer fulvescens</i>	4.0
	<i>Hylomys suillus</i>	1.0

### CONCLUSION

In connection with rapid decrease of number of monkeys, beasts of prey and ungulates in the region of Minh Hoa there arises the necessity of adoption of some urgent measures on their protection. The most radical solution would be organization of natural reserve on the investigated territory.

It is necessary to underline that the territory in question represents some particular interest from the point of view of ecology and zoogeography of mammals. First of all, the complex orography of the mountain crests forms population isolates from one side and ecological channels from the other. For example, species of the genus *Rattus* penetrate into mountainous territories along intermountain valleys, and rats of the genus *Niviventeris* spread along the mountain crests. It's very probable that some new subspecies for the region would be found in future. For the first time for Yen Hop we have registered such species as *Hylomys suillus* and *Maxomys moi*.

On the whole, theriofauna of Yen Hop region may be characterized by some mixed traits. Here southern forms are noticeably more numerous but northern elements of theriofauna are also present.

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## STUDY OF THE BAT FAUNA

Conducted by Sergey V. Kruskop

### MATERIALS AND METHODS

The work took place from 17 March to 29 April 1999 in the Minh Hoa district, mainly in the Yen Hop village vicinity. The main research sites are as follows:

- vicinity of the base camp, in Yen Hop valley (agricultural landscapes and secondary growth) — 27 trapping nights;
- primary broad-leafed forest - 10 trapping nights;
- mixed valley forest, vicinity of Mo and O villages - 1 trapping night.

Besides, brief surveys were conducted in the Qui Dat (Minh Hoa district center) and near Thuong Hoa village.

The work was composed of several aspects. Visual observations were conducted at night (mainly from dusk to around midnight) with the aid of an electric lantern and a D-100 heterodyne ultrasound detector (Pettersson Elektronik AB). The echolocation calls were recorded at several frequencies for further comparison with reference recordings. Bats were captured with nylon mist nets (523 net meters/nights) or with mobile bat traps - a 2.5 x 2 m nylon net stretched between two 5 m carbon-plastic rods (Borissenko, in press). Three bats were also captured in mist-nets set by Mikhail V. Kalyakin for ornithological purposes. Foraging behavior of several species was investigated by combination of visual and acoustic observations with subsequent capturing of certain specimens with the mobile bat trap to confirm their identification.

During the day time the study was conducted in known or possible day roosts of bats. Two horseshoe bat colonies, situated in caves near Yen Hop and Ban On villages, were observed and described. In the other places the methods of search for bat daytime shelters (in rocks and hollow trees) unfortunately proved to be ineffective, since only one such roost was revealed.

Captured bats were weighed to the nearest 0.1 g, and a set of 20 to 25 measurements were taken for most specimens. Collected specimens were fixed in 75% alcohol or prepared as skin & skull. Some individuals of the most abundant species were released after capture and observation. Samples of feces were collected from captured bats when possible for future investigation to estimate their prey preferences. Ectoparasitic flies of *Strebli-*

dae and Nycteribiidae families were also collected from captured bats and fixed in 75% alcohol.

## RESULTS AND DISCUSSION

On the observed territory we found the bat community to be composed of at least 21 bat species, representing 5 families from both suborders. The identification of most of them is provisional, however, it seems that at least 2 species are for the first time recorded in Vietnam, and the known distribution ranges of a number of others will be extended. The general composition of bat fauna distinctly shows the influence upon it of limestone habitats. The ratio of vespertilionid and non-vespertilionid species of insectivorous bats, typically subequal in Old World tropics, is noticeably shifted towards the domination non-Vespertilionidae representatives.

In the taxonomical list we used originally collected material and personal observations, as well as those of our colleagues. Numbers given to the right of the taxonomic names indicate: 1 – the species was collected; 2 – visual and/or acoustic observations of the species are available, made by ourselves and/or our colleagues.

Letters to the right indicate the approximate categories of abundance of bat species, which are mostly supported by subjective estimates rather than by quantitative calculations, since there are no ultimate criteria common to all mammalian taxa which could be used for such judgment. Since our investigation area was restrained by landscape characters and time budget, not all of this categories may be extrapolate to all the Ke Bang territory. Provisional estimates of abundance of Ke Bang bats are as follows: V — very rare; R — rare; F — fairly common; C — common; A — abundant.

## LIST OF BAT SPECIES COLLECTED

### ORDER CHIROPTERA

#### SUBORDER MEGACHIROPTERA

#### Family Pteropodidae

##### Subfamily Pteropodinae

*Cynopterus sphinx* (Vahl, 1797) 1 R

##### Subfamily Macroglossinae

*Macroglossus sobrinus* Andersen, 1911 1 C

*Eonycteris spelaea* (Dobson, 1871) 1 F

## SUBORDER MICROCHIROPTERA

## Family Hipposideridae

<i>Hipposideros armiger</i> (Hodgson, 1835)	1,2	A
<i>Hipposideros lylei</i> Thomas, 1913	1	?C
<i>Hipposideros larvatus</i> (Horsfield, 1823)	1,2	?R
<i>Hipposideros cineraceus</i> Blyth, 1853	1,2	?R
<i>Hipposideros pomona</i> Andersen, 1918	1	?F

## Family Rhinolophidae

<i>Rhinolophus pearsoni</i> Horsfield, 1851	1,2	?F
<i>Rhinolophus paradoxolophus</i> (Bourett, 1951)	1	V
<i>Rhinolophus malayanus</i> Bonhote, 1903	1	R
<i>Rhinolophus cf. borneensis</i> Peters, 1861	1,2	?C
<i>Rhinolophus</i> sp.	1	?C

## Family Megadermatidae

<i>Megaderma ?lyra</i> E. Geoffroy, 1810	2	R
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## Family Vespertilionidae

<i>Myotis (Selysius) cf. siligorensis</i> (Horsfield, 1855)	1,2	C
<i>Myotis (Leuconoe)</i> sp.	1,2	C
<i>Hypsugo cf. pulveratus</i> (Peters, 1871)	1,2	?F
<i>Murina cyclotis</i> Dobson, 1872	1,2	?R
<i>Scotomanes ornatus</i> (Blyth, 1851)	2	?F
<i>Scotophilus</i> sp.	2	F
<i>Ia io</i> Thomas, 1902	2	R

## ACCOUNTS OF FAMILIES AND SELECTED SPECIES

## Family Pteropodidae - Old world fruit bats

Despite that both subfamilies were represented, macroglossines were more abundant than pteropodines, which is quite uncommon. Only one specimen of the otherwise numerous Pteropodinae member — *Cynopterus sphinx* — was captured. Probably, this situation is connected with some local migrations. Complex landscape gives no abilities to observe a more wide area in such time ranks.



***Cynopterus sphinx* (Vahl, 1797)**

**Material.** Only one specimen (adult male) was captured into ornithological mist net near the base camp on April, 30.

**Habitat.** The bat was captured among the grassland, nearby the riverbank secondary growth. This species, abundant in the adjacent territories, commonly inhabits various types of forest landscapes.

**Ecological remarks.** The single individual was captured in the morning hours while flying from a small fig tree, growing on the river bank. However, observations near the fruiting fig trees revealed neither feeding bats nor typical bat droppings.

***Eonycteris spelaea* (Dobson, 1871)**

**Material.** Six specimens (5 adult females and 1 adult male) from the vicinity of the base camp.

**Abundance and Habitat.** This species is known to be confined to areas with caves, thus its relatively high abundance in Ke Bang limestone area is well explained. However, we have never seen individuals of this bat in observed caves. All the specimens were captured in mist net set among vegetation in secondary growth formations, including wild banana.

**Ecological remarks.** The capture of lactating females shows that reproduction in this species is synchronous with most of neighboring species, the peak of births probably confined to the end of April or beginning of May. However, two females, captured as lactating, after some time appeared to be pregnant. Three of captured individuals lived for some time successfully on the diet of soaked and mashed raisin, peach juice and pollen.

***Macroglossus sobrinus* Andersen, 1911**

**Material.** Six adult males, four adult females.

**Distribution and Habitat.** All specimens were captured in the vicinity of the base camp with mist nets. Several individuals have been taken over the river, others — in the secondary plant formation, including big amount of wild bananas.

**Abundance.** This species was most numerous among all the fruit bats.

**Ecological remarks.** This is a specialized nectarivorous bat. All droppings obtained indicated the presence of pollen. No bats were observed feeding; dietary preferences in the studied area are still unknown, but it is possible to suppose, that in their diet banana flowers are of great importance. The males appeared reproductively inactive, while most of the

females caught were on various stages of pregnancy. This indicates that reproduction in this species may be synchronous with *E. spelaea*.

#### **Family Hipposideridae - False horseshoe bats**

Five species were captured, one of which, *Hipposideros lylei*, was not previously recorded from Vietnam. Roosting behavior of *H. armiger*, *H. lylei*, *H. pomona* and *H. cineraceus* was observed in two limestone caves.

#### ***Hipposideros armiger* (Hodgson, 1835)**

**Material.** Eight adult males and two adult females. Besides, more than 200 individuals were observed in two caves near Yen Hop and Ban On villages.

**Abundance and Habitat.** This is one of the most common bat species in the study area. Specimens of this bat were captured and/or observed in most of the examined habitats, including agricultural lands, secondary growth and broad-leafed primary forest. *H. armiger* was also the most abundant species in the two rhinolophoid bat colonies (approximate numbers in the cave near Ban On — 70-100 individuals, in the cave near Yen Hop — ca. 150 individuals).

**Ecological remarks.** Bats of this species were observed flying high at canopy level in the secondary-growth plant formations. Instances of capturing and observing of this species in the primary forest enables us to suppose, that in the forested landscape *H. armiger* forage over the dry waterflow beds. Droppings of this bat always contain fragments of thick chitinous covers, and particles of large beetles and cicadas were collected under this species roosting site. In caves this species use large cavities on the ceiling, where individuals keep some distances (ca. 15 cm) between each two. Part of the captured females were pregnant; the peak of births probably confined to the end of April.

**Echolocation calls.** CF, 78 kHz. Such relatively low frequency agrees with supposition, that the given species is an aerial forager.

#### ***Hipposideros lylei* Thomas, 1913**

**Material.** Five adult males, four adult and one subadult females. More than 100 individuals were observed in the cave near Yen Hop.

**Abundance and Habitat.** Most of individuals of this species were observed and captured in the cave near Yen Hop village. In the given site *H. lylei* forms a colony of 100-150 indi-

viduals, partly mixed with an aggregation of *H. armiger*. One specimen was captured with the mist net in the primary forest.

**Ecological remarks.** No foraging behavior was observed. This species in its food and roosting site preferences is probably similar to *H. armiger*. Part of captured females was pregnant, which indicates that reproduction in this species may be synchronous with *H. armiger*.

**Taxonomical remarks.** Because of insufficiency of available identification keys, this species can be confused with *H. turpis* (as the author identified it primarily) or *H. pratti*. However, a complex of features confirms the correctness of its current identification. This species was not previously reported from Vietnam, at least according to published data.

### *Hipposideros cineraceus* Blyth, 1853

**Material.** Adult male and female collected in the cave near Yen Hop village.

**Abundance, Habitat and Ecological remarks.** The colony of ca 15 individuals was situated in the far right (from entrance) part of the cave. Animals used small cavities and holes in limestone as roosts and passes, which made their capturing rather difficult. Such behavior at least partly corresponds to the presence in the cave of *Megaderma lyra* individuals. When megaderms left the roost, *H. cineraceus* began to use open space more frequently. At least one individual was observed flying within and out of the vegetation and perching on the level of 1.5 m from the ground. This species may in fact be quite abundant, but extremely difficult to monitor.

### *Hipposideros pomona* Andersen, 1918

**Material.** Two adult males and four females.

**Abundance and Habitat.** All specimens were captured by the mobile trap in the small limestone cave near Ban On village. Probably individuals of this species were observed with the use of bat detector in the highly disturbed forest in the vicinity of the cave.

**Ecological remarks.** In the cave ca. 50 animals occupied ceiling cavities, sometimes in the mixed aggregation with *H. armiger*, single individuals remained aside from the main colony, using stalactites as perches. No foraging behavior was observed. Its large ears suggest that this species may be gleaner.

**Taxonomical remarks.** *H. pomona* is the member of a complex species group, which give reason for many misidentifications. The identification was confirmed by comparison with available reference specimens of this species.

***Hipposideros larvatus* (Horsfield, 1823)**

**Material.** One adult female, collected on April, 9.

**Abundance, Habitat and Ecological remarks.** The single specimen was captured by the mobile trap over the dry seasonal waterflow bed in the primary forest. Probably, individuals of this species were observed in the same locality the day after. This species probably forages under the forest cover, or over the seasonal stream beds, and use various sorts of caves as roosts.

**Taxonomical remarks.** Size of the collected specimen is distinctly smaller than the average known for the species, while for Indochina the larger geographic form was reported.

**Family Rhinolophidae - Horseshoe bats**

Among the captured species findings of *Rhinolophus paradoxolophus* noticeably extends it's known distribution area to south. The *Rh. pusillus* species group, common in tropical Asia, was not found. All captured small Rhinolophidae represent the «*ferrumequinum*» group. At least three species of this group were found, only one of which, *Rhinolophus malayanus*, was more or less definitely identified.

***Rhinolophus pearsoni* Horsfield, 1851**

**Material.** Six adult females.

**Abundance and Habitat.** This was the most abundant species of rhinolophoid bats in primary forest, however it was not captured or observed in any other landscape.

**Ecological remarks.** The biology of this species in Ke Bang closely connected with primary tropical forest and with limestone exposures. One specimen was observed in the small limestone cavity, three individuals were captured with the mist net set nearby. Perching behavior was not observed, but can be deduced on the basis of morphology.

**Taxonomical remarks.** The identification manuals are rather insufficient for the diagnostic of Vietnamese rhinolophoides; identification was confirmed by comparison with available specimens of this species.

***Rhinolophus paradoxolophus* (Bourett, 1951)**

**Material.** One adult female, collected by M.V. Kalyakin on April, 12.

**Habitat and Ecological remarks.** The single individual was captured with ornithological mist net, put in the dense vegetation in the primary forest. Taking into account this fact together with wing and ear morphology, it is possible to suppose, that this species must be

typical «forester» and perch-hunter. The captured female was pregnant, which confirms, that this species has a reproductive cycle synchronous with other Rhinolophoidea.

**Taxonomical remarks.** Despite the other Rhinolophidae, this species is easy to identify. Our record noticeably extends to the south the previously known distribution of this species, otherwise officially reported from Sa Pa.

***Rhinolophus* sp. [«*ferrumequinum*» species group]**

**Material.** Three adult males and eight adult females of small ferrumequinum-like horseshoe bats.

**Habitat and Ecological remarks.** This was the most abundant type of rhinolophoid bats at all habitats, both in primary and secondary formations. They were captured and/or observed in all study sites; however while they represent the species mix, unable to say properly to what species our observations correspond. All these horseshoe bats are, probably aerial or, in part, perch-hunting foragers, their hunting sites are situated over and among vegetation in secondary formations, over human passes and dry stream beds. As day roosts they probably use various types of caves and cavities, however only two individuals were captured in caves and one carcass was found. No rhinolophids have been seen among the *Hipposideros* individuals in the colonies.

**Taxonomical remarks.** One individual (adult female) captured in the cave near Yen Hop was identified as *Rhinolophus malayanus*. The diagnostic features of the other collected specimens do not fully agree with species descriptions, given in the available manuals. There are at least two species, among which one looks similar to *Rh. borneensis*, otherwise known only from extreme south of Vietnam.

**Family Megadermatidae - False vampire bats**

Three individuals were observed during one week in the limestone cave near Yen Hop village. They were provisionally identified as *Megaderma lyra* on the basis of visual observations and finding of vertebrate (small bird) remains under their roost. If the identification is proper, this record extends the species' known distribution in Vietnam by 200-300 km southward.

**Family Vespertilionidae - Plain-nosed or common bats**

At least five species were captured. In Ke Bang in the season of observations Vespertilionidae seemed to be closely connected with riparian or near riparian habitats. Capturing of

female of *Hypsugo cf. pulveratus* can probably be the first record of the species from Vietnam territory. Unidentified mouse-eared bats from subgenus *Leuconoe*, which were relatively common on the observed territory, probably are representatives of non-described species.

***Myotis (Selysius) cf. siligorensis* (Horsfield, 1855)**

**Material.** One adult male was captured in mist net in primary forest; two species, male and female, were caught by mobile traps in Qui Dat, center of Minh Hoa district, on March, 15.

**Habitat and Ecological remarks.** The single specimen was captured in primary forest over the dry stream bed, ca. 2 m from the ground. No other mouse-eared bat were seen in that habitat, so the captured one could be an occasional migrant. Bats provisionally referred to this species were rarely detected in the vicinity of base camp. However, in man-made habitat in Qui Dat this species seems to be very abundant, probably inhabiting under roof space of some buildings. According to observations in Qui Dat, *M. siligorensis* is typical aerial forager, similar in its behavior to small pipistrelles.

**Echolocation calls.** Low to medium intensity steep FM signals at 45-50 kHz; in places of animal concentration territorial calls in audible range are frequent.

**Taxonomical remarks.** Identification is provisional. This species may be confused with the very similar *M. mystacinus* and *M. muricola*. All tree bats differ slightly from the *M. siligorensis* specimens from Vu Quang, which were identified by Dr. Topal (Hungarian museum of Natural History). Moreover, individual from primary forest has dental aberration, which can put some new difficulties during its identification.

***Myotis (Leuconoe) sp.***

**Material.** Three adult males, and ten adult females.

**Abundance and Habitat.** Observed only above the water, over the small rivers in Yen Hop and Ban On valleys. On the observed area (excluding primary forest) one of the most common species. All above mentioned individuals were captured in the vicinity of the base camp, with mist nets set across the river or mobile traps.

**Ecological remarks.** The most typical flight pattern — in elongated circles ca. 10-15 cm above the water surface with occasional shifts of 30-60 cm. Foraging behavior very similar to that of the European *M. daubentoni*. Trawling behavior was observed in very few instances. According to the stages of females pregnancy, the peak of births is probably confined to the last days of April or beginning of May.

**Echolocation calls.** High intensity steep FM sweep from ca. 60 to 35 kHz, with maximum energy around 45 kHz.

**Taxonomical remarks.** The captured specimens were provisionally identified as *M. laniger* Peters, 1870, previously reported from the northern part of Vietnam. But our individuals differ in some features from this species as well as from other small Asian leuconoe; thus they may represent the separate taxon of subspecific or specific rank.

***Hypsugo cf. pulveratus* (Peters, 1871)**

**Material.** One adult female collected with a mist net on 13 April near the base camp.

**Habitat and Ecological remarks.** The single specimen was captured during the rainy night over the river. Several bats were observed in the same area and near the Ban On village, which seem to be referred to the same species. They were flying at the high ca. 15-25 m from the ground in uncluttered space. In the base camp these bats were mostly abundant in wet or slightly rainy nights during the time of insect light trap work. However they tried to keep off the light up zone.

**Echolocation calls.** Steep to shallow FM (range not determined), maximum energy around 30-40 kHz.

**Taxonomical remarks.** Identification is provisional. If it is adequate, it may prove to be the first documented record of the species from Vietnam.

***Murina cyclotis* Dobson, 1872**

**Material.** One adult male collected with a mist net on 24 April near the O-Mo village.

**Habitat and Ecological remarks.** The single specimen was captured in the mixed forestry habitat over the stream. One specimen, provisionally referred to this species, was once observed by the bat detector in the grassland on river bank in the vicinity of the base camp. Identification was based on the echolocation signal, typical to Vespertilionidae (FM), but of very high frequency (maximum energy around 90 kHz). The captured male was reproductively inactive.

**Taxonomical remarks.** *M. cyclotis* is the most common *Murina* species in Indochina, and identification of the specimen did not made large difficulties. However, other species of tube-nosed bats, probably inhabiting Central Annam, can cause some problems with identification, because of low level of knowledge about inter- and intraspecific variability.

***Scotomanes ornatus* (Blyth, 1851)**

**Material.** Two adult males and three females were captured with a mist net on April, 24-25.

**Habitat and Ecological remarks.** All specimens were captured over the stream, forming border between primary forest and lowland disturbed forest with elements of secondary plant formation. Bats with similar size and wing shape were observed in the same date near the O-Mo village. The flight pattern is relatively slow flight in open areas or near trees, usually not lower than 15 m above the ground. Our specimens were taken when they came down for drinking.

The species seems to be fairly common at least in complex forest areas. All three females were on the late stage of pregnancy, thus, this species is synchronous in its reproductive cycle with other insectivorous bats, observed by us. Females were slightly, but visibly large than males.

**Taxonomical remarks.** Our finding may be a slight southward extension of the previously known range of this species.

**Other bat species**

A number of bats with long narrow wings and high intensity low frequency shallow FM echolocation calls have been observed near the base camp and near the Thuong Hoa village. They were provisionally identified as *Scotophilus* sp., however, none have been captured. Large size of specimens, observed near the Thuong Hoa, and relatively smaller size of bats, seen in Yen Hop valley, gives the ability to suppose the presence in Ke Bang of the both *S. kuhli* and *S. heati*. One other species, *la io*, was seen once time in the Yen Hop vicinity. The animal was fly over the cultivated land, in the early evening in the conditions of lighting, satisfactory to see the details.

**GENERAL CONCLUSIONS**

The Ke Bang limestone area is the unique natural place within Central Annam. It is closely connected with Phong Na Nature Reserve famous for its caves, and with limestone territories in Laos, known for the original fauna. Meantime, Ke Bang represents a sort of «bridge» between limestone and carst areas and mountain Nature Reserves of North Annam, such as Vu Quang. Thus, the presence on the given territory of mammalian species, both small and large, new to Vietnam or to the science, can be supposed. The present survey confirms this argument by discovering of such a rare bat species as *Hypsugo pul-*



*veratus*, *Hipposideros lylei* and *Rhinolophus paradoxolophus*, and some unidentified species of bat (*Myotis* sp. and at least two *Rhinolophus* species), possibly new to science. There is good reason to suppose that further new (both for Vietnam and for the world) species of mammals (particularly, small mammals) may be found in Ke Bang or adjacent places.

Meantime the results of our work reveal relatively large amount of Rhinolophid species, and relatively small — of Vespertilionids. It can be suggested, that most of Rhinolophoids are cave dwellers, while among plain-nosed bats there are many tree or house dwellers, whose biology is closely connected with some sorts of forest habitats or permanent human buildings. On the other hand, plain-nosed bats need open water surface for drinking, which is represented in Ke Bang mainly by seasonal water flows. But, to our mind, the reason of the relatively low abundance of Vespertilionidae is in the high complexity of Ke Bang natural conditions. Supposition for the vespertilionid ability to commit local migrations finds confirmation in the fact of rather irregular appearance of some species in the base camp vicinity. Both plain-nosed bats and fruit bats can change their habitats, following the optimal life conditions. The distances of their displacements can be short for the flying animal, but rather long for the investigator because of the complex land surface.

Thus, the bat fauna of Ke Bang includes, according to our observations, about 20 species, mainly various cave dwellers, however there are no reasons to think, that the full faunal complex was revealed during one expedition. For the improvement of further monitoring and survey activities, efforts should be put to, at first, including Ke Bang into joint Nature Reserve territory, and establishing permanent or long term research station in it. This will give possibility to provide more complete and comprehensive research, paying special attention to places difficult to access, since they are more likely to be inhabited by species inaccessible for the short survey.

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RESULTS OF SURVEY ON MAMMAL FAUNA IN  
PHONG NHA - KE BANG AREA, QUANG BINH, VIETNAM

July 1<sup>st</sup> - August 21<sup>st</sup>, 1993

(A FINAL REPORT OF THE PROJECT - BUILDING TECHNICAL CAPACITY FOR  
PHONG NHA NATURE RESERVE THROUGH TRAINING AND FIELD SURVEY,  
FFI - INDOCHINA PROGRAMME, HANOI - VIETNAM)

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INDOCHINA OFFICE  
INSTITUTE OF ECOLOGY & BIOLOGICAL RESOURCES

1998

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*We wish you all good health and success!*

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## PART I : INTRODUCTION

Located in the largest lime-stone mountains of Indochina: Phong Nha - Ke Bang - Hin Nam No, having the primary ever-green tropical forests, covering almost all the area, the Phong Nha Nature Reserve is one of few protected areas that has the most valuable biological diversity in Vietnam. There resident many nationally and globally rare and valuable fauna and flora such as tiger, Sao-la (*Pseudoryx nghetinhensis*), Giant muntjac (*Megamuntiacus vuquangensis*), *Bos gaurus*, *S.f. hatinhensis*, etc... However, the local fauna has not yet been fully surveyed, many groups are not touched on, such as small carnivore animals, bat, rodent animals, etc.

The conservation and management of biological diversity of Phong Nha Nature Reserve is still weak. The technical and forest protection staff has not yet passed any training on biological resource survey, monitoring and management, while the bad affects of the local people in and near the Reserve are getting increased.

The project "*Building technical capability for Phong Nha Nature Reserve through training and field survey*" sponsored by Denmark Embassy aimed at the following objectives:

- Training on basic skills of biological diversity survey and monitoring method for forest protection and technical staff of Phong Nha Nature Reserve as well as local foresters;
- Carrying out the program on field survey in Phong Nha - Ke Bang to improve skills of the trainees, collect basic information on the local fauna.
- Making useful and practical recommendations, based on the survey results to improve the biological diversity conservation in Phong Nha - Ke Bang.

The Project was carried out from June 21<sup>st</sup> to September 30<sup>th</sup>, 1998 and conducted by Mr. Joe Walston - FFI Hanoi and with the participation of prestigious researchers from Institute of Ecology and Biological Resources and Forestry College of Vietnam.

The programme of the Project are as follows:

- 10 days of classroom training in Hanoi (June 21<sup>st</sup> - 30<sup>th</sup>, 1998);
- 60 days of training for field skill and fauna survey in Phong Nha - Ke Bang (July 1st - August 30<sup>th</sup>, 1998);
- 6 days of training on data analyzing skill, making plan on biological diversity survey and monitoring at the Headquarter of Phong Nha Nature Reserve, Quang Binh Province (September 3<sup>rd</sup> - 8<sup>th</sup>, 1998).

The results of the Project are reflected in two following respective reports:

Report I: Training results on method of biological diversity survey and

monitoring for staff of Phong Nha Nature Reserve and Quang Binh  
Forest Protection Department.

Report II: Results of the mammal survey in Phong Nha - Ke Ban  
area, Quang Binh, Vietnam.

## **PART II: OBJECTIVES OF THE SURVEY**

- Training the skills for carrying out several basic methods of survey and monitoring on biological diversity in general and on mammal fauna in particular for 10 staff of Phong Nha Nature Reserve and Quang Binh Forest Protection Department;
- Collecting additional confidence information to identify the presence of the mammal species which has been acknowledged to be present in the Reserve. Additionally studying the mammal that were not carefully surveyed in the previous ones, such as: small carnivore animals, bat, primates, etc.
- Assessing the human impacts on forest resources in general and on mammal fauna in the Reserve;
- Making recommendations on biological diversity survey and measures to improve the management and protection of biological diversity in the Reserve.

## PART III: PARTICIPANTS, DURATION AND LOCATION OF THE SURVEY

### 1. Participants of the survey teams:

The survey teams are consisting of 4 researchers and 11 staff of Phong Nha Nature Reserve, Quang Binh Forest Protection Department and Forestry College of Vietnam. The survey teams are divided into 4 small teams:

- *Team I:*

Nguyen Xuan Dang (Ph.D) - *Institute of Ecology and Biological Resources*  
Dinh Huy Tri (Engineer) - *Phong Nha Nature Reserve*  
Tran Ngoc Man - *Phong Nha Nature Reserve*  
Tran Tien Dung (Forestry Intermediate level) - *Phong Nha Nature Reserve*

- *Team II:*

Pham Nhat (Ph.D) - *Forestry College of Vietnam*  
Nguyen Nam Dinh (Intermediate level) - *Phong Nha Nature Reserve*  
Tran Quoc Buu (Intermediate level) - *Phong Nha Nature Reserve*  
Pham Van But (Engineer) - *Phong Nha Nature Reserve*

- *Team III:*

Pham Trong Anh (Ph.D.) - *Institute of Ecology and Biological Resources*  
Nguyen Xuan Viet - *Phong Nha Nature Reserve*  
Nguyen Ngoc Tam - *Phong Nha Nature Reserve*  
Nguyen Son Thuy (Intermediate level) - *Phong Nha Nature Reserve*

- *Team IV*

Ditte Hendrichsen (M.A) - *Expert of FFI*  
Tran The My - *Phong Nha Nature Reserve*  
Nguyen Manh Ha (Engineer) - *Forestry College of Vietnam*

### 2. Duration of survey

The survey was carried out from August to September 1998 and divided into following periods:

- Team I and Team II: July 1<sup>st</sup> to 27<sup>th</sup>, 1998.
- Team III: July 31<sup>st</sup> to August 21<sup>st</sup>, 1998.
- Team IV: July 1<sup>st</sup> to August 21<sup>st</sup>, 1998.



### 3. The survey locations:

Team I was carrying out the survey in 4 following areas:

- Ba Giang mountains I, II, III (That Day stream - Ba Cay stream - May stream): 17°28'95N, 106°17'92E - 17°28'45N, 106°18'80E - 17°27'61N, 106°19'15E.
- Rao Thuong valley (from Doong Village to Hang En cave): 17°27'02N, 106°19'12E - 17°27'06N, 106°17'35E
- So Dua - Cha Ang - Ma Day streams: 17°31'80N, 106°17'46E - 17°32'38N, 106°17'10E - 17°31'24N, 106°16'45E.
- Co Khu area (Stream 24 - Dai A lake - Dai Cao lake - Co Khu peak): 17°28'25N, 106°12'90E - 17°28'68N, 106°12'15E - 17°28'33N, 106°13'03E.

Team II, with Primate Fauna as the main surveying subject, carried out the survey in high lime-stone mountains, as follows:

- Hang Vom area: 17°30'91N, 106°12'80E
- Thung Nhang - Eo Cap - Xuong valley: 17°31'62N, 106°13'37E - 17°31'N, 106°12'E
- Thung Lau - Da Ban: 17°33'50N, 106°12'92E - 17°35'N, 106°15'E
- Tro Mong: 17°34'N, 106°15'E.
- Thung Ba Dau: 17°36'N, 106°17'E.

Team III carried the survey in the area of Minh Hoa District, which is outside of present Phong Nha Nature Reserve, but its represents an important part of the future expanded Reserve. The survey locations were:

- Yen Hop - Cha Long - Ca Thuc: 17°40'12N, 105°57'44E - 17°37'24N, 105°59'77E - 17°36'45N, 105°59'97E.
- Yen Hop - Pa Ro: 17°40'12N, 105°57'44E - 17°42'76N, 105°53'75E
- Dang Hoa - Da Nui - Duong Cau - Ma Rinh - Bang Xang - Tang Hoa: 17°45'83N, 105°52'98E - 17°44'92N, 105°50'97E - 17°44'45N, 105°50'58E. 17°43'68N, 105°50'97E - 17°43'10N, 105°52'75E - 17°42'97N, 105°57'95E.

Team IV is responsible for surveying bat, a part of Vietnam fauna which is less studied and very abundant in Phong Nha - Ke Bang where no survey of such species has been carried before. The survey was carried out within 2 months, covering the following locations:

- Ba Giang mountains I, II, III (That Day stream - Ba Cay stream - May stream): 17°28'95N, 106°17'92E - 17°28'45N, 106°18'80E - 17°27'61N, 106°19'15E.
- Rao Thuong valley (from Doong Village to Hang En cave): 17°27'02N, 106°19'12E - 17°27'06N, 106°17'35E
- So Dua - Cha Ang - Ma Day streams: 17°31'80N, 106°17'46E - 17°32'38N, 106°17'10E - 17°31'24N, 106°16'45E.
- Yen Hop - Cha Long - Ca Thuc: 17°40'12N, 105°57'44E - 17°37'24N, 105°59'77E - 17°36'45N, 105°59'97E.
- Yen Hop - Pa Ro: 17°40'12N, 105°57'44E - 17°42'76N, 105°53'75E

## PART IV: BACKGROUND OF NATURE CONDITIONS IN THE SURVEY AREAS

The survey areas were consisting of the Phong Nha Nature Reserve of Bo Trach District (Quang Binh Province) and Thuong Hoa, Hoa Son Communes of Minh Hoa District (Quang Binh Province) which will be the future expanded areas of the Reserve. Following is the geographical location of the survey areas:

Phong Nha Nature Reserve: 17°26'N - 17°37'N, 106°10'E - 106°20'E

Thuong Hoa - Hoa Son: 17°36'N - 17°48'N, 106°00'E - 106°10'E

The survey areas are located in the Phong Nha - Ke Bang lime-stone mountains, the biggest lime-stone mountains in Vietnam which link to Hin Nam No lime-stone mountains (Khammuone Province) of Laos. The terrain here is very complicated, including many high karst peaks, sloping sides and deep valleys. However, there are some rather low hills. The rivers and streams are generally short, some parts of which run underground of karst. Most streams are dry in dry season except some big ones, such as: That Day, Cha Ang, So Dua, Rao Thuong. In summer, it is very dry in the forest and lacking the surface water.

The survey areas are situated in tropical monsoon climate belt. The rainy season here lasts for 7 months (from August to February the next year), dry season lasts for 4 months (from April to July). The annual average rainfall is of 2.500 to 3.000 mm. The humidity is 85% in summer. The west-east dry and hot winds are common here in summer, blowing from Laos and known as Laotian breeze.

Most of the survey areas are covered with forests, mainly primary forests, but a part of forests on hills was selectively exploited 8 years ago. The forestation along the Provincial Road No. 20 and No. 15 was exploited and heavily affected by the wars, but it is still a good habitat for wildlife to exist and develop. The main types of forest here are ever-green tropical rainforest on lime-stone mountains, evergreen tropical rainforest on hills, semi-tropical forest on over 900m mountains.

The Phong Nha's fauna is very diversified and abundant, but less surveyed. In 1964, Prof. Dao Van Tien *et al.*, surveyed Tuyen Hoa and Le Thuy Districts (Quang Binh Province). In 1992, the Ministry of Forestry organized a feasibility study for the foundation of Phong Nha Nature Reserve. In 1995, Mr. Pham Nhat, Do Tuoc and Truong Van La surveyed some areas of Minh Hoa, Tuyen Hoa and Bo Trach Districts (Quang Binh Province). Recently, two biological diversity surveys in this area were organized in 1996 and 1997 under the Project RAS 93/102/WWF/UNDP with the participation of the researchers from the Ministry of Forestry, Institute of Ecology and Biological Resources and the Vinh Teachers' training College and already inventoried 66 animal species (table 1), 279 bird species, 53 of reptile species, 22 amphibian species, including many rare and valuable species, bearing high conservation value of biological diversity, such as: tiger, Sao la (*Pseudoryx nghetinhensis*), Giant muntjac (*Megamuntiacus vuquangensis*), *Bos gaurus*, S.f.

hatinhensis. However, the complicated terrain that makes it difficult to reach to the remote areas, together with hot climate and the lacking of surface water in summer, all that prohibit from organizing long field surveys. In addition, due to the shortage of experts participated in the previous surveys, the fauna in Phong Nha - Ke Bang, especially some groups of small carnivore animals, bat, rodents have not fully surveyed yet.

**Table 1: The list of mammals recorded in Phong Nha - Ke Bang**  
(By Le Xuan Canh et al., 1997)

Or.	Scientific Name	Document
1	<i>Suncus murinus</i>	Rep
2	<i>Tupaia glis</i>	Sp
3	<i>Cynocephalus</i>	Obs
4	<i>Cynopterus branhyotis</i>	Obs
5	<i>C. sphinx</i>	Obs
6	<i>Eonycters spelaea</i>	Obs
7	<i>Pteropus hypomelanus</i>	Obs
8	<i>P. vampirus</i>	Obs
9	<i>Rousettus amplexicaudatus</i>	Obs
10	<i>Aselliscus atoliezkamus</i>	Obs
11	<i>Hipposidero slarvatus</i>	Obs
12	<i>Rhinolophus pusilus</i>	Obs
13	<i>Rh. subadius</i>	Obs
14	<i>Nycticebus coucang</i>	Obs
15	<i>N. pygmaeus</i>	Obs
16	<i>Macraca arctoides</i>	Obs
17	<i>M. assamensis</i>	Obs
18	<i>M. nemestrina</i>	Sp
19	<i>M. mulatta</i>	Obs
20	<i>Pygathrix nemaus</i>	Obs
21	<i>Trachypithecus francoisi hatinhensis</i>	Obs

## PART V: SURVEY METHODS

The methods used for the survey are the common ones in surveying the fauna in Vietnam and the world as well, as follows:

- Direct observation of the fauna in nature by eyes and by binoculars along the survey routes;
- Detecting and identifying through signs of wildlife: foot-prints, dung, dens, nests, scratches on trees or food remains;
- Identifying through remaining parts of the hunted wildlife (bones, horns, skin or hoof) which are found in villages, in habitat or contained in carnivore animals' dung or hunted wildlife kept by local people;
- Using nest and *Harptraps* to catch bats;
- The village-based interview was also carried out, but such information is used for references and complementary to the information collected by the above-said methods.
- The human impacts on fauna and habitat and the status of habitat itself were assessed by the direct observation in nature during the survey.

The scientific names and the fauna species are classified as per Corbert and Hill (1992). The animals' foot-prints are identified by the authors' experience, using reference from mammal by Kanjanavanit (1997).

## PART VI: RESULTS OF THE SURVEY

### VI.1 Characteristics of Mammal in Phong Nha - Ke Bang

#### VI.1.1 Species composition of mammal in Phong Nha - Ke Bang

During the survey, the survey teams have directly observed 23 mammal species, found specimens and remaining parts of 48 species, identified tracks of 20 species. The total number of mammals which has been identified with confidence evidences is 85 species, belonging to 25 families and 9 orders (table 2), including *Scandentia*: 1 species; *Dermoptera*: 1 species; *Chiroptera*: 32 species; *Primates*: 10 species and sub-species; *Carnivora*: 22 species; *Artiodactyla*: 8 species; *Pholidota*: 1 species; *Rodentia*: 10 species (although this order is not the objective of the survey).

The previous surveys have identified 66 mammals species in Phong Nha - Ke Bang, of which 61 species had been identified by confidence evidences (observation, remaining, specimen or sign), 5 species identified by interview (Le Xuan Canh *et al.*, 1997 - table 1). In this survey, we have added confidence evidences to confirm the presence of 4 species (*Sao-la*, *Martes flavigula*, *Arctictis biturong*, *Arctogalidia trivirgata*) which previously had been only identified by interviews or documents. In addition, we have added 37 species that had never been reported before in Phong Nha - Ke Bang (table 3). Especially, this is the first time, the Chiroptera carefully surveyed and we have gained good results, identifying 32 species. So far, we have confirmed the presence of 97 mammal species, belonging to 25 families and 9 orders in Phong Nha - Ke Bang.

One more important point is that in this survey we directly observed a new form of langur - full black langur (proposed to be *Trachypiteus francoisi ebenus*), found foot-prints of a new wild pig (chao vao - *Sus.sp.*), collected information of possible presence of *Semnopithecus francoisi laotum* and *Canimuntiacus truongsongensis*.

"Full black langur" (*T. francoisi ebenus*) looks like (*Semnopithecus francoisi hatinhensis*, but they are different in that they do not have white-fur strip running from mouth margins to ears and their hands seem to be shorter. This may be a new species or sub-species. A group of this species was observed in Tram Me at 5 a.m. on July 26<sup>th</sup>, 1998.

"Chao vao" almost looks like *Sus scrofa* and different from it in the followings: they are bigger (up to 150 kg), more ferocious, have slimmer body, much longer snout (30 - 40 cm), longer hair, the hair basally is white, the distal hair is black. Their meat is not so delicious as *Sus scrofa*. The female "Chao vao" gives birth only 2-3 new-born ones (while as *Sus scrofa* gives birth to 8-12 new-born ones). At 17°31'61N, 106°13'41E; we saw foot-prints with the dimension of (nm) 75 x 70, 37 x 32, 45 x 43, 55 x 45. They may be *Sus bucculentus* that were described by Huede in 1892, based on two specimen of skulls

collected at in Bien Hoa and also discovered by G.B. Schaller *et al.*, in Laos (10°18'N, 104°44'E) in January, 1998, or maybe a new species that needs to be more studied.

The local people in Arem Commune (Commune 39) informed that they had ever caught the small muntjac. As per their description, this might be of *Muntiacus truongsoneis* discovered in Quang Nam in 1996 or of Roosevelt muntjac that need to be more surveyed and identified in the future.

Some hunters in Phong Nha hamlet, Son Trach Village, Bo Trach District (Quang Binh Province) told that they had killed a langur with white hair on its head and that it looked more like *Semnopithecus francoisi laotum*.

### VI.1.2. Key species account

1. Primate species (see VI.2)
2. Red dog (*Cuon alpinus*) and wild dog (*Canis aureus*)

Conservation value: *Cuon alpinus* is an endangered species, listed as E (Vietnam Red Data Book) and listed as Vu (IUCN, 1996). *Canis aureus* was discovered in Vietnam in 1990 (Pham Trong Anh, 1990) is nationally endangered species and will be listed in Vietnam Red Data Book in the future.

In Phong Nha - Ke Bang both species are present, but *Cuon alpinus* were more frequently seen. Its dung can be found along the Provincial road 20, running across the Reserve at km 16 - km 27, at Co Khu and Dai Cao streams and along the old exploited route from So Dua stream to Doong Village (especially near Ba Giang I stream). Their fresh foot-prints were found near Co Khu stream (17°28'46N - 106°12'72E) on July 21<sup>st</sup>, 1998. We saw a *Canis aureus* drinking water at Cha Ang stream (17°30'25N - 106°15'84E) at 21h15 on July 24<sup>th</sup>, 1998. There must have been a group, but when we heard them barking and ran out to the stream, we could see only one individual. The survey team led by Dr. Pham Trong Anh (August, 1998) also acknowledged that these two species sometimes sighted in the areas of Thuong Hoa and Hoa Son Districts (Quang Binh Province).

### 3. Viverrid species (*Viverridae*).

Conservation value: Some species of Viverrid confirmed to be present in Phong Nha - Ke Bang are nationally and regionally endangered species (Vietnam Red Data Book, 1992), including: *Arctictis binturong* listed as V, *Arctogalidia trivirgata* listed as R and *Viverra megaspila* listed as E.

*Paguma larvata*, *Paradoxurus hermaphroditus*, *Viverra zibetha* and *Viverricula indica* were popular in the survey areas, especially *Paguma larvata* and *Paradoxurus hermaphroditus*. Their dung, foot-prints, food remains can be frequently seen on survey routes in the forest and along So Dua, Cha Ang, Ba Cay, Rao Thuong streams. The *Paradoxurus hermaphroditus* was observed on the route from So Dua stream to Ba Giang I mountains (17°31'30N - 106°17'61E) on July 4<sup>th</sup>, 1998 at 09h41 near Ba Cay stream

(17°28'45N - 106°18'80E) on July 6<sup>th</sup>, 1998 at 8h30 near Pa Ro stream of Minh Hoa District (17°42'06N - 106°53'75E) on July 8<sup>th</sup> 1998 at 20h00 (night observation). The *Paguma larvata* was observed at Ma Rinh stream of Minh Hoa District (17°43'68N - 105°50'57E) on July 14<sup>th</sup>, 1998 at 20h15. The *Viverricula indica* was observed at Ba Cay stream (17°28'45N - 106°18'80E) on July 7<sup>th</sup>, 1998, at Thung Lau (17°31'60N - 106°30'08E) on July 10<sup>th</sup>, 1998 and in Dang Hoa Village (17°45'83N - 105°52'98E) on August 18<sup>th</sup>, 1998 at 19h30. Some mollusk shells left by an *A. trivirgata* were found in a cave on hillside (17°28'96N - 107°18'24E) 70 km from That Day stream. Mr. Ngo Van Phong (Phong Nha Village, Son Trach Commune, Bo Trach District, Quang Binh Province) said that he saw a group of *A. trivirgata* (3 strips on body, no spot, thin, high and white ears) eating land snails and they left the shells there in early June, 1998. The information of the presence of this species in the areas of Thuong Hoa and Hoa Son (Minh Hoa District, Quang Binh Province) was also acknowledged by Mr. Pham Trong Anh in August, 1998 (see part V.3).

The residents also confirmed the presence of *Arctictis binturong*. On July 25<sup>th</sup> 1998 the residents of Arem Commune (Commune 39) had trapped an *Arctictis binturong* of 17 kg. The specimen of *Viverra megaspila* in Phong Nha Nature Reserve was collected by Mr. Pham Nhat (killed by local people) on the survey on May 14<sup>th</sup>, 1997 (Le Xuan Canh *et al.*, 1997). In this survey, we have got no more information about this species.

#### 4. Mustelid (*Mustelidae*).

Conservation value: Among 7 species of mustelids we identified in Phong Nha - Ke Bang, there are 3 species of otters are nationally endangered species (Vietnam Red Data Book, 1992) including: *Lutra lutra* listed as T.I, *persipicillatta* listed as V and *Aonyx cinerea* listed as V. Two species are globally endangered species (IUCN, 1996), including: *L. persipicillatta* listed as Vu and *Aonyx cinerea* listed as LRnt.

The species of *Martes flavigula*, *Arctonyx collaris* and *Herpestes urva* were quite common in the survey areas. *Martes flavigula* was seen near Voi cave (So Dua stream, 17°30'31N, 106°17'6E) at 10h00 on July 13<sup>th</sup>, 1998, in a valley near km 25 of the Provincial road No. 20 (17°26'48N - 106°12'63E) at 11.20 on July 18<sup>th</sup>, 1998. The foot-prints and mouth-tracks of *Arctonyx collaris* were frequently found near That Day, Co Khu, Ba Cay streams. We also observed a new-born *Melogale moschata* near the stream north of Hang En, Rao Thuong (17°29'87N, 106°18'70E). The signs of 3 species of otters were rarely found on the streams of the survey areas. Some dung and foot-prints of otters were found near Cha Ang stream (17°31'57N, 106°16'61E) and around Dai Cao lake. The dung, foot-prints, food remains (crabs) of *Aonyx cinerea* were found near That Day stream (17°29'87N, 106°18'70E) and Cha Ang stream (17°31'24N, 106°16'45E). Dung of *L. persipicillatta* was found once near Cha Ang stream (17°31'57N, 106°16'65E).

#### 5. Tigers (*Panthera tigris corbetti*)

Conservation value: Tigers are nationally and globally endangered species: Vietnam Red Data Book, 1992 listed as E and IUCN, 1996 listed as En. The Phong Nha - Ke Bang area is famous for the plenty of tigers. At present, the number of tigers is seriously decreasing.

but their signs (dung, foot-prints) can still be found in some areas. In a valley along the Provincial Road 20 from km 24 to km 27 (17°27'12N, 106°12'85E - 17°26'22N, 106°12'53E), the local people saw tigers here in October 1997, February and April 1998. In this area, we found the remained bones of a wild pig near Stream 24 (17°27'01N, 106°12'72E), and many big snail shells left in a cave (17°26'91 N, 106°12'93E). At Co Khu peak, there were two new dung-loads and some scratches on rock found near Co Khu stream (17°28'25N, 106°12'90E) on July 21<sup>st</sup>, 1998. In Rao Thuong valley, there was a baby tiger strapped in the forest and died. A man of Arem Commune found it, collected and sold it at 12 million VND. Along the stream north of Hang En cave we found many new foot-prints on sand (with the dimensions of 10 x 11 cm) (17°26'53N, 106°17'52E) on July 9<sup>th</sup>, 1998. There also found a big load of snail shell's remains left by tigers and some foot-prints around (17°27'06N, 106°17'35E) and a dung-load outside the cave. The information of tigers was also confirmed in survey areas of Minh Hoa District. In 1997, Mr. Bao of Yen Hop Village (17°40'12N, 105°57'44E) trapped a tiger. The tiger foot-prints were frequently found in Da Nui area (17°44'92N, 105°50'97E).

6. The species: *Pardofelis nebulosa*, *Catopuma teminski*, cats: *Prionailurus bengalensis* and *Prionailurus viverrinus*.

Conservation value: This species is a nationally endangered species (Vietnam Red Data Book, 1992), including *Pardofelis nebulosa* listed as V, *Catopuma teminski* listed as V, *Prionailurus viverrinus* listed as R and globally, including *Pardofelis nebulosa* listed as Vu, *Catopuma teminski* and *Prionailurus viverrinus* listed as LRnt.

The *Pardofelis nebulosa* was confirmed to be seen in the survey areas. Its foot-prints and dung were found in Thung Lau (17°33'50N, 106°12'92E) on July 17<sup>th</sup>, 1998, the foot-prints and dung of *Catopuma teminski* were common in the survey areas on July 7<sup>th</sup>, 1998, its dung was found on a hillside near That Day (17°28'95N, 106°17'92E) on July 9<sup>th</sup>, 1998 and near the stream north of Hang En cave (17°26'53N, 106°17'52E). On July 6<sup>th</sup>, 1998 its foot-prints were found near Hang Vom cave (17°30'85N, 106°12'83E) and on July 9<sup>th</sup> 1998 in Thung Nhang (17°31'61N, 106°12'83E).

The leopard cats (*Prionailurus bengalensis*) was popular in the survey areas. Its dung was frequently found on the survey routes. The foot-prints and scratches on surface were found in Ba Giang I valley. On July 7<sup>th</sup>, 1998 at 16h50 we saw a *Prionailurus viverrinus* lying on rock at That Day stream (17°28'95N, 106°17'92E).

7. The species *Ursus thibetanus* and *Ursus malayanus*

Conservation value: Both species are highly endangered species, listed as E (Vietnam Red Data Book, 1992). The *Ursus thibetanus* is globally listed as Vu (IUCN, 1996).

The *Ursus thibetanus* is common in Phong Nha - Ke Bang. Its scratches on trees and at ponds were found in Ba Giang I valley (17°26'41N, 106°17'52E), near the north entrance of En cave (17°26'41N, 106°17'52E), near May stream of Doong Village and near the Stream 24. Especially on Co Khu peak (17°28'23N, 106°13'10E), almost big trees



remained the climbing scratches. At station 4 of Phong Nha Nature Reserve, there is a *Ursus thibetanus*, confiscated from the local people who illegally trapped in the Reserve in 1996.

The *Ursus malayanus* was less common than *Ursus thibetanus*. Its foot-prints were found in Thung Lau - Da Ban (17°34'16N, 106°11'90E).

#### 8. Wild pigs (*Sus scrofa*) and "Chao vao" (*Sus sp.*)

Conservation value: "Chao vao" may be a new species or sub-species of *Sus scrofa* and common in the survey areas.

"Chao vao" almost looks like *Sus scrofa* and is different from *Sus scrofa* in the following points: "Chao vao" is bigger (up to 150 kg), more ferocious, have slimmer body, much longer snout (30 - 40m), longer hair, the hair basally is white, the distal part is black. Their meat is not so delicious as *Sus scrofa*. The female "Chao vao" gives birth only 2-3 new-born ones (while as *Sus scrofa* gives birth to 8 - 12 new-born ones). At 17°31'61N, 106°13'41E, we saw a foot-prints with dimension of (mm) 75 x 70, 37 x 32, 45 x 43, 55 x 45. They may be *Sus bucculentus* that were described by Huede in 1892, based on two specimen of skulls collected at in Bien Hoa and also discovered by G.B. Schaller *et al.*, in Laos (10°18'N, 104°44'E) in January, 1998, or maybe a new species that needs to be more surveyed and identified in the future.

#### 9. Giant muntjac (*Megamutiacus vuquangensis*).

Conservation value: It is a new discovered mammal species (in 1994) and has highly genetic conservation value.

*M. vuquangensis* is confirmed to exist in the survey areas in a small number. Its horns were found kept in some families of Son Trach Commune, Bo Trach District, Quang Binh Province. For example, it was kept in the house of Mr. Dinh Xuan Dong (Tang hoa Commune, Minh Hoa District, Quang Binh) and it was found in Thung Nhang (17°31'62N, 106°13'37E).

#### 10. Serow (*Naemorhedus sumatraensis*)

Conservation value: Serow is a rare and valuable species, listed as V (Vietnam Red Data Book, 1992) and globally listed as Vu (IUCN 1996).

The Serow is still abundant in the survey areas. Its new foot-prints and dung were frequently found on hillsides and at the peak of mountains where existed high trees and open rocks. The Serow is a hunting object of the local people. Its horns were found kept in many families living in the areas. In the evening of July 6<sup>th</sup>, 1998, the local people in Doong Village trapped a *Naemorhedus sumatraensis*. We clearly heard the voices of *Naemorhedus sumatraensis* in some places: at 19h10 on July 7<sup>th</sup>, 1998 in the mountain near That Day stream, at 10h30 on July 7<sup>th</sup>, 1998 near Hang Vom cave (17°31'10N, 106°13'00E) and saw a *Naemorhedus sumatraensis* at 19h35 in Thung Nhang (17°32'11N, 106°12'83E).

#### 11. "Sao la" (*Pseudoryx nghetinhensis*).

Conservation value: It is a newly discovered mammal species (in 1993) and has highly genetic conservation value.

"Sao la" is confirmed to be present in the area of Minh Hoa District, but it has not been seen or trapped for several years. Mr. Cao Tiep (Yen Hop Village, Thuong Hoa Commune, Minh Hoa District killed one "Sao la", weighing from 50 - 60 kg near Trau cave (Buffalo cave) of On Village and this was the last information of the species in this area.

#### VI.1.3. Abundance.

In general, the mammals fauna in Phong Nha - Ke Bang is still abundant in comparison with other Reserves in the country. Although we have got not enough conditions to estimate the abundance of species, but our survey results could prove that there are 35 common species and 16 rare species among 88 species found in the survey. The species with high abundance are mainly of Primates, Artiodactyla, Carnivore (*Viverridae*, *Mustelidae*) such as: *M. arctoides*, *M. assamensis*, *S.f hatinhensis*, *P.n. nemaeus*, *Sus scrofa*, *Naemorhedus sumatranensis*, *Cervus unicolor*, muntjak, *Ursus thibetanus*, *Viverricula indica*, *Vivera zibetha*, *Paradoxurus hermaphroditus*, *Martes flavigula*, *Arctonyx collaris*,... The *Herpestes urva*, *M. arctoides*, *M. assamensis*, *S.f hatinhensis* were common in the areas. Each group was consisted of 6 - 10 individuals. There were much new dung and urine of these species on rock walls where they used to sleep. In some places, such as: Gieng Voo near Xuong valley, May stream (Ba Giang III), Hang En cave, Rao Thuong cave, Tram Me, Ma Rinh Moi caves, the primate lives in large mass (high density).

The foot-prints, dung and other signs of *Cervus unicolor*, *Muntjak*, *Sus scrofa*, *Mustelidae*, *Viverridae* species were common in survey areas, especially in Ba Giang I valley, En, Rao Thuong caves, Thung Nhang, Co Khu Peak. In some places, the foot-prints of *Cervus unicolor*, muntjac, *Sus scrofa* were as many as in a farm.

The dung of *Naemorhedus sumatraensis* was frequently seen in lime-stone mountain's wall, hillside. *Ursus thibetanus* lives in high density in Co Khu peak. Most of big trees in this area bear the scratches left by them.

The abundance of primate species and 2 species of *Ursus thibetanus* and *Naemorhedus sumatraensis* in Phong Nha - Ke Bang have contributed an important role to the genetic conservation, because these species are rare in the country as well as in the world and obtain high conservation priority.

The significant rareness of 9 species in the survey areas (Tiger, *P. nebulosa*, *C. temminskii*, *A. cinerea*, *L. lutra*, *L. perspicillata*, *I. javanicus*, *M. vuquangensis*, *A. binturong*) is mainly resulting from the excessive hunting and frequent disturbance in the areas. In fact, the habitat in Phong Nha - Ke Bang is very good for these species to exist and develop and this

area is famous for the richness and diversity of many species, even of tiger.

On the hills in Minh Hoa District (from Dan Hoa through Hoa Son to Thuong Hoa), there is a very good primary forest with rich water resources and a rich and diversified fauna, especially of hoof species, such as: *Bos gaurus*, *Sus scrofa*, *Muntjak*, elephant, *P. nghetinhensis*, *N. sumatraensis*... However, due to excessive hunting and human disturbance, the abundance of mammals of Phong Nha is significantly decreasing, although the habitat remains very good.

#### VI.1.4. Biological Diversity Conservation Value.

The list of 100 inventoried mammal species could not cover all species in Phong Nha - Ke Bang, but it includes many main species in this area and presents a high biological diversity conservation value. The biological diversity conservation value is presented in the following factors:

- The species diversity: in comparison with the mammal fauna in the whole country, the mammal species in Phong Nha - Ke Bang covers 44.6% of the total ever-known mammal species (100/224). In particular, the primates, carnivore, pangolin, rabbit, dermoptera, bats have the representatives of almost all family and occupy 40 - 100% of species (table 3).

Table 3. Phong Nha - Ke Bang fauna in comparison with fauna of Vietnam

Order name	Number of families			Number of species		
	PN-KB	Vietnam	%	PN-KB	Vietnam	%
Primates	3	3	100	9	14	64.3
Carnivora	5	5	100	24	38	63.2
Artiodactyla	4	5	80	9	15	60.0
Pholidota	1	1	100	1	2	50.0
Lagomorpha	1	1	100	1	2	50.0
Dermoptera	1	1	100	1	1	100
Chiroptera	?	3	?	35	62	56.5

- The presence of 28 rare mammal species in Vietnam (Vietnam Red Data Book, 1992), 20 highly endangered mammal species worldwide (IUCN, 1996) and 5 new discovered species: *P. nghetinhensis*, *M. vuquangensis*, *Sus. sp.*, *S.f. sp.*, *C. aureus* (table 4). Of which, there are 5 common species in Phong Nha - Ke Bang: *M. arctoides*, *S.f. hatinhensis*, *N. sumatraensis*, *U. thibethanus*, bat (*la io*).

Table 4: The species of high conservation interest in Phong Nha - Ke Bang

Or.	Name of species	Scientific Name	Vietnam Red Data Book, '92	IUCN, 1996
1		<i>C. variegatus</i>	V	
2	Slow loris	<i>N. coucang</i>	V	
3	Pygmy loris	<i>N. pygmaeus</i>	V	Vu
4	Stump-tailed macaque	<i>M. arctoides</i>	V	Vu
5	Assamese macaque	<i>M. assamensis</i>	V	Vu
6	Pig-tailed macaque	<i>M. nemestrina</i>	V	Vu
7	Hatinh langur	<i>S. f. hatinhensis</i>	V	Vu
8	Full black langur	<i>S. f. sp.</i>	New discovered	New
9		<i>P. n. nemaus</i>	E	En
10		<i>H. leucogenis</i>	E	En
11	Wild dog	<i>C. aureus</i>		
12	Dhole	<i>C. alpinus</i>	New discovered	
13	Binturong	<i>A. binturong</i>	E	Vu
14		<i>A. trivirgata</i>	V	
15		<i>V. megaspila</i>		
16	Common otter	<i>L. lutra</i>		
17		<i>L. perspicillata</i>	V	Vu
18	Oriental small clawed otter	<i>A. cinerea</i>	V	LRnt
19	Tiger	<i>P. tigris corbetti</i>	E	En
20		<i>P. nebulosa</i>	V	Vu
21	Golden cat	<i>C. temminckii</i>	V	LRnt
22		<i>P. viverrinus</i>	R	LRnt
23	Asiatic black bear	<i>U. thibetanus</i>	E	Vu
24		<i>U. malaynus</i>	E	
25	Giant muntjac	<i>M. vuquangensis</i>	New discovered	New
26	Serow	<i>N. sumatraensis</i>	V	Vu
27	Sao la	<i>P. nghetinhensis</i>	New discovered	New
28	Chao vao	<i>Sus. sp.</i>	New discovered	New
29		<i>Bos gaurus</i>	E	En
30		<i>T. javanicus</i>	V	
31	Red giant flying squirrel	<i>P. petaurista</i>	R	
32		<i>Ia io</i>	R	
33		<i>C. pygerthus</i>		Vu
34		<i>H. brachyura</i>		Vu
35		<i>M. javanicus</i>	V	LRnt

*S.f. hatinhensis* is an endemic species and its population in Phong Nha - Ke Bang is the largest one in Vietnam and in the world. Tigers are a rare and valuable species, in Vietnam there are only 150 - 200 individuals left. Its foot-prints, dung and other signs are frequently found in Phong Nha - Ke Bang area and local residents could see tigers sometimes (in 10/97, 2/98, 4/98). We also found many new foot-prints, snail shells left by tigers in the valley in the north of En and Rao Thuong caves, near Stream 24 and two new loads of tiger's dung and scratches on rock wall in Co Khu stream. *M. vuquangensis* - a newly discovered species in Vietnam in 1994 is also confirmed to be present in the area (horn specimen is kept in Son Trach Commune, Bo Trach District and Tang Hoa Village, Hoa Son Commune, Minh Hoa District, Quang Binh Province. The specimen of *V. megaspila* - a very rare species in Vietnam, was collected on May 14<sup>th</sup> 1995 (the local people of Cu Lac Village, Phong Nha trapped it) (Pham Nhat, 1997). This rare and valuable species may still exist in the area of Hoa Son, Minh Hoa District. Two pairs of horns of "Sao la" (*V. megaspila*) which were trapped by local people before 1990 are kept in the houses of Mr. Cao Tiep (On Village, Yen Hop Commune) and Mr. Dinh Hong Quang (Hoa Son Commune).

The confirmation of the presence of unidentifiable species such as: full black langur, chao vao and the possibility of the existence of *M. truongsongensis*, *M. rooseveltensis* or *Semnopithecus francoisi laotum* in this area will significantly increase the biological diversity conservation value of the Reserve.

## **VI.2 Characteristics of Primates in Phong Nha - Ke Bang**

### VI.2.1. Introduction

Vietnam has a primates fauna which is not only diversified in species composition but also rich in endemism. We have inventoried 15 species so far (24 species and sub-species including sub-species of *S.f. sp.* which was acknowledged lately in Phong Nha). These species are from 3 families: *Loridae*: 2 species, *Cercopithecinae* (of *Cercopithecidae*): 5 species (6 species and sub-species), *Colobinae* (of *Cercopithecidae*): 5 species (10 species and sub-species) and *Hylobatidae*: 3 species (6 species and sub-species).

The Primates in Quang Binh Province has been less surveyed. During the field surveys in Tuyen Hoa and Le Thuy in 1964, Prof. Dao Van Tien could collect specimens of two species (*Macaca mulatta*, *Trachypithecus francoisi hatinhensis*). Since 1995, with the assistance of international organizations (WWF, PCI, FFI), Prof., PH.D. Pham Nhat and some Vietnamese scientists have organized many surveys to study the Primates in Quang Binh Province, especially in Phong Nha - Ke Bang and have gained considerable results.

### VI.2.2. Primates Species Composition in Phong Nha Nature Reserve

Basing on the results of the survey and analyzing the specimens kept by the local people and other confidence information, we have made a list of the primates in Phong Nha - Ke

Bang. (Table 6).

The 3 teams have inventoried 10 species and sub-species of primates in Phong Nha - Ke Bang, 7 of which by direct observation, 1 by voice (*Hylobatidae*) and 2 by specimens (hair of *Nycticebus coucang* and skull of *Nycticebus pygmaeus*).

**Table 6: The list of the primate species in Phong Nha - Ke Bang**

Or.	Scientific Name	Common Name	RH	CK	VN	LB	BR	HS
	<i>Loridae</i>							
1	<i>Nycticebus pygmaeus</i>	Pygmy loris				Sp	Re	Re
2	<i>Nycticebus coucang</i>	Slow loris			Sp			Re
	<i>Cercopithecidae</i>							
	<i>Cercopithecinae</i>							
3	<i>Macaca mulatta</i>	Rhesus macaque	Obs	Obs		Obs	Sp	Re
4	<i>Macaca arctoides</i>	Stump-tailed macaque	Obs	Obs	Obs	Obs	Obs	Obs
5	<i>Macaca nemestrina</i>	Pig-tailed macaque				Obs	Sp	Re
6	<i>Macaca assamensis</i>	Assamese macaque				Obs		Re
	<i>Colobinae</i>							
7	<i>Trachypithecus francoisi hatinhensis</i>	Francois's leaf monkey	Obs	Obs	Obs	Obs	Sn	Sn
8	<i>T. francoisi ebenus</i> (l)	Full black langur				Obs		
9	<i>Pygathrix nemaeus nemaeus</i>				Obs		Re	Obs
	<i>Hylobatidae</i>							
10	<i>Hylobates leucogenys siki</i>	White-checked gibbon	Sn	Sn		Sn		Sn

**Note:**

Location:

- RH. Rao Thuong, Hang En cave
- CK. Co Khu
- VN. Hang Vom cave, Thung Nhang, Eo Cap, Xuong valley
- LB. Thung Lau, Thung Ba Dau
- YC. Yen Hop, Cha Loong, Ca Thuc
- HS. Dang Hoa, Ma Rinh, Tang Hoa

Information types:

- *Obs.* Field observation
- *Sp.* Specimen (skull, skin, hair)
- *Sn.* Signs (voice, dung, location).

A special matter is that during our survey we discovered a new form of full black langur by direct observation. Although we do not have specimens, but we think, this is the same species as that had been described by Osgood in 1932 basing on analysis of specimen collected by Wulsin in Lai Chau, Vietnam in 1924.

This form is much the same with the full black langur that was recorded in Hin Nam No Reserve, Laos (Timmins R.J and Khamkhoun Khambouline, 1996; Prof., PH.D. Pham Nhat, 1998). Tilo Nadler (1998) also informed that a tourist had bought a full black langur in Quang Binh in January, 1998 and this might be brought in from Laos by smugglers. This langur is being fed in Endangered Primate Rescue Centre, Cuc Phuong National Park. If the species that we observed in Ba Dau valley is the same as the one which was described by Osgood, so after 73 years, this species has been rediscovered in the area of Phong Nha mountains, Quang Binh Province (17°36N, 106°17E).

So far, we haven't got specimens of "full black langur", but the field observations can show that this langur has the same appearance, hair colour with the one that is kept in Endangered Primate Rescue Centre, Cuc Phuong National Park, but its arms seem to be shorter than its legs. This may be the sub-species *Trachypithecus francoisi ebenus* (Brandon - Jones, 1995) as described by Tilo Nadler (1998).

The second information about white-headed langur (possibly *Trachypithecus francoisi laotum*) provided by Tram Village's people is very useful. They saw it in the bordering area between Vietnam and Laos. But we have not discovered it, so this species is not listed in the list.

The survey results have confirmed that Phong Nha - Ke Bang is really the area of the richest and most diversified Primates in Vietnam and may be considered as the "capital" of Primates. In comparison with the Primates in the country, the Primates in Phong Nha covers:

For the family:	100% families (3/3 of the whole country)
For the species:	60% species (9/15 of the whole country).

### VI.2.3 Species account

#### 1. *Nycticebus pygmaeus*:

Present status: World Red Book listed as Vu, Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT, group IB.

The *N. pygmaeus* named "xấu hổ" by the Tram's villagers was acknowledged by the



specimen (skull) in two survey areas: Thung Nhang and Ba Dau valley. In other areas, such as: (Rao Thuong, Hang En cave, Co Khu, Hang Vom, Thung Lau, Da Ban) there was no confidence signs, except information from hunters of Hoa Son and Yen Hop Communes.

The skull specimen of *N. pygmaeus* at Da Ban (17°33' N, 106°12 'E) was provided by a hunter who had caught it at Ba Dau valley area. He also provided the specimens of lower maxilodenture, but they were broken. We didn't see any *N. pygmaeus* in the survey areas.

The *N. pygmaeus* is very rare in this area. The local hunters and the guide had the same opinion with us.

## 2. *N. coucang*

Present status: Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT group IB.

The *N. coucang* named "xấu hổ" by Tram and Me's villagers was acknowledged only in one survey areas - Thung Nhang and only by analyzing specimens of hair collected in a hunter's camp. The *N. coucang* is very rare and seldom seen in Phong Nha - Ke Bang.

## 3. *Macaca mulatta*.

Present status: CITES appendix II, Decree 18/HDBT, group IIB.

The *Macaca mulatta* (the local people name this form "Khỉ đá") was directly observed in 3 survey areas at Rao Thuong, Co Khu and Thung Lau. We took a photograph of the *M. mulatta* which was kept in Hoa Son. This species is very common in Phong Nha - Ke Bang, but its population is in a high density in Ba giang and Co Khu, where exist forests with rocky mountains and streams. This species is uncommon in Thung Nhang and Thung Lau, maybe due to lack of water.

## 4. *Macaca arctoides*

Present status: World Red Book listed as Vu; Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT group IIB.

The *M. arctoides* (the local people name this form "Khỉ đất" - maybe because it used to look for food mainly on the ground) was frequently seen in almost all survey areas. However, there was only 6 to 14 individuals in a group. Those groups which were seen in Ba Giang, Rao Thuong had more individuals (> 10) than those in Thung Lau, Thung Nhang (< 10).

## 5. Pig-tailed monkey (*Macaca nemestrina*)

Present status: World Red Book listed as Vu; Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT, group IIB.

The local people name this form "Khỉ quăng". We saw only one group of 3 individuals in Ba Dau. The team led by Pham Trong Anh has got more information in Ruc Commune (Yen Hop, Hop Hoa), Hoa Son. This species is uncommon in Rao Thuong, Ba Giang, Co

Khu, Thung Nhang, Thung Lau.

In comparison with our previous observations, the number of the *M. nemestrina* seems to be decreased.

#### 5. *Macaca assamensis*

Present status: World Red Book listed as Vu; Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT, group IB.

This is a rare species. In the survey organized in 1995, we collected only one skull in Yen Hop (Thuong Hoa, Minh Hoa). In the surveys organized in 1996 and 1997, we didn't get any information on this species. During this survey, we only saw the group of 7 individuals in Da Ban (17°35' N, 106°12' E) on July 18<sup>th</sup>, 1998. Other teams didn't see any individuals of this species, only team III got some information on it from the local people in Hoa Son.

#### 7. *Trachypithecus francoisi hatinhensis*

Present status: World Red Book listed as Vu; Vietnam Red Data Book listed as V, CITES appendix II, Decree 18/HDBT group IB.

The local people in Yen Hop, Yen Hoa call T.f. *Hatinhensis* "the Khung", but in Tram, Me, Phong Nha, Chay, Bau Sen call it "Vượn đen bạc má" (White-cheeked black ebenus). This species was common in Phong Nha - Ke Bang. Almost all the team members saw it in the field in all survey areas. We could see or hear its voice "hoot, hoot..." every day. Although we saw many groups of Hatinh langur, each group was consisted of 4 to 8 individuals. In the area between Xuong and Thung Lau (17°39' N, 106°13' E), there is a stone well of about 50m depth and we saw a group of 7 Hatinh langurs sleeping there frequently. This was the only case, we saw the langur sleeping in a such condition. However, the people can't get down the well or shoot the animal, because people can't get the animal out of the well even they already died.

#### 8. Full black langur (*Trachypithecus francoisi ebenus* ?)

Present status: This is a new form which hasn't got any name in documents.

The local people name this form "all black gibbon". There was only one group of the langur to be observed. It was not clear how many individuals in the group as they left the sleeping place very early in the morning (04h30) and came back late in the evening (19h25). We saw this species twice, but the same individuals in the same sleeping place, in two different mornings: first time, in the morning of July 26<sup>th</sup>, 1998 at 05h10 and second time in the morning of July 27<sup>th</sup>, 1998 at 05h00. We tried to take a photograph, but we couldn't because of darkness and hurry.

The T.f. *ebenus* group must have been shot many times and it had only 2 places for sleeping, so it was very frightened by human appearance. We heard the voice of a group and they have to sleep on the mountains above the cave, only one came back to the rock wall and we could observe this individual in two early mornings.

Although we have directly observed this form, we think that more study and survey should be carried out, as our observation was in only one place and the number of observed animal was so little.

#### 9. *Pygathrix nemaeus*.

Present status: World Red Book listed as En; Vietnam Red Data Book listed as E, CITES appendix I, Decree 18/HDBT group IB.

The local people and hunters provided lots of information on *P. nemaeus* in Rao Thuong, Ba Giang, Co Khu, Eo Cap, Xuong, Thung Lau, Hoa Son. We (Team II) observed only one group of 8 individuals (2 male old, 5 female old and 1 female matured) at 15h42 on July 11<sup>th</sup>, 1998 on the survey route from Eo Cap to Vooc well. There was no sign of reproduction in this group, as there was no young individual. The habitat and food sources in Ba Giang, Xuong valley, Eo Cap, Thung Lau, Hoa Son are ideal for this species. We also found many remains of leaves left by *P. nemaeus* on the survey routes.

#### 10. *Hylobates leucogenys siki*

Present status: World Red Book listed as En; Vietnam Red Data Book listed as E, CITES appendix I, Decree 18/HDBT, group IB.

The local people name this form "Vtrơn hót". All the 4 teams didn't see any individuals of this species, but we heard the voices of many groups. There would be many individuals of *H. siki* in Ba Giang - Rao Thuong forests. Although we didn't observe this species, we heard the voice of this species at least of 4 different groups from different directions on July 7<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 12<sup>th</sup>, 1998.

The voices of *H. siki* were also heard in Co Khu, Thung Lau and Hoa Son, but the voices were a bit little as in Rao Thuong - Hang En.

### VI.2.4 Species distribution in survey areas.

#### 1. Ba Giang - Rao Thuong - Hang En mountains area.

This area is consisting of hills, lime-stone mountains and is quite sophisticated and sloping. There are two types of forests: hill forest and lime-stone mountain forest. The forest is still high, and it has many big timber-trees, multi-storeyed, thick and dense canopy.

The human activities in this area are very busy and strong, mainly concentrating on wood cutting, especially for Diospiros wood. Besides, the hunting, honey and hat-leave collecting were also frequently seen here. There also found the signs of Lauraceae of extracting.

The 4 Primates species were confirmed to be present by Team I. The most common were *M. mulatta*, *M. arctoides*, *T.f. hatinhensis*.

### Co Khu - Dai Cao area

Co Khu forest is similar to Ba Giang's but there is more lime-stone mountain forest in the West and North - West. The terrain is sophisticated with many slopes and rock walls which form obstacles to access. Co Khu forest is very rich and has many big and valuable timber-trees.

The people activities in this area are more furious than in Ba Giang - Rao Thuong. The people in Tram, Me, Phong Nha, Cu Lac etc... often gather in groups of 5 - 12 persons to exploit *Dalbergia rimosa*. Team I even found many cut woods in this forest, but no information on hunting was collected. There were some signs of Lauraceae oil extracting, in some places, the waste of residues was of 5 - 6m<sup>3</sup> left.

Team I also confirmed the presence of 4 primates species in this area: *M. mulatta*, *M. arctoides*, *T.f. hatinhensis* and *H. siki*. The 3 former species were eye-witnessed and the latter *H. siki* was confirmed by its voice.

### 3. Hang Vom cave - Eo Cap - Xuong valley - Thung Nhang.

The terrain here is strongly segmented. There are plain valleys between rocky mountain belts. In order to go from one valley to another, people have to go across the sloping hills or high rocky walls and it is very difficult to move.

Thung Nhang forest is very poor due to previous exploitation and the bombing during war. The forest from Vom isthmus to Vom valley, to Xuong valley is very rich both in lime-stone mountain and in valley. There are many big *dracontomelum* trees, some have the diameter of more than 1 m or 2.5 m. The forest canopy reaches to 80% of covering level. The forest is a multi-storeyed forest and is very typical for tropical ever-green rainforest and tropical forest on lime-stone mountains.

The people activities in this area are as furious as in Co Khu, Ba Giang. We did not find *Dalbergia rimosa* wood cutters in the routes, but there were many hunters and about 200 traps were collected in Thung Nhang.

Only 4 species of Primates were recorded in this area, 3 of which by direct observation (*M. arctoides*, *T.f. hatinhensis*, *P. nemeaus*) and the last one by identification of hair collected in a hunters' camp.

### 4. Treo Mountain- Thung Lau - Da Ban area

Like Eo Cap, Xuong valley, the terrain in Treo mountains - Thung Lau - Da Ban is very complicated and difficult to access due to the slopping hills and rocky walls. Thung Lau is rather large and flat, but the forest is poor. There were only some big wood trees in the middle of the valley. In the North-East area of Thung Lau and even on the low hillsides, there remained only regenerating forest. According to the route guide, valuable timber-trees were exploited about 10 years ago in this area. There still existed some routes for exploiting woods left, used for buffaloes.

Many people came there for extracting Lauraceae oil and collecting leaves for making hats.

There was no sign of hunting, only some bird and small animal traps used by oil extractors found there. The Lauraceae oil extracting is the biggest concern there.

There were 6 species of primates confirmed to be present here: *N. pygmaeus*, *M. mulatta*, *M. arctoides*, *M. assamensis*, *T.f. hatinhensis*, *H. siki*. The abundance of Primates is not high.

The reason why the *P. nemaus*, *T.f. hatinhensis* and *H. siki* species were not commonly found in Thung Lau during the survey is the human activities for oil extracting, only month before we came to survey this area. The activities, such as: wood cutting, Lauraceae tree chopping and others had driven them away.

#### 5. Tro Mong - Ba Dau

Ba Dau area was chosen after having information on the presence of "full black langur" and Ba Dau valley is outside the Phong Nha area.

The Ba Dau valley's terrain is more sophisticated than other survey areas, as there are many high mountains, rocky hills. The forest is not controlled by the Phong Nha Nature Reserve, so it is poor and has no valuable timber-tree left. There were a few big trees remained, but they are of no value.

The human activities are furious. Besides, the local people in Tram, Me, Bau Sen Villages harvest woods for housing construction, they also cut woods to exchange for food. The hunting may exist but not much, as there are no many big animals here, and the animals are very shy, so it is difficult to hunt.

Although the survey time was lasting only 7 days and 3 nights, but we recorded the 4 species of Primates in this area. They are *M. mulatta*, *M. arctoides*, *M. nemestrina* and "full black langur".

### VI.2.5 The Primates quantity and threats to primate fauna in Phong Nha - Ke Bang

#### 1. The quantity

Thanks to its advantages of terrain, habitat, food sources, Phong Nha - Ke Bang is the place where the biggest number of Primates species in Vietnam live. On the other hands, the Primates in this area have many endemic and valuable species and sub-species.

Table 7: The quantity and threatened level of the Primates in Phong Nha - Ke Bang

Or.	Scientific Name	Common Name	VN	TG	SL
1	<i>Nycticebus pygmaeus</i>	Pygmy loris	V	Vu	PO
2	<i>Nycticebus coucang</i>	Slow loris	V		P
3	<i>Macaca mulatta</i>	Rhesus macaque			C
4	<i>Macaca arctoides</i>	Stump-tailed macaque	V	Vu	C
5	<i>Macaca nemestrina</i>	Pig-tailed macaque	V	Vu	P
6	<i>Macaca assamensis</i>	Assamese macaque	V	Vu	PO
7	<i>Trachypithecus francoisi hatinhensis</i>	Francois's leaf monkey	V	Vu	C
8	<i>Trachypithecus francoisi ebenus (!)</i>	Full black langur	N	N	PO
9	<i>Pygathrix nemaeus nemaeus</i>		E	En	C
10	<i>Hylobates leucogennys siki</i>			En	C

**Note:**

- VN: Vietnam Red Data Book: E.: endangered, V.: Vulnerable, N: New recorded
- TG: World Red Book: En: endangered, Vu: Vulnerable N: New recorded
- SL: Quantity C: Common, PO: Present, but common, P: Present, unidentified number

Among the 10 recorded species and sub-species, there are:

- endemic species in Vietnam :T.f. hatinhensis
- endemic species in Indochina: T.ebenus, P. nemaeus, H.siki

Vietnam Red Data Book has classified endangered levels:

- Endangered level (E): P nemaeus.
- Vulnerable level (V): 6 species and sub-species: N. pygmaeus, N. coucang, M. arctoides, M. nemestrina, M. assamensis, T. f. hatinhensis

The World Red Book has classified endangered levels:

- Endangered level (En): 2 species: P. nemaeus, H.siki;
- Vulnerable level (V): 6 species and sub-species: N. pygmaeus, N. coucang, M. arctoides, M. nemestrina, M. assamensis, T. f. hatinhensis;
- The new discovered langur hasn't been listed. M. mulatta and H. siki are not included in Vietnam Red Data Book maybe due to lack of updated information. H. siki is severely endangered as the distribution and habitat are narrowed due to increasing loss of natural forest.

Basing on the survey results, we rank the abundance of primates in Phong Nha - Ke Bang, as follows:

- 5 common species (C) and were frequently seen in the survey areas: *Macaca mulatta*, *M. arctoides*, *T.f. hatinhensis*, *P. nemaëus*, *H.siki*.
- 3 present but not common (PO) species :*N. pygmaeus*, *M. assamensis* and *T. ebenus*.
- 2 present (P) species: *N. pygmaeus*, *T. ebenus*. These two species were in the survey areas but we still couldn't identify their diversity.

## 2. Threats.

Although the composition of the primates in Phong Nha- Ke Bang is diversified, but its quantity is not high. The reasons leading to the decreasing of the Primates are as follows:

- The hunting: The local people of Tram, Me, Chay, Bau Sen Villages never dare to frankly say that they still go hunting, but through their answers, we know that this activity was still on and quite furious. If they did not go hunting, they would never know the groups of *ebenus* and *nemaëus* as well as the quantity of each group. They knew quite exactly not only its sleeping place, but also the quantity of each group.
- The human activities: with the quantity of several dozens of people went exploiting *Diospiros*, *Dalbergia rimosa* wood and laying traps for animals. This not only narrows the habitat, but also disturbs the habitat of the animals in general and of the fauna in particular. These activities have driven the animals away further to the border between Vietnam and Laos. All animals need water, so the activity of Lauraceae oil extracting not only destroyed the habitat but also robbed the only water resource in the dry season. This is the main reason why the quantity of animal is getting decreasing.

## VI.2.6 Conclusion and recommendation

### 1. Conclusion

- There are 10 species and sub-species of primates in Phong Nha - Ke Bang discovered. They belong to the 3 families: Loridae: 2 species, Cercopithecidae: 7 species and sub-species, Hylobatidae: 1 species. The sub-species of *T. f. ebenus* was rediscovered for the first time in Vietnam after 73 years. This is the place where the most diversified Primates in Vietnam living.
- There are 7 species listed in Vietnam Red Data Book: *N. pygmaeus*, *N. coucang*, *M. arctoides*, *M. assamensis*, *M. nemestrina*, *T. francoisi hatinhensis*, *P. nemaëus*. Two species of *T. francoisi ebenus* and *H. leucogenys siki* are not listed but they are endangered species now.
- The Primates in Phong Nha- Ke Bang is able to reserve the rare and valuable genetic resource, since the quantity of rare and valuable species is high.

- This Primates is endangered for many reasons, of which the hunting is the main one.

## 2. Recommendation

- As recommended in the previous surveys, it is urgent to accelerate the project of upgrading the Phong Nha Nature Reserve to National Park. By doing this, we can only enlarge the territory and improve the ability of conserving the Primates as well as other animal species.
- Continuing to improve the skills of forest protection staff through training and exchanging information, so that they can survey, control the animal resources in general and the Primates resources in particular to discover the impacting reasons and draw out the management solutions in due time. The monkey species that need to pay attention on when surveying are: *M. mulatta*, *M. arctoides*, *T.f. hatinhensis*, *P. nemeaus*, *H.siki*.
- The international organizations should provide financial assistance to carefully survey the distribution of *T. francoisi ebenus* and *T. francoisi hatinhensis* in the Reserve and near the border between Vietnam and Laos. We should map out plans to control the endangered species, such as: *P. nemeaus*, *T. francoisi hatinhensis*, *M. assamenis*, *M. nemestrina*, *H. leucogenys siki*.
- The hunting should be prohibited and banned in the Reserve. In order to do so, the Province People's Committee, the Forest Protection Department, the People's Committee of Bo Trach, Minh Hoa Districts, the Management Board of Phong Nha Nature Reserve and local communes and villages should have a common point of view on the situation, find out a appropriate solution to protect national valuable natural resources. The most critical issue is to alleviate hunger and reduce poverty for the people living in and around the Reserve. Only by doing so, we can reduce the pressure of the local people's activities on the Reserve and protect the natural resources.
- The Government, especially Quang Binh People's Committee needs to invest in the construction of infrastructure as well as the human resources, improve working capacity of the Reserve's staff, so that they can fulfill the managing responsibilities for these resources.
- Carrying out propaganda, stimulate the mass to participate in forest resource management. International organizations should consider the assistance, besides, large programmes and projects, the information through printing materials on school apparatus (pupils' bags, note books). This is a very effective way and can be done immediately.

All the above recommendations are basing on actual demands. The Quang Binh People's Committee, The Forest Protection Department, The People's Committee of districts and international organizations should provide financial assistance to make these recommendations a success.



## VI.3 Characteristics of mammal in Thuong Hoa, Hoa Son, Minh Hoa (Quang Binh Province)

### VI.3.1 Species composition

1. *Macaca mulatta*: is kept/fed in On hamlet, Yen Hop, Thuong Hoa and in Hoa Luong, Hoa Son.
2. *Hylobates leucogenis*: its voice was heard in early morning (recorded tape) and a couple was observed in Ma Rinh (17°43'68N, 105°50'97E) on August 15<sup>th</sup>, 1998.
3. *Viverricula indica* (:) was observed by night survey on August 18<sup>th</sup>, 1998 at 19h30 in Dang Hoa's bushes.
4. *Paradoxurus hermaphroditus*: was observed by flash along Pa Ro stream (near 17°42'06 N, 105°53'75 E) at 20h00 on August 7<sup>th</sup>, 1998.
5. *Paguma larvata* was observed by flash along Ma Rinh stream (near 17°43'68N, 105°50'97E) at 20h15 on August 14<sup>th</sup>, 1998.
6. *Ursus thibetanus* was observed by signs, traces, scratches on trees. There were 3 dry fruit trees left by the bear (17°45'36N, 105°57'65E) on August 12<sup>th</sup>, 1998. Mr. Dong said that he saw one bear eating this tree in September, 1997.
7. *Sus scrofa*: There were many foot-prints seen on Pa Ro mountain 400m south of the coordinate 17°42'07N, 105°59'75E. We also observed lower jaw of *Sus scrofa* (photo included) at Mr. Dinh Xuan Dong's (Tang Hoa, Hoa Son).
8. *Muntiacus muntjak*: there were foot-prints at the Cha Loong stream. We heard the voices of two muntjacs near the camp (17°37'24N, 105°59'77E) in the evening on August 3<sup>rd</sup>, 1998. Some muntjac's heads were observed in Da Nang, Dang Hoa and Tang Hoa.
9. *Megamuntiacus vuquangensis*'s head was observed at Mr. Dinh Xuan Dong's, Tang Hoa (photo included).
10. *Cervus unicolor*: We observed and took a photograph of its horns in Da Nang on August 11<sup>th</sup>, 1998 and at Mr. Dinh Xuan Loan's (Dang Hoa, Hoa Son) on August 18<sup>th</sup>, 1998. There were many *Cervus unicolor* in Thuong Hoa, Hoa Son in the past, but they almost disappear at present.
11. *Naemorhedus sumatraensis*: the photograph of eating trace on a tree on Cha Loong mountain on August 3<sup>rd</sup>, 1998, the photograph of horns in Dang Hoa and Tang Hoa, of foot-prints in Da Nui (80 x 52) on August 13<sup>th</sup>, 1998 and its dung in Ma Rinh cave on August 15<sup>th</sup>, 1998.
12. *Pseudoryx nghetinhensis*: Mr. Cao Tiep, a 50-year villager of On hamlet, Yen Hop, Thuong Hoa shot one *P. nghetinhensis* about 1 km south of Trau cave in 1986, its weight was approximately 50 - 60 kg. The animal was as black as Serow, it had white hock, long and straight horns, many white spots on its face, it fought against the hunting dog fiercely. Its horns were lost when Mr. Tiep moved house from Yen Hop in 1994. In Mr. Dinh Hong Quang's house, there was a horn of a sao la of 43,5cm long (photo included), the *nghetinhensis* was trapped by Dinh Tai in 1947-1948 at Duong Ngui near Dan Hoa; we also took a photograph of a pair of *nghetinhensis*'s horns in Mr. Dinh Xuan Khong's house. Mr. Khong is 76-year man, who trapped the

nghetinhensis when he was young . The length of the horns is about 41.27 - 41.57 cm. (Photograph included).

The local residents call Sao la "chon ken" as its snout is similar to a mustelid's, its horns are long and parallel as pincers. The existence of Sao la in the survey areas has not been exactly confirmed.

13. *Bos gaurus*: There were old foot-prints on ground under Da Nui, about 400m South-East of coordinate 17°44'45N, 105°50'58E on August 13<sup>th</sup>, 1998. Mr. Dinh Xuan Trang and Dinh Xuan Loan said that in August, 1997, they saw two *B. gaurus*: a female and its baby in Da Nui area. They looked like buffaloes, the two front legs were big and the two back ones were small. Many people said that there were 1-3 *gaurus* living in the area from Thuong Hoa to Hoa Son - Dan Hoa.
14. *Petaurista petaurista*(:) was observed by night survey along Bang Sang stream 17°43'10N, 105°52'75E at 21h:00 on August 16<sup>th</sup>, 1998.
15. *Ratufa bicolor*: We heard its voice at 10h20 on August 8<sup>th</sup>, 1998 near the camp at Cha Long stream (17°37'24N, 105°59'77E), at Mu Hon mountain near Pa Ro (17°42'06N, 105°53'75E) and also observed one *Ratufa bicolor* eating on Duong Cau (coordinate was not defined) on August 13<sup>th</sup>, 1998.
16. *Dremomys rufigenis*: We observed *D. rufigenis* at Ca Thu rock wall (917°36'45N, 105°59'97E) on August 4<sup>th</sup>, 1998 and on the ground of mountain from Dang Hoa to Ca Nui on August 12<sup>th</sup>, 1998.
17. *Callosciurus flavimanus*: We observed many individuals in all 3 survey routes.
18. *Atherurus macrourus*: We took a photograph of its tail in Ruc Village on August 7<sup>th</sup>, 1998 and foot-prints of a macirus group in Ma Rinh forest.

Apart from 18 species confirmed by confidence evidences, such as direct observation, signs and specimens kept in the local people's houses, by interviewing the local people, analyzing specimens photograph and with the experience in selecting information, we think that the following species to be present in the survey areas (for reference).

- *Cynocephalus variegatus*: Local name "cap cap" (Ruc language). This species has wings like bats, no tail and it can hang on trees upside down.
- *Nucticebus sp.* Local name "tang toi" (Ruc language). There are two species with different sizes: big and small, dark and yellow hair.
- *M. arctoides*. Local name "sac" (Ruc language). These monkeys are big, black. They have short tails and usually search for food on the ground.
- *Pygathrix nemaeus*. Local name "Khi bảy màu" (Vietnamese), "muom" (Ruc language). It has 7 colours, long and white tail. It eats tree leaves.
- *Cuon alpinus*, *Canis aureus*. Local name "sonl ruc". There are two species: the big yellow dog called "sonl mong" and black one called "sonl ra" which always move in group in open places.
- *Arctictis biturong*: is as black as a bear, it weighs about 20 - 25 kg, has long tail that can be used as a foot. Local name: "tu du" or "to du".
- *Arctogalidia trivigata*: Local name "manh rum rui ruc". This species has striped body, thin ears with an end up to the sky. It eats fruit.

- *Martes flavivigula*: Local name "co roc ruc". It has yellow colour, long tail. They always go in couples and can run on the ground and climb very well. It like to catch monkeys.
- *Arctonyx collaris*: Local name "ca thua, ca cho". It is as big as a bear, weighing about 20 - 30 kg, it eats worm.
- *Herpestes javanicus*: Local name "ca thoi R". It is brown, pointed snout and tail, it likes to catch chickens in farining areas.
- *Lutra sp*: Local name "pxe". The small species is water otter, the big one is forest otter.
- *Panthera Tigris*: Local name "khai", "ca hoan R". It is yellow, its stripes have sickle shape. Mr. Bao's team trapped one tiger in Yen Hop in 1997. Their foot-prints were often seen in Da Nui area.
- *Catopuma temmincki*: Local name "peo R". It has stripes on face and often catches monkeys.
- *Pardofelis nebulosa*: Local name "dun R". It is gray, has flower vein, often lives in stone mountains.
- *Prionailurus bengalensis*: Local name "meo bru", "meo ra". It looks like a pet cat, and it is yellow, it has beautiful spots, likes eating mouse and chicken.
- *Ursus thebatamus* and *Ursus malaymus*: There are two species (some said three). The *Ursus thebatamus* "cha cu ngua" is big, has long hairs, letter V chest and the *Ursus malaymus* "cha cu cho" weights only 50-70 kg, clear body, fat, deep yellow letter U chest.
- *Tragulus javanicus*: Local name "to roi R". It looks like a vuquangensis, but it is as small as a cat, it doesn't have horns.
- *Manis sp.*: Local name "thut R". There are two kinds: black and yellow hair.
- *Hystrix brachyura*. Local name "ke nhung R". It has long, black and white hairs.

Besides, the 18 confirmed species in the list and more than 18 species referred from local people's information, we also found a specimen of *Platysternum megacephalum* at Da Nui stream (17°44'92N, 105°50'58E) with a photograph included.

### VI.3.2 Rare and valuable species in the survey areas.

<i>Hylobates leucogenis</i>	E (VN Red Data Book, 1992) Asiatic black bear VU
<i>Ursus thibetanus</i>	E (VN Red Data Book, 1992)
<i>Megamuntiacus vuquangensis</i>	E (VN Red Data Book - a draft for republishing)
<i>Naemorhedus sumatraensis</i>	V (VN Red Data Book, 1992)
<i>Pseudoryx nghetinhensis</i> (Saola)	E (VN Red Data Book - a draft for republishing)
<i>Bos gaurus</i>	E (VN Red Data Book, 1992) Red giant flying squirrel
<i>Petaurista petaurista</i>	R (VN Red Data Book, 1992)

### VI.3.3. The diversity of mammal fauna in the survey areas

Although, we collected confidence information on only 17 species during survey period. But this data doesn't fully reflect the diversity of mammal fauna in the survey areas. Basing on selected information and natural condition of the survey areas, we can affirm that Thuong Hoa and Hoa Son have a very rich and diversified animal resources. The *Cervus unicolor*, elephant, sao la, *P. nghetinhensis* were present in this area in the past time, but today they seem almost in extinct.

Basing on the selected information, we also confirm the presence of the following species (not including the listed rare and valuable species): *C. variegatus*, *N. coucang*, *N. pygmeus*, *M. arctoides* S.f. *hatinhensis* S.f. sp., *C. aureus*, *C. alpinus*, *A. binturong*, *A. trivirgata*, *L. perspicillata*, *A. cinerea* (2 species), *P. tigris*, *P. nebulosa*, *C. temmincki*, *M. javanicus*, *M. javanicus*.

Besides, the lime-stone mountain covered by forest ecosystem, there is also ecosystem of tropical ever-green rainforest, primary forest on hill, upstream forest: slopping hills, many streams and mountain belts from Thuong Hoa, pass Hoa Son to Dan Hoa. The *Sus scrofa*, *M. muntjak*, *Cervus unicolor*, *Bos gaurus*, *T. javanicus* are very common in this area, There also exist other carnivore animals such as tiger, *P. nebulosa*, *C. aureus* and *C. alpinus*.

It is necessary to take into account that in a limited area of hill forest which is surrounded by rocky mountain and crowded with the people of Dan Hoa, Hoa Hop, Hoa son, Trung Hoa, Thuong Hoa, the quantity of hoof animal has seriously decreased. *Cervus unicolor* was very common 10 years ago, but now they are already in extinct. Other species such as *Sus scrofa*, *Muntiacus muntjak*, *Bos gaurus*, *Tragulus javanicus* and even *N. sumatraensis* are not as abundant as before.

### VI.3.4 . Community features and animal distribution in the survey areas

#### 1. Cha Loong - Ca Thuc area (from Yen Hop, Ban On to the south)

The main feature of Cha Loong - Ca Thuc area is the lime-stone mountain covered by forest with many valuable timber-trees especially Diospiros. These trees are illegally exploited by local people from nearby villages and from Bo Trach, Quang Trach. On 3<sup>rd</sup> and 4<sup>th</sup> August 1998, we met four teams of wood cutters, totaling 38 persons (See photo enclosed).

The lime-stone mountains in this area are not in a chain like in Ma Rinh Moi (Hoa Son), as they are separated by small valleys and forests. The Karst characteristic is clearly shown here, many big streams become dry in dry season. There are many Karst holes (the out-running water or water of a stream running into a hole, deeply under the rock and are called "ruc").

Due to segmented terrain and excessive forest exploitation, animal quantity is very low in this area. They are mainly monkey, squirrel, serow and muntjac, but only in a small quantity.

2. Pa Ro area ( from Yen Hop to the north-west, passing 3 small hamlets Mo O, O O and Ruè Lan to Pa Ro hill forest area).

This is the last end to the south of the old hill forest that runs along Ke Bang lime-stone mountain chains from Dan Hoa pass Hoa Son to the border with Yen Hop (Thuong Hoa). There are many streams in this area, such as: Mu Hon, Mu Ron. There are post-exploited secondary forests along mountain side to the village. From Pa Ro to the north, there is the wood forest which has closed canopy, not many bushes and creepers, so it is easy to move there. This forest is not far from the villages of Yen Hop, so the local people usually goes there for trapping animals and fishing.

In Pa Ro forest, we saw some *Sus scrofa*, *Muntjak's* foot-prints and palm civet. It is clear that *Pa Ro's* fauna is typical for normal tropical ever-green forest one, but its quantity is not high due to human's impact.

3. Da Nui - Duong Cau - Ma Rinh - Bang Xang - Tang Hoa area.

This area is mainly mountainous with virgin forest that belongs to Hoa Son Village. But the above listed names are from the names of the streams in this area. Almost all these streams have running water in dry season. The wood forest has 3 generations: young trees have diameter of 10-14 cm, wood trees with crown contact (closed canopy) - diameter 30-50 cm and big timber trees: > 50 cm. It is easy to move in the forest as it is sparse, its canopy close more than 90%. There are some pine-wood in Da Nui forest which is typical for high mountain forest. The areas's terrain is divided/isolated by many streams so there are not many large and flat valleys.

Many people in the areas go cutting "Tram" trees (*Aquillaria ogallocha*), hunting tortoises in dry season and trapping animals in rainy season. (We saw many people go cutting trees and hunting tortoises during the survey).

The mammal fauna here is mainly hoof animal, such as: *Sus scrofa*, *Muntiacus muntjak*, *Bos gaurus* and carnivore species, such as: *P. tigris*, *C. temminckii* and *A. binturon*, *A. trivigata*, *P. larvata*, *A. collaris* and bear.

The areas which were reported to be rich and diversified in fauna species by the local people are: the area of the Duong Cau upstream , Da Nui, Ma Rinh, Bang Xang, especially Ma Rinh Moi is a large lime-stone area running up to Lao borders and has the only one entrance. There are not many people who come to this area and it is famous for its richness in Primate species. The local people usually come here in rainy season, as there are few streams there.

### VI.3.5 Socio-economic characteristics and human's impact on habitat.

The survey areas are in Thuong Hoa and Hoa Son Villages of Minh Hoa District. However, many hamlets of Thuong Hoa are located along the Provincial Road 15, only Yen Hop is in forest area of Thuong Hoa 10 km far from Road 15. Yen Hop Village has the following hamlets: "7 house" hamlet, "On" hamlet has 11 houses, Yen Hop has 20 houses, Mo O, O O, Ruc Lan Villages have 8 houses each. The total population of Yen Hop is 230 people, mainly of Ruc and Trai ethnic groups.

Hoa son Village is in Hoa Son forest 6 km far from Road 15. It has 3 communes: Hoa Luong: 88 houses, Dang Hoa: 88 houses, Tang Hoa: 47 houses. The total population is 1.327 people of Sach, Ruc, May, Khua, Tho ethnic groups and the Kinh. The living condition in Yen Hop and Hoa Luong is very low, the main food is corn flour. The main source of subsistence is cultivating corn, manioc. Besides that, the local people also raise pig, chicken, cow, buffalo and go hunting, trapping birds, animals, collecting honey and harvest other forest products. Especially, there is a few area for cultivation of water rice in Yen Hop and Hoa Son, resulting from destroying forest for cultivation and making the forest denuded (see photo), speeding up land's corrosion and elution.

Apart from human activities in two above-said villages, the people from neighboring villages and other districts (Quang Trach, Bo Trach) also come here to earn for their living by illegally exploiting forest products (see photo of Quang Trach's local people exploiting diospiros trees).

These activities not only quickly retrograde the lime-stone mountain ecosystem and valuable virgin forest in the area, but also bring harassment to wildlife. Thus, the wildlife is being driven away to the area with worse ecosystem, resulting from decreasing the species composition, its abundance and distribution.

### VI.3.6. Recommendation

- The expanded Phong Nha - Ke Bang Reserve from present area of 40,000 ha to around 150,000 ha along provincial Road 15 and 12 near the border between Vietnam and Laos (the detailed limit is under discussion) and make it a National Park basing on the following factors:
  - It has the largest lime-stone ecosystem in Vietnam which remains original features;
  - It has high faunal and floral biological diversity;
  - There are a large number of rare and valuable animals and plants;
  - It has an attractive natural scene and many beautiful caves;
  - The human population is not very large and sophisticated in the Reserve area. Hoa Son Commune could be planned as buffer zone.
  - It has a trans-boundary bio-diversity conservation value.
- It is necessary to carefully study the biological diversity, especially in non-survey areas

such as Ma Rinh Moi, bordering area and Dan hoa - Cha Lo area.

- **The Quang Binh People Committee, the Forest Protection Department need to work with Management Board of Phong Nha - Ke Bang Reserve, the People's Committee of Bo Trach and Minh Hoa Districts to find out the particular solutions to prevent hunting, natural resources exploitation in the area in order to eliminate the losses, before receiving the approval from the Government for upgrading to Phong Nha - Ke Bang National Park. During the survey, we realized that the Reserve's security is not strictly followed, law is usually in breach.**

#### ***VI.4 Human impact on management of natural resources in Phong Nha - Ke Bang***

##### **VI.4.1 Introduction**

Phong Nha is one of the 53 Nature Reserves in Vietnam, but is very famous for its rich natural resources and has an unique cave called "Phong Nha".

Phong Nha - Ke Bang is also known as a "burning" area in the war against American aggressions, because of ferocious bombings and noble people who were ready to sacrifice themselves for the liberty of the nation. The images and place names such as Xuan Son, Ho Chi Minh Road (Road 20 and Road 15), Tam Co cave, Y Ta cave will always live in the heart of every Vietnamese people as well as everybody who visit the Phong Nha cave for the first time.

Together with historical and socio-economic development, the Phong Nha - Ke Bang has been also changing. Besides the foundation of Phong Nha Nature Reserve, more and more local and foreign tourists come to visit Phong Nha cave. The Road 15 and Road 20 have started to be frequently used for transporting forest products and goods between the two countries Vietnam and Laos.

The Phong Nha Nature Reserve was founded with the most important objectives for reserving natural resources and environment for the country, improving the living conditions of the local people in and around the Reserve. After 5 years (from November 18<sup>th</sup>, 1993), thanks to good natural conditions, mainly to rocky mountains, together with the attention and assistance from Quang Binh People's Committee, the Forest Protection Department, the People's Committee of Bo Trach District and its communes, the natural resources are generally well controlled. After 5 years, there have appeared many conflicts and problems, especially the pressure of local people on the Reserve. The Forest Protection Department's staff - the protectors of Phong Nha forest resources are now facing with these conflicts daily. Especially in the coming time, when the Reserve is to be upgraded to National Park, the responsibilities of managing and controlling natural resources of forest protection staff and the Management Board will be more heavy.

In general, this report touches on what we observed in the survey carried out by our 3

teams in July and August, 1998 in Rao Thuong - Hang En cave, Co Khu - Dai Cao, Thung Nhang - Hang Vom cave - Eo Cap, Thung Lau - Da Ban areas and around Tro Mong control station and the areas outside the Reserve, such as Ba Dau valley (Phuc Trach), Hop Hoa and Yen Hop (Thuong Hoa Village), Dang Hoa, Ma Rinh (Hoa Son Village) of Minh Hoa District. However, we also summarize and provide with additional references and data which we had observed in the previous surveys.

#### VI.4.2 Survey result on human impact.

The Phong Nha - Ke Bang forest is the largest ever-green forest on lime-stone in Vietnam. Combined with Khammuone mountain chains, this will be the largest lime-stone mountain area in the Indochina. The Phong Nha Nature Reserve has very rich natural resources, but it is heavy exploited by human being in many places and with different forms.

##### 1. *Diospiros* and *Dalbergia rimosa* exploitation

"Mun soc" is a valuable wood, name of which is still not defined by scientists (*Diospiros sp.*). It must be a new type of *Diospiros*. In fact "Mun Soc" in Phong Nha has its own special beauty which is different from the others (*Diospiros mun*, *Diospiros sletti*) found in Vietnam. The result of the previous surveys showed that "Mun Soc" of Phong Nha was distributed mainly in Lut valley of Phu Nieu (Thuong Hoa, Minh Hoa). We have counted at least 10 these trees with the diameter of 60 - 80 cm and length of 30 - 35 m in a standard stand of 2.000 m<sup>2</sup> on a 300 - 400 m high mountain. However, some of these trees were already marked (on their skin, arrow lines) to show someone's ownership.

In the period of 1995 - 1997, many *Diospiros sp.* were seriously exploited and transported to different market places. The Reserve's Management Board arrested many exploiters, especially the case of arresting 72 people in October, 1995. At present, *Diospiros sp.* is still exploited, but not as furiously as before 1995 and it mainly takes place in Thuong Hoa, Minh Hoa District.

The exploitation of *Dalbergia rimosa* was very common in our July and August survey. *Dalbergia rimosa* is a type of *Dalbergia*, the wood is beautiful and valuable. It is distributed from the centre of Vietnam down to the South. In Phong Nha, it was frequently seen in Rao Thuong - Hang En (Hang En cave), Co Khu - Dai Cao, Eo Cap - Xuong valley, Thung Lau - Da Ban. Everyday, there must be hundreds people exploiting *D. rimosa* in and around the Reserve. The exploitation of *D. rimosa* has been and continue to be a very serious problem.

*Diospiros sp.* and *D. rimosa* exploiters were often grouped in team of 5-7 people, they brought with them rice, food, axes, sharp knives and went exploiting for 5-6 days. They cut down big trees, then cut them into cubes of 1 - 2 m long, 40 - 50 cm wide, 10 - 20 cm thick and brought home. The local people of Cu Lac, Phong Nha, Me often went along the Road 20 and exploited in Ba Giang or Co Khu. The local people of Tram, Chay, Bau Sen often went along Nha valley to Thung Lau and exploited in Xuong valley. The trails in the forest became common routes, even on rock and became well-known for the local people.



In order to avoid the examination at station Tro Mong and station 4, the exploiters often went through forest to the mountain when coming back. At night, taking the advantage of darkness, they used car's rubber tube full with air attached with woods and swam along Son river to pass Tro Mong station.

The survey teams saw not only many sleep-camps but also temporary cooking - fire just left by the exploiters. In these places where they stopped for rest, forest was destroyed and looked like a battlefield. Team I led by Nguyen Xuan Dang arrested some exploiters with cubes of *D. rimosa* and escorted to the Reserve Management Board.

At present, there is not any *D. rimosa* found at Thung Lau, Da Ban, Eo Cap and a few left in Rao Thuong, Co Khu and Xuong valley. Its existence is endangered. *D. rimosa* and *Diospiros* will certainly be in the same situation as it is of *Aquillaria gallocha*.

## 2. Oil extracting of Lauraceae tree

The oil extracting activity in Phong Nha - Ke Bang appeared later than in other places, maybe in mid 1997. Although started late, the oil extracting spreads all over the Phong Nha Nature Reserve's area.

The nature of extracting is the distillation of essential oil from trees in *Lauraceae* family such as *Cinnamomum balansea*, *Machilus trijuga*, *Machilus velutina* ... Roots and foots of these trees were finely chopped, put into big buckets full of water and then cooked as wine distillation.

Along the Co Khu - Dai Cao streams, there were two oil extracting places with 2 to 3 m<sup>3</sup> of waste left about a month ago (in June). The oil extracting is most seriously in Thung Lau. We saw 5 people collecting waste and preparing for distillation at our camp's location i.e. Thung Lau (17°33'25N, 106°12'10E) on August 17<sup>th</sup>, 1998. They said that they were from Quang Trach and that was the first time they came here to extract oil. In fact, they must have been there for many times. Their equipment (including those things later found) were 2 buckets of about 300 liters, 8 plastic cans from 5 to 10 liters, swamp hens and bush-whackers. Their food, sugar and milk must be enough for 1,5 to 2 months. Our survey team forced them to burn their extracting equipment and foods. We wrote a minute and forced them to come back home.

In Thung Lau, we found at least 6 oil extracting places. Together with cutting trees for oil extracting, many trees, especially hardwood trees were cut down for fire wood in extracting places. These places were looked like a battlefield bombed by US B52 aircraft in the war, where oil extracting waste/remains piled in heaps of at least 5 m<sup>3</sup> and at most 15 m<sup>3</sup>. It is more dangerous that after leaving the extracting places, they always burned old waste. In some places, waste was still in fire until we came, fortunately it didn't turn into forest fire. It is possible that if there was water and no drought, the oil extracting would have been in action and more trees would have continuously been cut down.

The oil extracting not only destroys the forest but also pollutes the living environment and drives the animal away.

### 3. Rattan exploitation.

During the survey period, the rattan exploitation was not as serious as it was in November and December 1995 - 1996, maybe due to exhaustion of rattan in Phong Nha - Ke Bang and impossibility to coordinate with the rattan exploitation in Laos, since it was in rainy season there.

We met and observed rattan exploitation in 2 places: along Road 20 from Co Khu to Rao But and along Chu Ngut stream of Thuong Hoa Commune, Minh Hoa District.

Basing on the statistics of the special forest protection control organizations, Bo Trach District exploited 120 tones of rattan in 1995 and Minh Hoa exploited 400 tones. The price was 800 - 1.000 VND per kg.

The exploited rattan is reducing in comparison with that in the past years. The exploited volume of rattan in 1991 was 315 tones (120 tones in 1995).

Rattan exploiting does not destroys the forest as seriously as Diospiros and *D.rimosa* exploiting, but human activities brought much noise and disturbed the wildlife, especially the living condition of large animals and Primates.

### 4. Hunting

Hunting is a factor that directly threatens the presence and diversity of animal in general and Primates in particular.

Hunting activities in Phong Nha - Ke Bang was famous for producing "compressed dry monkey". The local people were in groups of 3 or 5 (there were about 50 people) hunting in forest for weeks with AK guns and each returned with about 25 - 30 kg of dried monkey (equal to 75 - 90 kg of live monkeys or 10 - 12 monkeys). According to our survey, before 1991 in Yen Hop and Hop Hoa (Ruc and Sech Villages) Thuong Hoa Village about 18 to 20 tones of monkey was killed annually. "Compressed dry monkey" is to make "monkey bone glue" or to send to traders from Qui Dat and Ba Don, Hoan Lao.

Many large animals such as *Bos gaurus*, Tiger, *Ursus thibetanus* and *P. nebulosa* in Rao Thuong, Hang En cave, Co Khu were also killed.

Since the Quang Binh Army Commander Board promulgated Decree of weapon/guns retrieval and especially since the Phong Nha Nature Reserve was founded (18.11.1994), the hunting activities were significantly decreased. However, there is still illegal hunting somewhere. "Compressed dry monkey" business is still taking place in Yen Hop and Hoa Son.

During our survey period, the most common form of hunting is laying traps for catching animals. Hundreds of traps were found in Ba giang I, Ba Giang II. About 150 traps were destroyed by Mr. Nhat team in Thung Nhang. These traps were carefully laid more than 2 - 3 km along Vom stream in order to block all the way that animals, birds and reptiles go to

the water sources. Hunter's sleep-camps were found in many places. Beside the camps, there were kennels that made of small trees and iron wires. The remains such as hair, feathers were also found around them. Mr. Dang's team saw hunters of Doong Commune shooting a *Sus scrofa*, *N. sumatraensis*; the hunters of Commune 39 shooting an *A. binturong*. This team also said that in May 1997, a tiger was trapped by the hunters of Doong Village and died in forest, then an local people in Arem sold it 12 at millions VND. Mr. Nhat's team found the *Sus scrofa's* skull, *A. macrourus's* hairs, *V. indica's* specimen, different kind of chicken feathers (pheasant,..).

Hunting activities were not very bustling during our survey in July and August, because it was dry season and hunters didn't have water for living. Moreover, in that season there were many mosquitoes in the forest and it was easy to make noise due to dried leaves on ground, so hunters turned to wood cutting. Hunting season is from October to March next year. In this time of the year, there are plenty of water, the hunters are not afraid of malaria and the forest is wet, so no noise is made when moving. Also in the winter, the temperature is low, animals are not as quick-minded/active as in the summer, monkey species come back to their cave earlier. They often go to valley as there are many fruit trees there. In 1996 winter, we felt as there was a hunting festival in Thuong Hoa forest.

Apart from hunting, hunters and local people of Son Trach, Thuong Trach, Tan Trach, Phuc Trach, Xuan Trach (Bo Trach District), Thuong Hoa, Hoa Son, Dan Hoa (Minh Hoa District) also collect honey, catch tortoises, snakes and trap birds. In 1995, we saw a family trading tortoises in Qui Dat, they had more than 100 tortoises in their tank. In August 1998, Mr. Pham Trong Anh's team met tortoise hunters with hunting dogs in Hoa son (Minh Hoa District).

Today, hunting activities take place in many areas, but it is most serious in Yen Hop (Sech Village) and Hoa Hop (Ruc Village) areas of Thuong Hoa, Minh Hoa District.

##### 5. Forest burning and destroying for cultivation

Compared with the years of 1995 - 1997, forest burning is decreased. However it has not stopped. The danger is that the hunters, wood cutters have burned many places intentionally or unintentionally. On the hill down the Vom cave and in Thung Nhang, hunters had burned 2 places, each was about 0.5 ha. On the way, from Thung Lau to Xuong valley, we observed a big forest fire on the foot of rock mountains, burning 6 wood-trees of 30 - 45 cm in diameter. In the condition of rocky mountains, the reproduction time for trees is 20 - 30 years. In Hoa Son the team led by Pham Trong Anh also eye-witnessed many ha of forest destroyed by the local people without any control and prevention from authorities. Unintentional activities of hunters and forest product exploiters have brought a serious loss to the country.

In December, 1996 survey, we had chances to observe the forest burning for cultivation in Villages 39, 51, 61, Yen Hop, Hop Hoa. The local people of these villages still burns forests for cultivating, but not as furiously as before.

The consequences of furious war again American aggressions, together with forest burning

for cultivation have left the Phong Nha Nature Reserve many denuded mountains, hills. In the rocky mountains condition and with good control, it must take hundreds years for these forests to reproduce as rich as in the past.

#### 6. Cattle pasturing

Cattle pasturing is a common event in many mountainous areas in Vietnam, especially in the areas of ethnic groups.

It may not threaten the forest, if it is not in high density. But the cattle pasturing may bring a danger of infection diseases to the wild animals. We know that cattle is easier to get diseases than wild animals and they may infect wild animals. On the other hand, while there is cattle pasturing, cattle usually drive wild life away.

Cattle pasturing was seen in Doong, Yen Hop, Hop Hoa, Dang Hoa Villages.

#### VI.4.3 Control and management situation

As analyzed above, the life of major part of human population in the area depends on forest product exploitation. Especially, the local people of Arem, Ruc, Sech ethnic groups regarded it as an important mean to earn their living in the past, but now it becomes a mean to save all local people in and around the Reserve from hunger. Therefore, the main pressure now is the exploitation of forest products and expanding cultivation area.

Although the pressure is so strong, the Reserve's security staff is too little. This is an unequal comparison in this period. The Reserve's security staff is not only so little in number, but also poor in professional quality. There are only some staff passed secondary training on forestry and only 4 staff graduated from Forestry College of Vietnam.

The conservation plan is not suitable and not updated with the present situation. There are only 2 guard stations in the Reserve: station No. 4 and Tro Mong station, 1 boating group and 1 mobile group. There is not any station at the "hot" points such as Rao Thuong, Hnag En cave, Commune 39 where the wood cutting and forest destroying for cultivation are most serious. The number of people working at these 2 stations (No. 4 and Tro Mong) is quite great, but half of them is on contract basis (not staff). Moreover, in July when we came, more than half of them had got malaria, the others had to work in a large area for many days and nights.

The staffs at these stations are very poorly equipped. With only some old AK guns, 1 electric club, they can't control and suppress the forest law-breakers. They don't have any means of communication. Even the Management Board does not have a telephone. Once they need to communicate with the Forest Protection Department of province or other staff in and out the province, they have to go to Trung Ha Post station which is 7 km far from the Management Board's office. This not only decreases the effectiveness of the work but also eliminates the attention and assistance from domestic and foreign organizations to the Phong Nha Nature Reserve. The fighting between Tro Mong station's staff and Chay

Commune's local people gave us a lesson of lacking control and communication equipment in emergency cases.

While the protecting activity still has so many difficulties, the outside pressure is increasing, especially from *Diospiros* and *Dalbegia rimosa* wood exploiting of the local people in Cu Lac, Xuan Son, Phong Nha, Tram, Me, Chay, Bau Sen... People in these hamlets have been facing with many living difficulties, such as: loss of crops due to harsh weather condition. In 1998, their living condition will be more difficult, due to long drought and loss of crops. Interviewing some people from Me, Tram and Chay hamlets, we understand that at least 60% population will be starving for 2 to 4 months. 60% of population of these hamlets has no other way than sticking to the forest to earn their living. The above-mentioned issues warn the Reserve's Management Board of the difficulties which they will have to cope with in the coming time.

#### VI.4.4 Conservation solution

The target aim of natural conservation is to reserve human. The human protects living environment for himself, but also human himself has been destroying his living environment. Therefore, a human action of today will be a result or a consequence for our tomorrow life. The excessive exploitation of natural resources is only situational solution and it will bring about very unexpected consequences. All the disasters that we saw are the direct consequences of abusing forest resources. The main result of this situation is backward customs and habits. To live unshakable or to develop unshakable are the recommendations that IUCN, UNEP and WWF raised to all countries in order to properly use natural resources. In order to protect the Phong Nha Nature Reserve and help the local people in and around to have a stable life, we propose the following solutions:

- Change community's customs and habits and their attitude to life.

This work doesn't require very great fund. The point is to make the local people in these areas understand the importance of natural resource control and protection. If only they change their present living habits and customs they themselves will bring a considerable contribution in protecting natural resources, for example: economizing firewood, paying more attention when cutting firewood, trying to keep other trees from being wooded and wasted. To do this it is required to have a wide and deep propaganda programme which can be carried out immediately by all the organizations and schools. The districts and villages People's Committees should support and provide some financial to assist capital sources from Cultural and/or Social Benefits budget. The International organizations and provincial staff help print brochures, propaganda slogans on note books and donate them to the pupils. Speeches at flag saluting at the beginning of a week or weekly class meetings are a good chance to propaganda the ideas of natural conservation to the young generations.

- Improve community's living quality.

This is one of the most effective, most supported by international organizations and it is the most difficult solution. It is called The "Integrated Conservation and Development Programme" (ICDP). This is also a strongly developing social project of forest protection in our country. The project's goal is to improve living condition of community in and around the Reserve's Centre by providing technical assistance and other necessary working condition to increase population's income. It also encourages people to take part in conservation activities and become the owner and controller of their natural resources.

- There is a large population in the communes around the future expanded Phong Nha Reserve. The population statistics of 1995 showed there were at least 35,000 people of 5 different ethnic groups (table 8) and their living condition should be further improved.

We are not able to do this right now due to low local people's cultural level and shortage of financial support. In spite of all these difficulties, we should carry out this programme and will do it from location to location. Chay, Tram, Bau Sen are the first three villages around Phong Nha Nature Reserve, from where the programme need to start immediately.

**Table 8: Population, Population Density, Ethnic Groups of the Communes in Phong Nha - Ke Bang**

Or.	Commune Name	Number of Population	Population Density (person per km <sup>2</sup> )	Ethnic Groups				
				Kinh	Arem	Sech	Ruc	Ngon
1	Tan Trach	132	0.6		132			
2	Thuong Trac	1,241	5	148	1,093			
3	Phuc Trach	8,335	160	8,335				
4	Xuan Trach	4,645	118	4,645				
5	Son Trach	7,883	199	7,883				
6	Thung Trach	9,676	211	9,676				
7	Thuong Hoa	2,445	10	107		236	248	1,864
8	Hoa Son	1,399	8	32		504	37	826
	<b>Total</b>	<b>35,766</b>	<b>30</b>	<b>30,826</b>	<b>1,225</b>	<b>840</b>	<b>285</b>	<b>2,680</b>

- In order to implement the economic programme in these three villages, besides the strategy supported by Quang Binh and Bo Trach People's Committees, it also needs financial support from the Government and NGOs. The first thing we need to do is to

build an electricity network, then to construct a water supply and irrigation system. If there is enough water, the cultivated area will increase. There will be high utilization of land, many labours will be attracted into the farming work. As the results, the pressure of the human on natural resources significantly decreases and the Phong Nha Nature Reserve will be protected. FFI, WWF should send their experts to study the Phong Nha Nature Reserve and prepare projects to receive the aids from overseas, in order to implement the conservation and development programme.

- Properly exploit tourist potentials of Phong Nha's Cave .

Phong Nha cave is a part of the Phong Nha Nature Reserve, well-known for its landscapes. Recently, the number of tourists to Phong Nha has significantly increased and is expected to increase when we have more travelling services: Basing on daily activities in Phong Nha Cave's Guidance and Tourist Service Center, we could find many obstacles. The accommodations need to be further improved. Tourist guides need to be trained on basic skills. The service system need to be planned. There should become an united system of income. This income, after paying tax and budget, need to be reinvested to the conservation. The most practical way is to invest to the socio-economic programme in Phong Nha, Me Villages in the form of social - forestry product programme as mentioned above.

- We hope that the people will take part in the managing of the natural resources, Consequently, the conservation programme will surely be a success. The Phong Nha Nature Reserve is a ideal tourist address to welcome all visitors to famous Phong Nha Cave, to a largest lime-stone mountain ecosystem in Vietnam with thousands of rare and valuable species.

## PART VII. CONCLUSION AND RECOMMENDATIONS

### VII.1 Conclusion

1.1. This survey has collected confidence information and confirmed the presence of 85 mammal species, belonging to 25 families, 9 orders in Phong Nha - Ke Bang area, of which there are 23 species confirmed by direct observation, 48 species by analyzing specimens and 20 by recording signs. In comparison with the previous list, there were 4 species which were acknowledged by interview confirming with confidence information, 37 species have been added, making the total number up to 97 species, belonging to 25 families and 9 orders discovered in Phong Nha - Ke Bang. A new form of langur and pig were discovered in the survey areas.

1.2. This is the first time, the bat is carefully studied by standard methods and 32 species are confirmed, some of them have high conservation value.

1.3. The Primates in Phong Nha - Ke Bang is the richest and most diversified in Vietnam with 10 species and sub-species, of which there are 7 rare and valuable species at national and international level, 1 new species "*T. f. ebenus (?)*".

1.4. The fauna in Phong Nha - Ke Bang has high value of ecological conservation, because of the following reasons:

- It has high species diversity (97 species is 43,3% total of animal species in Vietnam)
- There are 28 endangered species at national level, 20 species at international level. 5 of these species are still common in Phong Nha - Ke bang, namely: *M. arctoides*, *S. f. hatinhensis*, *N. sumatraensis*, *Ursus thibetanus*, *Ia io*.
- There are 5 recently discovered species and sub-species, namely: *P. nghetinhensis*, *M. vuquangensis*, *C. aureus*, *S. f. ebenus*, *Sus sp.*, and there may be *Truong son muntjac* too.

1.5. The fauna and flora resources in Phong Nha - Ke Bang are illegally exploited under various forms such as: *Diospiros sp.*, *D. Rimosa* wood cutting, rattan exploitation, *Laraceae* oil extracting, hunting, forest burning for cultivation, cattle pasturing. These activities are getting more and more furious in Minh Hoa District (not in territory of the present Reserve) whereas the Reserve's Management and Security staff is quite a few number and not well qualified and equipped.



## VII.2 Recommendation

### VII.2.1 Ecological diversity survey and control.

- Continuing to organize the training courses on biological resources survey and control methods for the Reserve's staff in order to improve their capacity of assessing and controlling the biological resources changes in the area, give them more knowledge of conservation of biological diversity, present critical issues and provide them with more basic materials about wildlife in this area.
- The Reserve's Management Board should build plans to encourage and help its staff who attend this training and other previous training to collect information on the fauna in the Reserve, paying high attention to the presence of high conservation value, such as: tigers, *S.f. hatinhensis*, *R. nemaneus*, *Sus. sp.*, *M. vuquangensis*, *M. truongsoneis*, *M. rooserveltensis*, *U. thibathanus*, *U. malayanus*, wolf, *P. nghetinhensis*. When working in forest, the staff should be equipped with binoculars, map, compass and other recording apparatus to observe, collect specimen and information about species in the Reserve and give them to the Management Board. The Management Board and Controlling Stations need to have log books to write down and summarize all information on the collected survey forms. When finding a new foot-print, it is necessary to cast the plaster. The unidentifiable dung, remains of animals, such as: skin, bone, hairs, horns, teeth should be collected and kept at the Management Board Office to have them analyzed by scientists. Whenever possible, these staff need to be trained to improve their professional skills.
- The Reserve should prepare a plan to survey, identify the presence, the quantity and study species taxonomy, biology, etc. of the new species, namely: "*Ebenus*", "*Sus sp.*", *M. vuquangensis*, *P. nghetinhensis*... in the area in order to find out suitable method of conservation.
- It is necessary to carry out the quantity assessment and have programmes to control the changes in quantity of species with high genetic conservation value in the area, such as: *Hatinhensis*, *ebenus*, tiger, bear, *Alpinus aureus*... in order to have suitable protection methods.
- Carrying out the study in remote places in order to have a exact assessment of the ecosystem in the area.
- Carrying out the survey on community's living condition in the area and control human impact on biological natural resources in order to have suitable methods to settle problems.

## VII.2.2 Management and Protection

- The Government should increase more investments in training management capacity for the Reserve's Management Board, so that they can undertake difficult duties, increase the number of staff, equipment and tools, means necessary for controlling activities, such as: cars, motorbikes, boats, cameras, telecommunication devices, computers and software, establish more controlling stations in critical places.
- Calling for more investments from international organizations in developing the Reserve, improving management skills for the Reserve's staff, surveying, assessing and controlling biological resources in the Reserve and carrying out other activities to improve knowledge and living conditions for the local people in accompanied areas.
- The Reserve's Management Board should co-ordinate with other organizations, related sectors to minimize illegal activities, such as: exploiting wood, firewood and other forest products, burning forest for cultivation, hunting, pasturing cattle in the Reserve.
- Carrying out deep and wide propaganda to residents living in and around the Reserve, focus on pupils, young people about the importance of the Reserve and state law and regulations on forest and biological resources protection. It is necessary to use different forms of propaganda such as organizing seminars, training courses, distributing posters and simple, understandable propaganda documents, signing minute of protection.
- Calling for financial investment and experts in building and implementing programmes for accompanied areas in order to change community's vocational structure, turn them from acting harmfully into acting usefully for the Reserve, then gradually draw them to conservation work, stick a part of their benefit to the Reserve, such as sharing profit from tourist services, protection of forest, planting forest, adopting economic wild animals (bees, python, gecko...)
- Quickly implementing project of widening/enlarging Phong Nha - Ke Bang Reserve (150.000 ha) in order to prevent strong impact on the forest resources in the areas which at present are not planned to the Reserve. Connecting the Phong Nha - Ke Bang Reserve with Hin Nam No of Laos to create a large inter-zone and grant facility for reserving a complete forest ecosystem on lime-stone mountains.

**Appendix 4b**

**COPIES OF STATE DECISIONS AND DOCUMENTS  
CONCERNING THE PROPERTY**

**Decision N° 194/CT dated 9 August, 1986 by the  
chairman of the Council of Ministers  
On the Decision of Prohibited Forest areas**

**The Chairman of the Council of Ministers**

Pursuant to Article 5 of the Define of the State Law on forest protection was declared dated 11 September, 1972.

Following Decisions N° 41/TTg dated 24 January, 1977; N° 360/TTg dated 7 July, 1978; N° 65/HDBT dated 7 April, 1982; N° 85/CT dated 1 March, 1986 on define of prohibited forest areas and establishing Cat Ba National Park.

Researching the propose by the Minister of Ministry of Forestry.

**Decises**

Article 1: Decision of Forest prohibited areas are listed in combination with this decision.

Article 2: The Ministry of Forestry has responsibility in combination with People s' Committee of Provinces to determine the boundary, context for each prohibited forest area....

Article 3: Establishing, protecting and managing for Prohibited areas have to follow the principles as:

...

Article 4: The People s' Committee of Provinces which have the prohibited forest area to bear the responsibility on communication, education of people... to enhance their tasks to protect the prohibited forest area....

Article 5: During the period of 5 years, the Ministry of Forestry to speed up some works such as: forest resources inventory, Establishing the national prohibited forest area system...

Article 6: The Minister, General secretary of the Council of Ministers; The minister of Ministry of Forestry... have responsibility to execute this decision.

For the Chairman of the council of Ministers

Signed  
Vo Chi Cong

The People s' Committee of  
Quang Binh Province

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N<sup>0</sup> :914 QD/UB

Dong Hoi, 3 December, 1998

**Decision by Provincial People s' Committee**  
*On Approval of the Technical and Economical  
Management Plan of Phong Nha Nature Reserve*

-Based on the Law of organising People council and Provincial People s' Committee dated 30 June, 1989.

- Based on the decision N<sup>0</sup> 327/CT, dated 15 September, 1993 by the Minister Council (the Prime Minister at present time) on policies for the use of bare land, denuded hills, forests, alluvial flats and water bodies; The dispatch N<sup>0</sup> 507/KTN, dated 15 February, 1993 by Government on implementation of Decision N<sup>0</sup> 327-CT.

- Based on the record N<sup>0</sup> 2538/KH, dated 10 November, 1993 by the Ministry of Forestry.

- Studying the office dispatch N<sup>0</sup> 240/LN, dated 9 December, 1992 by the Forest Department of Quang Binh Province for approval the Management Plan of Phong Nha Nature Reserve.

- According to the propose by the Chief of 327-CT Steering Board.

**Decises**

Article 1: Approval the Management Plan of Phong Nha Nature Reserve, with the main content as follow:

- 1- Location...
- 2- The area of Nature Reserve is 41,132 ha
- 3- The orientation and tasks ...
- 4- The main targets ...
- 5- Construction of infrastructure ...
- 6- The organisation and to organise the staff ...
- 7- Fund and rouses of investment.
- 8- Responsibility distribution ...

Article 2: The Management Board of Phong Nha Nature Reserve based on its targets and tasks to implement and use effectlly the fund sources.

Article3: The Chief of the Provincial Office of People s' Committee... are responsibility to carried out this decision.

For the People Committee of Quang Binh Province

Receive place

- The steering Committee
- AS the Article 3
- Detaining

Signed  
Tran Su  
Chairman

The People s' Committee of  
Quang Binh Province

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N<sup>0</sup> :941 QD/UB

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Dong Hoi, 18 November, 1993

**Decision by Provincial People s' Committee**  
*On Establishing the Management Board of Phong Nha Nature Reserve*

**The People s' Committee of Quang Binh Province**

-Based on the law of organising People council and Provincial People s' Committee dated 30 June, 1989.

- Based on record N<sup>0</sup> 2538/KH, dated 10 November, 1993 by the Ministry of Forestry on the approval of Management Plan of Phong Nha Nature Reserve.

- Studying the office dispatch N<sup>0</sup>208 TT/LB, dated 18 November, 1993 from the Forest Department and the proposal from the Board Chief of provincial authority organisation.

**Decises**

Article 1: Establishing management board of Phong Nha Nature Reserve, that belong to the Provincial Forest Protection Department from the signed date.

- The Phong Nha Nature Reserve Management Board has right to open the account number at the Bank as well as the Private Sign for their activities.

Article 2: Based on Government present regulations , the Director of the Provincial Forest Department to decide the rights, duties organization and number of staff of Phong nha Nature Reserve.

Article 3: The Chief of the Office of People s' Committee, the Head of provincial Authority Organisation, the Director of Provincial Forest Department, the Chairman of People s' Committee of Bo Trach District, the Directors of all related Branches and the Director of Forest Protection Department have responsibility to put in to practice this decision.

For the Provincial People s' Committee

Signed  
Tran Su

Chairman

Receive place:

- As the Article N<sup>0</sup> 3
- The Ministry of Forestry
- The Forest Protection Department
- The Department of Culture and Information
- Detaining

The Ministry of Culture  
and Information

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N<sup>o</sup> :204- CV/BT-BT

Re: preparing records of the  
Phong Nha area for the listing  
propose of World s' heritage

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Ha noi, 19 January, 1998

**To: People s' Committee of Quang Binh Province**

For implementing the Prime Minister s' opinion( at the office dispatch N<sup>o</sup> 5932-KGVX , dated 21 November, 1997 from the Office of Government) on preparing 6 symbolised Vietnamese Cultural and Nature Heritage area, in which have beauty spot of Phong Nha Cave...

....

Proposing the People s' Committee of Quang Binh province to put forward for leading and promoting all the related Units to implement their duty as soon as possible.

For the Minister of Ministry  
Signed  
Luu Tran Tieu  
Vice Minister

Receive place

- Above mention places
- The Government Office
- The Department of Culture and Information of Quang Binh province
- Detaining



Ministry of Agriculture and  
Rural Development

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N<sup>o</sup> :367/BNN.KH

Re: Upgrading the Phong Nha-  
Ke Bang Nature Reserve to  
National Park

Ha noi, 16 January, 1997

**To: People s' Committee of Quang Binh Province**

The Ministry of Agriculture and Rural Development received the office dispatch N<sup>o</sup> 969/CV-UB, dated 27 December, 1997 from the People Committee of Quang Binh Province on proposed of upgrading the Phong Nha - Ke Bang Nature Reserve to a National Park. Based on the related document, the Ministry of Agriculture and Rural Development has following opinion :

1- The Phong Nha-Ke Bang Nature Reserve had been approved by the Decision N<sup>o</sup> 194CT, dated 9 August, 1986 by Prime Minister on National Nature Reserve System. The Ministry of Forestry (Now, the Ministry of Agriculture and Rural Development) approved this project for the People s' Committee of Quang Binh Province to approve and invest. The Phong Nha-Ke Bang Nature Reserve is priority at highest level ( 39 marks )based on National and International targets. The Ministry of Agriculture and Rural Development agreed with the People s' Committee of Quang Binh Province propose to request the Prime Minister to allow upgrading the Phong Nha-Ke Bang Nature Reserve to a National Park.

2- The Phong Nha -Ke Bang Nature Reserve area should be choose one of two proposed plans, which do not have inhabitant living in this area.

- The proposed plan 1: The National Park area is 116,700 ha ( The buffer-zone is not included)

- The proposed plan 2: The National Park area is 127,700 ha (The buffer-zone is not included)

3- The Ministry of Agriculture and Rural Development will be manage the National Park, because of the need of bio-diversity protection relates to the investment and International co-operation.

4- The Ministry of Agriculture and Rural Development had decision three consultative Units for preparing Nature Reserve and National Park plans, the Forest Inventory and Planning Institute is most experience Unit.

Proposing the People s' Committee of Quang Binh Province to assign consultative Units of the Ministry and Agriculture and Rural Development in collaboration with provincial professional branches to prepare the plan and propose to the Prime Minister for approval.

For the Minister of Ministry  
Signed  
Nguyen Quang Ha  
Vice Minister

Receive place

- Above mention places
- The Government Office
- The Department of Agriculture and Rural Development of Quang Binh province
- The Forest protection Department of Quang Binh Province
- The Forest Development Department of MARD
- Detaining

The Office of Government

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N<sup>0</sup> : 5932/KGVX

Re: 6 heritage choice to propose  
for UNESCO s' approval as the  
World heritage.

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Ha noi, 21 November, 1997

- To:
- Ministry of Culture and Information
  - Ministry of Foreign Affairs
  - National UNESCO Committee of Vietnam
  - People s' Committee of Quang Ngai Province
  - People s' Committee of Quang Binh Province
  - People s' Committee of Lao Cai Province
  - People s' Committee of Bac Can Province

Based on proposes of the Ministry of the Cultural and Information (The official dispatches N<sup>0</sup> 234-VH/BT dated on 23 February, 1997 and the office letter N<sup>0</sup> 3578-VH/TT dated on 13 November, 1997) on the choosing propose of 6 heritage (Hoi An Town, My Son Cham Tower, Huong Pagoda, Phong Nha Caves, Old stone area of SaPa, Ba Be Lake) to UNESCO s' approval for listed as the World s' heritage; Deputy Prime Minister Pham Gia Khiem on behalf of the Prime Minister had the opinion as follow:

Allow the Ministry of culture and Information for choosing and preparing the records of 6 heritage as mention above and to propose to UNESCO for approval as the World s' heritage.

The Ministry of Culture and Information is requested to cooperate with the People Committee of Provinces of above 6 mentioned heritages, Ministry of Foreign Affairs, National UNESCO Committee of Vietnam, Vietnam Historical Association and the other related Ministries and branches in preparing records and registrating the heritage follow the UNESCO regulations as soon as possible.

Minister of Government office

Signed: Lai Van Cu

Copy from the original  
Dong Hoi, 25 November, 1997  
Executing the orders of the  
Chairman of Quang Binh province  
Chief of Office  
Mai Xuan Thu

People committee of Quang Binh Province

N<sup>0</sup> :233/SL

Receive places:

-Current affairs of Province Party committee,

**People Provincial council**

- Chairman, Vice Chairman of Quang Binh Province
- The Department of Culture and Information,  
Department of Science Technology and Environment  
Department of Planning and Investment
- The Committee Office.
- Detaining

The Office of Government

Socialist Republic of Vietnam  
Independence-Freedom-Happiness

-----  
N<sup>0</sup> : 1923/QHQ

-----  
Ha noi, 21 November, 1997

Re: Biodiversity protection  
in Vietnam - Lao border area

To:

- Ministry of Science Technology and Environment
- Ministry of Agriculture and Rural Development
- Centre of National Technology and Nature Science
- Boundary Board of Government
- The People Committee of Lai Chau, Son La, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Quang Nam, and KonTum provinces.

Based on the proposed of official dispatch N<sup>0</sup> 775/MTg dated 07 April, 1997, from the Ministry of Science Technology and Environment, the Prime Minister had the opinion as following::

- Allowing the Ministry of Science Technology and Environment to practice and monitor gradually the co-operation content following 10 points of conclusion and proposal of the Vietnam - Lao Workshop on protection Bio-diversity in border area in January, 1997.

- The Ministry of Science Technology and Environment is the main responsible and in co-operation with the Ministry of Agriculture and Rural Development, the Centre of National Technology and Natural Science, the People Committee of Quang Binh Province and WWF Organisation for preparing the procedure and records. The record will be submitted to the Prime Minister for the decision of upgrading the Phong Nha - Ke Bang Nature Reserve (Quang Binh) to National Park and to propose UNESCO to recognise it as The World s' Nature Heritage.

- Allowing provinces located along Vietnam -Lao boundary take the initiative to study and sign the Agreements of collaboration activities on Bio-diversity protection, especially Nature Reserves, National Parks in the boundary area.

For the Minister, Manager of Government Office  
Signed

Receive place:

Doan Manh Giao

- Above mention places

Deputy Manager

- Government Office

- Detaining

**Ministry of Planning and Investment**

-----  
N<sup>o</sup>: 3557 BKH/NN

Re: Phong Nha - Ke Bang National Park

**Socialist Republic of Vietnam**  
**Independence - Freedom - Happiness**

-----  
Hanoi, 12 June 2000

**TO: PRIME MINISTER OF THE GOVERNMENT**

- Base on the Decision N<sup>o</sup> 194/CT dated 9 August 1986 by the Prime Minister on establishing the Special Use Forest System of Vietnam.
- Base on the Decree N<sup>o</sup> 52-CP dated 8 July 1999 by the Prime Minister on the regulation of the management of the investment and construction.
- Base on the Decision N<sup>o</sup> 645/TTg dated 22 December 1995 by the Prime Minister on the biodiversity action plan to upgrade the area of Special Use Forest System from 1 million hectares to 2 million hectares.
- Base on the Decision N<sup>o</sup> 661/QD-TTg dated 29 July 1998 by the Prime Minister on the 5 million hectares of plantation
- Base on the Official Dispatch N<sup>o</sup> 59/TB-VPCP dated 23 March 1998 by the Prime Minister Phan Van Khai on changing the Phong Nha Nature Reserve to the Phong Nha - Ke Bang National Park.

Studying the Management Plan of Phong Nha - Ke Bang National Park, the Ministry of Agriculture approves the Management Plan as following contents

**I. Name: Phong Nha - Ke Bang National Park**

**II. Objectives**

...

**III. Located arrangement and zoning**

...

A total area of the core zone of the Phong Nha - Ke Bang National Park is 147,945 ha.

...

A total area of the buffer zone is 190,400 ha

...

**IV. Activities**

...

**V. Funding: 21,885 million Vietnamese Dong or equivalent to 1,5 million USD**

...

## **VI. Effective**

...

## **VII. Implementation**

- People's committee of Quang Binh Province is a investor and owner of the National Park.

...

- A investment period is from 2000 to 2005

-

Ministry of Agriculture has approved the above contents, and submitted to Prime Minister to approve the Management Plan of Phong Nha - Ke Bang National Park.

For the Minister of Ministry

Signed

Vice Minister Nguyen Van Dang

Receivers:

- Above mention receiver
- Ministry of Planning and Investment
- MOSTE
- Forest Protection Department
- People's Committee of Quang Binh Province
- Department of Forest Protection of Quang Binh
- Department of Agriculture and Rural Development of Quang Binh
- Department Science, Technology and Environment of Quang Binh
- Detaining

## **Appendix 4i**

### **Statistics of hotel/guesthouse and visitors in Quang Binh Province**

#### **1. The Trade- Tourism Department and its units**

No.	Name	Address	Number of rooms	
			International. level	Domestic level
	<b><u>Tourist Companies</u></b>			
1	Quang Binh Hotel tourism Company	50-Quang Trung	56	
2	Phuong Dong Hotel tourism Company	20-Quách Xuân Kỳ	50	
3	Nhat Le Hotel tourism Company	16-Quách Xuân Kỳ	55	
4	Huu Nghi Hotel tourism Company	22-Quách Xuân Kỳ	23	
5	Quang Binh Union Hotel tourism Company	Hải Thành Community		24
	<b><u>Hotels</u></b>			
6	Phong Nha Hotel	5-Trương Pháp	37	
7	Hoa Binh Hotel	52-Lý Thường Kiệt	24	
8	Phuong Nam Hotel	10-Quang Trung		8
9	Tan Binh Hotel	01-Lê Lợi		10
10	My Ngoc Hotel	5-Lý Thường Kiệt		12
11	Hoa Hong Hotel	Hải Thành Community	50	
12	Da Nhay Hotel	Đèo Lý Hoà-Bố Trạch		14
	<b><u>Guesthouse</u></b>			
13	Guesthouse of Post office	36-Lý Thường Kiệt	10	
14	Guesthouse of Development and Investment Bank	3-Nguyễn Trãi	16	
15	Guesthouse of Food Department	19-Lý Thường Kiệt		12
16	Guesthouse of General Trade Department	1-Mẹ Suốt		7
17	Guesthouse of Dong Hoi Railway Station	Đông Hới Station	16	
18	State Bank Guesthouse		14	
19	Linh Giang Guesthouse	Ba Đồn Town		14
20	Phong Nha Guesthouse	Sơn Trạch Community		6
21	Guesthouse of Provincial Security Department		10	
22	Huong Quynh Guesthouse	18-Quang Trung		9
23	Trang Dai Guesthouse	7-Thống Nhất		6
24	Hoai Huong Guesthouse	2-Nguyễn Tuấn		6
25	My Ngoc Guesthouse			8

#### **2. The Number of visitors in Quang Binh Province**

Visitors	1993	1994	1996	1997	1998	1999
Total	1000	5000	20000	28000	48000	81400
Domestic visitors	1000	4800	18800	26100	47300	80500
International visitors	-	200	1200	1900	700	900





# Vietnam National Commission for UNESCO #15

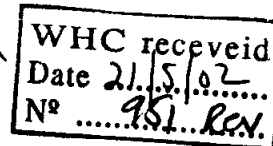
8 Khuc Hao, Ha Noi  
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199.3520

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E-mail : unescovn@netnam.vn

951 Rev  
21/05/02

Ref. 81 /BTK/ 2002

PSH / Tsh



The Vietnam National Commission for UNESCO presents its compliments to the UNESCO World Heritage Centre and has the honour to inform the latter that further to the submission of the candidature files of Phong Nha- Ke Bang Natural Reserve Area to the World Heritage Centre in June 2000, the Government of Vietnam has decided to upgrade this Natural Reserve Area to Phong Nha- Ke Bang National Park and to readjust the boundary of the National Park to cover a total area of 85,754 hectares. To supplement the already sent candidature files, the following documents are enclosed herewith:

1. Decision of the Prime Minister of Vietnam on the upgrading of Phong Nha- Ke Bang Natural Reserve Area to Phong Nha- Ke Bang National Park
2. Projects on the Conservation and Development of Phong Nha- Ke Bang
3. Other related materials

With the good relationship between Vietnam and UNESCO in view, the Vietnam National Commission for UNESCO has the honour to request the invaluable support and positive consideration of the World Heritage Centre of UNESCO for the candidature files of Phong Nha- Ke Bang National Park.

The Vietnam National Commission for UNESCO avails itself of this opportunity to renew to UNESCO World Heritage Centre the assurances of its highest consideration.

Hanoi, 8 May 2002



**UNESCO World Heritage Centre**  
7, Place de Fontenoy  
75352 Paris 07 SP  
FRANCE

GOVERNMENT

THE SOCIALIST REPUBLIC OF VIETNAM

Independence - Freedom - Happiness

No.: 189/2001/QĐ-TTg

Hanoi, December 12<sup>th</sup> 2001

**DECISION OF PRIME MINISTER**

*On the upgrading of Phong nha - Ke bang Natural Preservation Zone to  
Phong Nha – Ke Bang National Park*

**PRIME MINISTER**

*Pursuant to Law on Governmental Organization dated September 30<sup>th</sup> 1992*

*Pursuant to Law on Forest Protection and Development dated August 19<sup>th</sup> 1991*

*Considering the proposals of: Ministry of Agriculture and Rural Development (document no. 3697/BNN-KH dated November 29<sup>th</sup> 2001), Quang Binh Provincial People Committee (document no. 1149/IUB dated January 5<sup>th</sup> 2001) and opinions of Ministry of Investment and Planning (document no. 3557/BKH/INN dated June 12<sup>th</sup> 2000), Ministry of Finance (document no. 2270/TC/DT dated June 6<sup>th</sup> 2000), Ministry of Science, Technology and Environment (document no. 1330/BKH/CNMT-MTG dated May 18<sup>th</sup> 2000), Ministry of Culture and Information (document no. 1783/VHTT-BTBT dated May 11<sup>th</sup> 2000),*

**DECIDES**

**Article 1:**

Upgrading Phong nha - Ke bang Natural Preservation Zone, located in Bo Trach District, Quang Binh Province to **Phong Nha – Ke Bang National Park**.

The name of the National Garden is: **Phong Nha – Ke Bang National Park**

## **Article 2:**

Position, geographical co-ordinate, area scale of **Phong Nha – Ke Bang National Park**:

### **1. Geographical position:**

**Phong Nha – Ke Bang National Park** comprises in its administrative boundary these villages: Tan Trach, Thuong Trach, Phuc Trach, Xuan Trach and Son Trach, belonging to Bo Trach District, Quang Binh Province.

### **2. Geographical co-ordinate:**

**Phong Nha – Ke Bang National Park** is located in the North West of Quang Binh Province, along Vietnam-Laos frontier, having the geographical co-ordinate as follows:

From 17°21'12" to 17°39'44" north latitude

From 105° 57'53" to 106°24'19" east longitude

### **3. Area scale of Phong Nha – Ke Bang National Park**

Total area: 85,754 ha; comprising different functional sub-regions:

- Strictly protected zone: 64,894 ha
- Ecological recovery zone: 17,449 ha
- Administrative-service zone: 3,411 ha

## **Article 3:**

**Objectives and tasks of Phong Nha – Ke Bang National Park**

- Protecting forestry natural resources and diverse ecosystems in the boundaries of the **National Park**
- Preserving scientific values of typical faunas in the Centre, especially the Linh truong and newly-discovered species like Mang lon
- Constructing and developing material facilities of National Garden, facilitating the research and preservation of typical faunas, botanical garden of the Center. At the same time, creating favourable conditions for promoting scientific research co-operation domestically and overseas, serving for training, sightseeing and studying according to Prime Minister's Decision issued at the Decision no. 08/2001/QD-TTg dated January 11<sup>th</sup> 2001 on regulations on the protection of specific forest, preventive forest, production forest and natural forest.
- Exploring natural landscape to promote eco-tourism, assisting local citizens by creating jobs, participating in tourism and service activities to improve the living standard, contributing in environmental protection and socio-economic development of the region

## **Article 4:**

Assign Quang Binh Provincial People Committee to directly manage **Phong Nha – Ke Bang National Park**.

Chairman of Quang Binh Provincial People Committee are in charge of conducting the submission for approval of **Phong Nha – Ke Bang National Park** Investment-Construction and Development Project, **Phong Nha – Ke Bang National Park's** buffer zone Investment-Construction and Development Project according to existing regulations.

Annually, for the fund from investment budget allocated to Quang Binh Province, Ministry of Planning and Investment should indicate clearly the each item of investment for the above mentioned **Phong Nha – Ke Bang National Park** in order that the realization will go correctly in the process as per the project approved.

**Article 5:**

This Decision comes into force after 15 days since the day of signature

Ministers, Chief of Ministry-rank offices, Governmental bodies and President of relating Provincial and Central Municipal People Committee are responsible for following and implementing this Decision.

**ON BEHALF OF PRIME MINISTER  
Deputy PM**

*Archives:*

- Central Secretariat Department
- Prime Minister, Deputy Prime Ministers
- Ministries, Ministry-rank offices,  
Governmental Bodies
- Provincial and Central Municipal  
People Council and People Committee
- Central office and Party Departments
- National Assembly office
- State President office
- People's Supreme court
- People's Supreme organ of control
- Gazette
- Governmental office, other departments
- Archive: NN (5b), administration department.

NGUYEN CONG TAN

QUANG BINH PROVINCIAL  
PEOPLE COMMITTEE

THE SOCIALIST REPUBLIC OF VIETNAM  
Independence - Freedom - Happiness

Ref. No.: 123 QD/UB

Dong Hoi, January 18<sup>th</sup> 2002

**DECISION OF PROVINCIAL PEOPLE COMMITTEE**

***Subject: Approving the Feasible Study of Phong Nha – Ke Bang National Park Establishment Project, Bo Trach District, Quang Binh Province***

**QUANG BINH PROVINCIAL PEOPLE COMMITTEE**

- Pursuant to Law on Organization of People Council dated June 21<sup>st</sup> 1994;
- Pursuant to Law on Forest Protection and Development dated August 19<sup>th</sup> 1991;
- Pursuant to Circular no.: 52/1999/ND-CP dated July 8<sup>th</sup> 1999, Circular no.: 12/2000 of Government dated May 1<sup>st</sup> 2000 on the Issuance and Supplement to Construction and Investment Management Regulations;
- Pursuant to opinions of Ministry of Investment and Planning, Ministry of Finance, Ministry of Science – Technology - Environment, Ministry of Agriculture and Rural Development on the upgrading of Phong nha – Ke Bang Natural Preservation Zone to Phong Nha – Ke Bang National Park;
- Considering the proposal of Provincial and Interdisciplinary Evaluation Board according to minutes of meeting dated January 11<sup>th</sup> 2002 and January 14<sup>th</sup> 2002;
- Considering the proposal of Director of Planning and Investment Service according to document no. 36 – TT/KHDT-KT dated January 15<sup>th</sup> 2002,

**DECIDES**

**Article I:**

Approving the Project of Establishment of **Phong Nha – Ke Bang National Park** with the main content as follows:

- Name of the Project: Investment - Construction of **Phong Nha – Ke Bang National Park**
- Investor: Quang Binh Provincial People Committee  
Employer:  
**Phong Nha – Ke Bang National Park Project Management Unit**
- Type of Investment: New investment
- Method of project management: directly managed by Employer
- Geographical location and area scale:
- Location: in the North – West of Bo Trach District, spreading along Vietnam – Laos frontier, belonging to administrative area of these hamlets: Tan Trach, Thuong Trach, Phuc Trach, Xuan Trach and Son Trach of Bo Trach District. The boundaries are as follows:
  - o The West: bordering on People Republic of Laos
  - o The South: bordering on Quang Binh province
  - o The East and North: bordering on provincial road no. 20 and Son river.
    - Geographical co-ordinate:  
From 17°21'12" to 17°39'44" north latitude  
From 105° 57'53" to 106°24'19" east longitude
- Area scale of **PHONG NHA – KE BANG NATIONAL PARK**: Total area: 85,754 ha; comprising different functional zones:
  - o Strictly protected zone: 64,894 ha
  - o Ecological recovery zone: 17,449 ha
  - o Administrative-service zone: 3,411 ha
- **Objectives and tasks**
- Preserving and developing stably natural resources, forestry ecosystems in the above mentioned area and scientific values of typical botanic and fauna systems in the Central Region.
- Establishing and developing material facilities of national garden, creating favorable conditions for the study and preservation of above mention botanic and fauna systems. At the same time, facilitating the research and scientific cooperation, domestically and overseas.
- Exploring the strength of natural landscape to develop eco-tourism, providing jobs to local citizens, participating in tourism activities to improve living standard, decreasing the pressure on forest, contributing to the protection of ecology and socio-economic development of the whole project area.
- **Action programs of the Project:**
  - Protection program:

- Human source arrangement to protect the whole area of existing forest area of the project
- Investigating, verifying to define the boundaries of zones, subdividing and mapping, setting up landmarks at site. Establishing instruction regulations for protected main areas.
- Establishing protection units at main places
- Constructing working office, museums, scientific study and service centers; Establishing botanical garden and semi-natural animal raising zone.
  - Scientific research program
- Conducting fundamental study on botanical and fauna system, application study on wild animal raising, growing endemic plants, medical plants, collecting plant specimens for study.
  - Ecosystem recovery program
- Delineate areas for natural afforestation and for planting supplementary local trees on empty land.
  - Material facility construction program
- Constructing headquarter of Project Management Unit, Forestry Protection units and other infrastructure facilities serving for forest protection, biological diversity and precious gene source preservation of the national garden.
  - Socio-economic development program
- Settling those households in the project area, moving those illegally-settled households and supporting them in re-settling at a new location.
  - Tourism program
- Organizing and developing eco-tourism, establishing tourism spots and eco-tours in the project area.
- Principal investment items: (see attached annex)
- General estimation of investment capital and financial source:
- Total estimation investment capital: 34,170 million VND (Thirty-four thousand one hundred and seventy million VND).
- Financial source:
  - Budget: 32,370 mil. VND
  - Loan: 800 mil. VND
  - Association fund and self-mobilized fund: 1,000 mil. VND
- Progress of project implementation: 5 years (from 2002 – 2006)
- Project implementation method: According to existing State regulations on investment and construction.
- Responsibility of Employer: using fund for correct purposes, efficiently. Conforming to existing State regulations on investment and construction.

**Article II:** Chief of Administration Department of Provincial People Committee, Directors of Planning and Investment Service, Financial-Price Service, Agriculture and Rural Development Service, Trade Service, Transport Service, Construction Service, Land office, Director of Provincial Forest Protection Office, Project Management Unit of **Phong Nha – Ke Bang National Park**, Chairman of Bo Trach District People Committee and directors of concerning departments are in charge of implementing this Decision.

**ON BEHALF OF QUANG BINH  
PROVINCIAL PEOPLE COMMITTEE  
Chairman**

Archives:

- Government Office
- MPI, MoARD, MoF
- Provincial People Committee
- Provincial People Council
- As indicated in Article II
- Administration Dept.

**DINH HUU CUONG**



## TABLE OF INVESTMENT ITEMS

Annex attached to Decision No.: 123 QD/UB dated January 18<sup>th</sup> 2002 of  
Quang Binh Provincial People Committee

No.	Project program and investment item	Unit	Qty.	Investment capital (mil. VND)	Notes
	<b>TOTAL</b>			<b>34,170</b>	
<b>I</b>	<b>Protection program</b>			<b>7,150</b>	
1	Defining broadened boundaries of national garden			600	
2	Constructing new forest protection units	Unit/m <sup>2</sup>	4/600	900	
3	Upgrading existing forest protection units			300	
4	Constructing new gate and designing symbol of National Garden			150	
5	Constructing new road investigation system	Km	75	2250	
6	Protection facilities				
-	Power-boat	Unit	2	200	
-	Russian Jeep car	Unit	2	400	
-	Motorcycles	Unit	14	350	
-	Van	Unit	1	250	
7	Equipping with radio communication system among units	Set	1	250	
8	Education propaganda			450	
9	Organizing to take back illegal weapons			50	
10	Fire prevention, animal rescue and harmful insect prevention			1,000	
<b>II</b>	<b>Forest's ecosystem recovery program</b>			<b>3,250</b>	

1	Hiring forest protection by the piece to households	Ha	9,000	2,250	
2	Planting local trees at the centre, at forest protection units and along highway no. 20	Ha	50	500	
3	Botanical garden	Ha	40	500	
<b>III</b>	<b>Scientific Research Program</b>			<b>5,970</b>	
1	Fundamental investigation, documentation on National Garden			300	
2	Studying ecosystem of limestone mountain-forest			300	
3	Studying several kinds of linh truong			300	
4	Studying several kinds of precious plants			300	
5	Studying several kinds of precious fishes			150	
6	Positioning zones for forestry research (5 years)		20	400	
7	Establishing semi-natural animal raising zone	Ha	365	3,000	
8	Making hedge with botanical garden	M	3,000	600	
9	Studying the preservation of precious gene source			100	
10	Studying medicine from medical plants			100	
11	Training managers and researchers	Person	30	300	
12	Organizing studying visit to different national gardens	Person	12	120	
<b>IV</b>	<b>Material facility construction program</b>			<b>10,650</b>	
1	Constructing working centre of Nation Garden PMU + office appliances (C2	M2	1,200	2,150	

	Building; dining room + appartments forstaff C4)				
2	Upgrading, improving working office of Forest protection unit of Phong nha – Ke bang National Garden			350	
3	Constructing research and working office at botanical garden	M2	120	150	
4	Establishing cultivate seeding garden	M2	1.000	170	
5	Constructing education propaganda center in combination with guest house at national garden	M2	500	950	
6	Constructing hydrometeorology station	Station	1	300	
7	Constructing animal watch-tower and salt-setting location	Unit	5	300	
8	Constructing transient station for road investigation	Unit	6	350	
9	Constructing low-phase electric station for Central zone	Station	1	150	
10	Constructing fresh water supply and filter		1	250	
11	Constructing waster water treatment and drainage		1	200	
12	Constructing electric system for units	Set	7	150	
13	Constructing water supply system and water tank at units		7	280	
14	Constructing museums, specimen storage and research centre	M2	400	880	
15	Constructing harbor for boats		2	350	

16	Constructing new roads and upgrading existing roads				
-	Road from km 0 to Central Zone	Km	1	1,000	
-	Domestic roads	Km	2	800	
-	Lanes in the botanical garden	Km	3	270	
17	Sport yard for forest protection staff	M2	250	500	
18	Car for National Garden PMU	Unit	1	600	
19	Preventive + site clearance...			500	
<b>V</b>	<b>Socio-economic program</b>			<b>4,800</b>	
1	Support for re-settling citizens	Household	26		
2	Production support for 2 hamlets: Arem and Ruc	Year	5		
3	Constructing school, medical center + equipment	Unit/m2	3/450		
4	Hiring afforestation by the piece to households	Ha	3,600		
<b>VI</b>	<b>Tourism – sightseeing program</b>				
1	Constructing resort centre combining tourism and ecosystem	M2	500	800	
2	Training tourist guides	Person	25	300	
3	Ethnic cultural village			1,000	
4	Establishing project for eco-tour development			250	

# PHONG NHA-KE BANG NATIONAL PARK

VIETNAM





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## WORLD HERITAGE NOMINATION – IUCN TECHNICAL EVALUATION

### PHONG NHA – KE BANG NATIONAL PARK (VIETNAM) – ID N° 951Rev

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**Background note:** The Phong Nha Nature Reserve was first nominated as a World Heritage site in 1998 and IUCN carried out a field inspection in January/February 1999. The complete IUCN evaluation report is attached in annex A.

The following is the decision of the Bureau at its twenty-third ordinary session (July 1999):

*“The Bureau noted that the nominated area has potential value as a World Heritage site under natural criteria (i) and (iv) on the condition that it was expanded to include the larger Phong Nha/Ke Bang National Park with an associated fully integrated management structure. The site is part of an extremely complex and ancient karst plateau with high geodiversity which also encompasses Ke Bang and Hin Namno karsts. The reserve is largely covered in tropical forest with a high level of biodiversity and endemic species. Lack of research means that the true significance of the biodiversity and geology of the area cannot be fully assessed. The area on its own is not considered to meet World Heritage criteria. However, if jointly nominated with the Hin Namno karst ecosystem in Lao PDR, the combined site would constitute the largest surviving area of karst forest in South-east Asia and may merit World Heritage status.*

*The Bureau decided to **defer** a decision on the site, pending review of the possibility of expanding the boundaries of the site as proposed. It is also strongly recommended that there be discussions with the Lao PDR State Party with a view to further expanding the boundaries of the site, at a later stage, to include the Hin Namno Karst reserve of Lao PDR and any other relevant areas.”*

The site was thus subject to a revised nomination submitted in 2000 including a much larger area. At this time, however, the State Party also advised that it would be constructing the north-south Ho Chi Minh Highway and a link road between the Highway and Route 20 that bisects part of the core area of the Phong Nha Nature Reserve. When the Government of Vietnam made public its plans for road construction in the Reserve a number of organizations (e.g. IUCN, Flora and Fauna International) urged caution and advised the Government of the potential impact of roads on the conservation values of the area and, in particular, the potential loss of outstanding values. Consideration of the nomination, therefore, did not proceed further at that time.

Additional information was submitted in May 2002, announcing the decision of the Prime Minister of Vietnam (December, 2001) on the upgrading of the Phong Nha – Ke Bang Nature Reserve to the Phong Nha – Ke Bang National Park with a total area of 85,754 ha; providing information on projects for the conservation and development of the Park and revised maps. This revised nominated site has a much smaller area than the 2000 nomination, though still relatively larger than that of 1998. The size of the area proposed in each of the three nominations varies, as set out in Table 1 below.

1998	Phong Nha Nature Reserve	41,132 ha.
2000	Phong Nha – Ke Bang National Park	147,945 ha.
2002	Phong Nha – Ke Bang National Park	85,754 ha.

Table 1. Size of the area proposed in each new or revised nomination

## 1. DOCUMENTATION

- i) **IUCN/WCMC Data Sheet:** 13 references
- ii) **Additional Literature Consulted:** Many of the references cited in the 1999 evaluation remain relevant, but only those recently and directly utilized are repeated here. Wikramanayake, E.D. et al., 2002, **Terrestrial Ecoregions of the Indo-Pacific: A conservation Assessment**. Island Press; Cao Van Sung & Le Quy An (eds.) . 1998. **Environment and Bioresources of Vietnam**, Gioi Publishers; WWF, *LINC*. 1998. **Linking Hin Namno and Phong Nha through Parallel Conservation**; Timmins, R.J., Do Tuoc & Trinh Viet Cuong. 1999 **A preliminary assessment of the conservation importance and conservation priorities of the Phong Nha - Ke Bang proposed national park, Quang Binh Province, Vietnam**. Flora and Fauna International. Hanoi; Meijboom, M. & Ho Thi Ngoc Lanh. 2002. **He Dong – Thuc Vat / O Phong Nha – Ke Bang Va Hin Namno**. Phong Nha-Ke Bang National Park with WWF; Gilmour, D.A. & Nguyen Van San. 1999. **Buffer Zone Management in Vietnam**. IUCN Vietnam; Pham Khang. 1985. The development of karst landscapes in Vietnam. *Acta Geologica Polonica* 35 (3-4). pp 305-319; Anon. 1999. Geology of the Phong Nha – Ke Bang Area. Unpublished Paper; Do Tuyet. 1998. Overview on Karst of Vietnam, in Daoxian, Y & Zaihua, L. (eds.) **Global Karst Correlation, Science Press, Beijing**. pp. 179-192; Drew, D. & Hotzl, H. (eds.) 1999. **Karst Hydrogeology and Human Activities: Impacts, Consequences and Implications**. Balkema; Nguyen Quang My & Limbert, Howard. 2002. **Ky Quan Hang Dong Vietnam (The Wonders of Vietnamese Caves)**. Trung Tam Ban Do Va tranh Anh Giao Duc.
- iii) **Consultations:** 5 external reviewers. Additional consultations were held with staff of Flora and Fauna International; many individual speleologists; Senior officials of the Department of Conservation and Museology (DOCAM), Vietnam; Geologists from the Karst Studies Group of the Research Institute of Geology and Mineral Resources; Park staff and senior officials from many branches of the Quang Binh Provincial People’s Committee; the Chairmen and others from the communes of Son Trach and Xuan Trach.
- iv) **Field Visit:** E. Hamilton-Smith, January 2003. E. Hamilton-Smith and H. Friederich, January-February 1999.



## 2. SUMMARY OF NATURAL VALUES

The Phong Nha – Ke Bang National Park (PNKB) covers a total area of 85,754 ha, including three zones:

Strictly protected zone	64,894 ha
Ecological recovery zone	17,449 ha
Administrative service zone	3,411 ha

It is bounded on the west by the Lao People’s Democratic Republic (PDR), and consists of a limestone plateau and hills. The limestone province extends to and adjoins the Hin Namno and Khammoune karst of Lao PDR. Both sectors are rich in large, often spectacular and scientifically significant caves.

The Phong Nha–Ke Bang karst has evolved since the Palaeozoic (some 400 million years ago) and so is the oldest major karst area in Asia. It has been subject to massive tectonic changes, and comprises a series of rock types that are interbedded in complex ways. Probably as many as seven different major levels of karst development have occurred as a result of tectonic uplift and changing sea levels, thus the karst landscape of PNKB is extremely complex with high geodiversity and many geomorphic features of considerable significance. Like much of Vietnam, it has been subject to extensive tectonic change, and so the limestones of Phong Nha are inter-bedded with a number of other rocks. There is also strong evidence that sulphurous solution and hydrothermal action have played an important role in shaping the broad-scale landscape and the caves, though this has not yet been properly assessed.

The incorporation of the Ke Bang forest into the park has added another very important dimension. This sector has many “fossil” caves at a high level, which occur when the groundwater and rivers move to a lower level. Like many such caves, they are probably repositories of a great deal of palaeontological and geomorphological scientific evidence. Only a very few have been visited to date and based on the limited information available it is possible to say that some of these caves have ancient deposits of geological importance, some have unusual calcite (and perhaps other) mineral displays, and some are home to bat populations and a diversity of cave-adapted invertebrates still to be properly studied.

Special problems arise in assessing the biodiversity of the site. It is a sample of the Northern Annamites eco-region, one of the most important eco-regions of the Indo-Pacific (Wikramanayake et al.). A large number of faunal (568 vertebrate) and floral (876 vascular plant) species, including some endemic to the site (13 species of plants and 7 species of primates), are listed in the 2000 nomination document. However, systematic assessment began only five years ago and collections have been limited. Statistical analyses of the rate at which new species have been added to the fauna indicate that many more will be discovered and identified. Field workers also report the collection of currently undescribed species. For example Timmins *et al.* and others have been locating new species on a virtually daily basis right up to the end of each period of fieldwork, suggesting that many species remain to be found. More importantly, many of the species that have been identified are considered to be extremely rare and little known.

It should be noted that knowledge of the PNKB is remarkably limited, and this has constrained both the preparation of the nomination document and the IUCN evaluation.

### 3. COMPARISON WITH OTHER AREAS

#### 3.1. Karst Areas and Geomorphology

Most of the 41 existing World Heritage sites containing karst are in temperate regions and include Skocjan Caves (Slovenia); Caves of the Aggtelek Karst/Slovak Karst (Hungary/Slovakia); Plitvice Lakes National Park (Croatia); Canadian Rocky Mountain Parks and Nahanni National Park (Canada); Mammoth Cave National Park and Grand Canyon National Park (USA); Te Wahipounamu (New Zealand); Huanglong and Jiuzhaigou Valley (China); Tasmanian Wilderness and Fossil Mammal Sites (Australia); and East Rennell World Heritage site (Solomon Islands) which is an insular tropical site in the South Pacific. None of these can be compared with Phong Nha as they have very dissimilar geologic, geomorphic, climatic and biotic conditions.

However, comparison with the karsts of the wet tropics of South-east Asia is realistic. Many of these areas, like Phong Nha, are located within large and spectacular limestone plateaux, and the caves have often only been recognised and explored in recent years. Some have been the subject of considerable scientific research, and have been proven to be significant on a wide range of criteria. Three areas have recently been inscribed to the World Heritage List:

- Gunung Mulu National Park World Heritage site in Malaysia, has caves and underground river systems of greater international importance than those of PNKB. It has a rich biodiversity, but from a totally different faunal province to that at Phong Nha.
- St. Paul Subterranean Park on Palawan in the Philippines is again centred about a large underground river, but it is a relatively young (in geological terms) and simple system.
- The Massive Baliem River karst of the Lorentz National Park World Heritage site of West Irian in Indonesia is even less investigated than PNKB but is again totally different in character as it has been influenced by glaciers and it is combined with metamorphosed oceanic sediments of Cretaceous and Eocene origin.

Other Southeast Asian karst areas of note include large sites found in Vietnam and China; the Niah Caves and Gomantong of East Malaysia, each of great biodiversity and palaeontological / archaeological significance; many karst areas of Indonesia, including the famous Gunung Sewu of Java – one of the archetypal tropical karst landforms; Papua New Guinea, with extensive cave systems and underground rivers such as those of Atea Kanada, Mamo Kanada, Selminum Tem and the Nakanai mountains of New Britain; many of Thailand's National Parks and major areas of largely unexplored karst in Lao PDR.

However, many of these are both younger and much less complex areas, which do not rival PNKB in their contribution to understanding the geological history of the region. Of these areas, the only one that is of very similar character to PNKB is the adjacent Hin Namno and Khammoune karst of Lao PDR.

On broad criteria that take into account the totality of the karst system, PNKB must be seen as one of the most significant karst sites in south-east Asia. As in many other aspects of the site, there is, however, a lack of knowledge and previous research, so the significance of the site will only be fully identified and demonstrated when the site has been researched as thoroughly as many others have been.

## 3.2 Biodiversity

There are three other forest protected areas in South-east Asia which have World Heritage status: the Thungyai-Huai Kha Kheng Wildlife Sanctuaries in Thailand (Tropical Dry Forest); the Ujung Kulon National Park in Indonesia (Tropical Moist Forest); and the 3.5 million ha Lorentz National Park in Indonesia (West Papua province). This latter is the largest protected area in South-east Asia and includes one of the largest expanses of tropical forest in that region. The forest biodiversity values of PNKB as currently known are probably less rich than these three sites. However, if the nominated area were expanded, especially by linking it with the Hin Namno and Khammoune karst ecosystems of Lao PDR (both existing protected areas), then this would constitute an area of extremely high significance for forest biodiversity conservation. Adjoining forests in Lao PDR have been identified as priority areas for conservation and protect forest ecosystems, and exhibit high levels of species endemism. Such a transboundary protected area system would constitute one of the largest surviving areas of karst forest in South-east Asia, totalling 317,754 ha.

## 4. INTEGRITY

### 4.1 Site Integrity

Although considerable progress has been made in protection of the surface environment, the rugged nature of the country, difficulty of control, low income of many local families and relative shortage of resources for control purposes mean that wildlife poaching and illegal timber gathering are difficult to eliminate. Staff have been making great efforts to improve the protection regime, but this remains a challenging issue, particularly considering the demand associated to the growing ‘wild meat’ market.

### 4.2 Road Construction

In the 1999 evaluation report of the site (annex A), IUCN noted serious integrity concerns with the proposed road construction project. The project includes two different elements: the Ho Chi Minh Highway and the connection road between the Highway and the Route 20 (see attached map).

- The Ho Chi Minh Highway is clearly justifiable, appropriately located, outside and to the north of the nominated area, and has been constructed with a high level of environmental responsibility. It will provide an important benefit to the National Park in opening up views of and access to the Ke Bang forest area. It also greatly enhances year-round traffic flow from North to South of the country as a whole, with related benefits.
- Regrettably, the road that provides a link between the highway and Route 20 is a very different matter. The road is likely to carry little traffic and is used mainly for the movement of cattle and other domesticated animals, which raises the question of its necessity. It is most unlikely that any benefits will affect the immense economic and environmental costs of its construction. Its location, crossing through core natural areas of the site, is environmentally insensitive and inappropriate, running along the Chay River valley and destroying strategic wildlife habitats, then cutting across and through dominant geomorphic landforms of the park. Also, given the well documented negative impacts of new roads in protected areas (encroachment, removal of timber and non-timber forest products, increased wildlife hunting and trade), the task of park management and monitoring will be substantially increased.

The construction of this connecting road has inevitably faced considerable difficulties and this is reflected in the severe environmental impacts of the construction. It is a striking contrast with the care exercised along the main highway. Major impacts include:

- important faunal habitats have been destroyed, and there is an extensive swathe of vegetation destruction;
- enormous cuttings impact upon the landforms and geomorphic quality of the route (in a letter to UNESCO dated 15 December 2000, Fauna and Flora International advised that 4.5 tonnes of explosives per kilometre would be needed for construction);
- aesthetic considerations have been ignored; and
- the large-scale soil erosion along the route has led to sedimentation of the groundwater system and the surface streams which emerge from the plateau, e.g. through the Phong Nha Cave. This is not only likely to alter patterns of groundwater movement and the continuing evolution of the cave system, but in particular will have major impacts upon the biodiversity of the groundwater and in turn that of the emergent streams.

### **4.3 Boundaries**

The watershed is not fully included in the nomination, and as the integrity of any karst area is dependent upon the quality and quantity of the water input, this is a matter of concern. Moreover, the current boundary appears to be arbitrary and needs to be further reviewed and expanded to ensure it can more effectively protect natural values, including large areas to maintain viable populations of species such as the tiger and the Asiatic Black Bear.

It is emphasized that both the 2000 and 2002 nomination dossiers have given due attention to the identification of a properly delineated buffer zone. However, IUCN is not aware of any documentation of the regulations and managerial procedures for these buffer zones.

IUCN would recommend the State Party to consider two strategies to address these serious issues:

- Extending the boundaries to those proposed in the 2000 nomination, returning the park to the 147,945 ha as proposed by the State Party at that time.
- Promoting a transboundary agreement with the Lao PDR that would integrate PNKB and Hin Namno, either as two parks operating on agreed and equivalent management protocols or with fully integrated management. It is recognized that this will be a long process and will demand further resource inputs. This is particularly true in Lao PDR as on-ground management is still at the early stages of development. But should such integration take place it would result in the most important karst protected area of Southern Asia.

### **4.4 Visitor management**

A visitor management plan does not exist for the site but information made available during the field inspection is cause for some concern. It suggests a more-or-less opportunistic development of attractions scattered throughout the park as opposed to systematic planning for current and future sites for recreation and visitation. Clearly Phong Nha Cave already offers a major opportunity for visitation. The strikingly beautiful Hang Vom probably provides the best (and only viable) basis for another cave-based visitor's experience foreseen

for the site. The very different character of the Ke Bang area provides a valuable opportunity for a soundly based ecotourism programme, yet this is not considered in the current plan.

It is also proposed by the Provincial authorities that a series of associated and complementary attractions should be developed at the Phong Nha park entrance. While these may be economically viable, it is not at all clear how they would forward the objective of experiencing the values of the park itself. A botanic garden, for instance, might be much better located in Dong Hoi, on the North-eastern border of the Park, while the park budget might be better spent on the development of boardwalks and focal points within the park itself.

## 5. ADDITIONAL COMMENTS

The broad and specific conservation values of PNKB have been recognized for many years and, as indicated above, ongoing research has confirmed the regional and global importance of the area. Acknowledgement of the high value of the area has led the State Party to submit the area for World Heritage nomination. However, as noted above, the link road between the Ho Chi Minh Highway and Route 20 has been constructed and appears to have resulted in substantial damage to key values of PNKB, damage that – in the view of the current evaluation – would be difficult to repair in order to return the area to its original ecological and geomorphological condition. The fact that this happened during the period of re-nomination and review of the PNKB nomination unfortunately brings into question the State Party's commitment to maintaining the World Heritage values should the site be listed.

## 6. APPLICATION OF WORLD HERITAGE CRITERIA

PNKB has been nominated under natural criteria (i) and (iv).

### Criterion (i): Earth's history and geological features

IUCN reiterates its recommendation from the 1999 evaluation report (see Annex A) that “the nominated site has potential to meet criterion (i), however the potential value for World Heritage would be greater under criterion (i) if the nominated area was linked to the Hin Namno karst reserve in Lao PDR”.

### Criterion (iv): Biodiversity and threatened species

As noted in Section 2, information arising from research on flora and fauna that is occurring within the site highlights its importance for biodiversity conservation. However, the nominated site, despite it being larger than that nominated in 1998, is still too small to provide adequate protection for threatened species such as the tiger and the Asiatic Black Bear. Thus IUCN does not consider that the nominated site by itself meets this criterion. However, if the site is expanded the revised area may have potential to meet this criterion. The further consideration of a transboundary site with Hin Namno and Khaummoune protected areas in Lao PDR would considerably enhance the potential of the site to meet criterion (iv).

As noted in Sections 4 and 5 the nominated site does not meet the Conditions of Integrity.

## 7. RECOMMENDATIONS

7.1 The impact of the link road construction through Phong Nha - Ke Bang National Park is a major new factor in the evaluation of the site since it was nominated in 1998 and re-

nominated in 2000. IUCN, therefore, recommends that the World Heritage Committee **defer** the decision on Phong Nha - Ke Bang National Park.

IUCN recommends the Committee to urge the State Party to undertake an independent assessment of the impacts of the road construction so as to:

- determine the precise nature and scope of the impacts of the link road construction on the biodiversity, landscape and karst geomorphological values of the site;
- determine whether and how identified impacts can be mitigated and the site's values restored; and
- assess if exclusion of the area impacted by the link road construction from the Phong Nha - Ke Bang National Park is a feasible option for the viability and integrity of the World Heritage nomination, should restoration / mitigation not be possible.

7.2 IUCN also recommends that the Committee reiterates the request made to the State Party in the 1999 evaluation of this site, to review the boundaries of the nomination, as noted in point 4.3 above, so as to provide more complete coverage of natural values and karst geomorphological processes.

7.3 IUCN recommends that the Committee request the State Party to prepare and submit:

- a visitors management plan for the site;
- information on the regulations that apply to the management of the buffer zone, and
- information on enforcement measures and other actions that will be taken to control illegal poaching.

7.4 IUCN recommends that the Committee reiterates the request made in 1999 to the State Party to continue dialogue on a transboundary agreement with the State Party of Lao PDR that would integrate Phong Nha–Ke Bang and Hin Namno National Conservation Area, either as two parks operating on agreed and equivalent management protocols or with integrated management. This might form the basis of a potential transboundary World Heritage site.

## Annex A – IUCN evaluation report 1999

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**IUCN TECHNICAL EVALUATION REPORT FROM 1999  
PHONG NHA CAVE (VIETNAM)**


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**1. DOCUMENTATION**

- i) **IUCN/WCMC Data Sheet** (13 references)
- ii) **Additional Literature Consulted:** Deharveng, L. 1999. **Phong Nha Cave Biodiversity**. Unpublished Report. 3p; Government of the Socialist Republic of Vietnam and Global Environment Facility. 1994. **Biodiversity Action Plan for Vietnam**. Hanoi; Dillon, T.C. & Wikramanayake, E.D. 1997. **A Forum for Trans-boundary Conservation in Cambodia, Laos and Vietnam**. WWF, Hanoi and Washington. Project VIE/91/G31-1994; Limbert, H. 1992. The caves of Phong Nha and Hang Toi, Quang Binh Province, Vietnam. **The International Cave**. Vol. 2. pp 4-9; Limbert, H. 1992. Vietnam 1992, Return to the river caves of Quang Binh. **The International Caver** Vol. 5. pp 19-25; Limbert, H. 1994. **Vietnam 1994**. The 1994 British/Vietnamese Speleological Expedition Report. Privately published; Limbert, H. 1994. Vietnam: A Caver's Paradise. **The International Caver**. Vol. 12. pp 39; Limbert, H. 1997. Vietnam '97. **The International Caver**. Vol. 20. pp 11-18; WWF, *LINC*. 1998. **Linking Hin Namno and Phong Nha through Parallel Conservation**. WWF Indochina Programme. Hanoi; Nguyen Quang My & Vu Van Phai. n.d. **Cavern Tourism in Vietnam**; Pham Khang. 1985. The development of karst landscapes in Vietnam. *Acta Geologica Polonica*. 35 (3-4). pp 305-319; Nguyen Van Thang. ed. 1997. **Danh gia hien trang moi truong khu bao ton thien Phong Nha nam 1996-1997**; Multiple Authors. 1997. **Report of Field surveys on biodiversity in Phong Nha - Ke Bang Forest**. Mimeo Report. Hanoi. 84 p; Quang Binh Peoples Committee. 1998. **Investment Project: Establishment National Park Phong Nha-Ke Bang, Quang Binh**. Mimeo report; Timmins, R.J., Do Tuoc & Trinh Viet Cuong. in prep. **A preliminary assessment of the conservation importance and conservation priorities of the Phong Nha - Ke Bang proposed national park, Quang Binh Province, Vietnam**. Draft Report only, to be published by Flora and Fauna International. Hanoi; Vermeulen, J. & T. Whitten. eds. in prep. **Impacts of industrial use of limestone resources on biodiversity and cultural heritage (in East Asia)**. Draft Report only of the joint World Bank-IUCN project, together with various background papers; Watson, J. *et al.* 1997. **Guidelines for Cave and Karst Protection**. IUCN.
- iii) **Consultations:** 5 external reviewers. Staff of: CNRS, France; Gunung Mulu Caves, Malaysia; WWF Vietnam; University of Sydney; Nottingham Technological University; and the Geological Society of Australia. Individual speleologists and historians. Senior officials of the Department of Conservation and Museology (DOCAM), Vietnam. Park staff and senior officials from: Quang Binh Provincial People's Committee; Department of Science, Technology and Environment; Phong Nha / Ke Bang Program; Phong Nha Forest Protection Division; Relics and Landscape Management Board within Department of Culture and Information; Provincial International Relations Department; and the Department of Science, Technology and Environment.

- iv) **Field Visit:** January-February 1999. Elery Hamilton-Smith, and Hans Friederich.

## 2. SUMMARY OF NATURAL VALUES

The Phong Nha Nature Reserve (PNNR) is situated on the edge of the Phong Nha/Ke Bang Karst plateau in Central Vietnam. It is only part of the total plateau, which extends to and adjoins the Hin Namno karst of Laos. Phong Nha contains many caves, 17 of which have been explored and mapped by members of the British Cave Research Association, in conjunction with the University of Hanoi. Many caves are large and spectacular, and together they total (to date) some 65km. in length. However, investigation has so far been limited to mapping the extent of the caves, which in itself is a major undertaking.

The karst landscape of (PNNR) is an extremely complex and ancient one, with high geodiversity and some geomorphic features of considerable significance.

The reserve is largely covered by tropical forest, and although this was severely damaged by fire during the war, it is recovering rapidly and is now in a healthy state. It has a high level of biodiversity and endemic species. Data also indicates a high level of faunal diversity. The nomination documentation reports that:

- ◆ there are currently 735 vascular plants recorded in 413 genera and 140 families;
- ◆ preliminary faunal surveys have identified 461 vertebrate species, comprising 65 species of mammals, 260 bird species, 53 reptile species, 22 amphibians and 61 freshwater fish.

In summary, it must be emphasised that knowledge of the Phong Nha area is remarkably limited, and this has constrained both the preparation of the nomination document and the IUCN evaluation.

## 3. COMPARISON WITH OTHER AREAS

### 3.1. Karst Areas and Geodiversity

Attention to date on karst features has concentrated upon the caves, but the surface features, and in particular a large polje (a flat floored area surrounded on all sides by steep limestone hills), are considered to be of greater importance.

Most existing World Heritage sites containing karst are in temperate regions and include Skocjan Caves (Slovenia); Caves of the Aggtelek Karst/Slovak Karst (Hungary/Slovakia); Plitvice Lakes National Park (Croatia); Canadian Rocky Mountain Parks and Nahanni National Park (Canada); Mammoth Cave National Park and Grand Canyon National Park (USA); Te Wahipounamu (New Zealand); East Rennell (Solomon Islands); Huanglong and Jiuzhaigou Valley (China); Tasmanian Wilderness and Fossil Mammal Sites (Australia).

None of these can be justly compared with Phong Nha as they have vastly dissimilar geologic, geomorphic, climatic and biotic conditions. It is interesting that the surface topography of Phong Nha is not unlike that of Skocjanske (source of the term karst, and generally seen as the classical karst site) but the geologic structure and processes are vastly different. Ha Long Bay in Vietnam is an outstanding example of partly submerged towerkarst, and is totally different from Phong Nha. These are other karst areas under consideration by IUCN in 1999. These include the Alejandro de Humboldt National Park and the System of Marine Terraces of Cabo Cruz and Maisi, both in Cuba. Neither are directly comparable with Phong Nha. These two occur within an island ecosystem and do not have the complexity and diversity of karst geomorphology.



Turning to the karsts of the wet tropics in the South-east Asian region, one can much more justly make comparisons. Many of these areas, like Phong Nha, are located within large and spectacular limestone plateaux, and the caves have often only been recognised and explored in recent years. However, many have been the subject of considerable scientific research, and have been proven to be significant on a wide range of criteria. Three areas are currently in the process of consideration for World Heritage status:

- ◆ In East Malaysia, the Gunung Mulu Caves have National Park Status, have river systems which dwarf those of Phong Nha, and have the world's largest cave chambers and passages;
- ◆ St. Paul Subterranean Park on Palawan in the Philippines; and
- ◆ The Massive Baliem River karst of the Lorentz National Park of West Irian.

Other Asian karst areas of note include:

- ◆ Many regions of China, particularly in the South, and including the remarkable tower karst of Guangxi, have immense and complex karst systems;
- ◆ Niah Caves of East Malaysia with their great biodiversity and palaeontological/archaeological significance;
- ◆ Gomantong, also in East Malaysia, with its truly significant geomorphic character, including cave passages of over 200m. in height and a remarkable biodiversity;
- ◆ Many karst areas of Indonesia, including the famous Gunung Sewu of Java – one of the archetypal tropical karst landforms;
- ◆ Neighbouring Papua New Guinea, which is at a very early stage of environmental management, has extensive cave systems and underground rivers such as those of Atea Kanada, Mamo Kanada, Selminum Tem and the Nakanai mountains of New Britain;
- ◆ Finally, many of Thailand's National Parks contain cave systems. There are some thousands of identified and documented caves, many of which are immense in size, very often richly and beautifully decorated, and many with well-researched biodiversity and important archaeological sites; and
- ◆ Major areas of largely unexplored karst in Laos.

However, all of these are less complex, and many of them probably younger, karst systems than those of Phong Nha. In brief, although the nomination document emphasises the extent to which the caves of Phong Nha are large and striking, they are in themselves no more and sometimes much less so than many other sites throughout SE Asia. On broader criteria which take into account the totality of the karst system, Phong Nha must be seen as possibly one of the most significant karst sites in south-east Asia. As in virtually all aspects of the site, there is a great lack of knowledge or previous research, so the significance of the site can only be fully identified and supported when the Nature Reserve is researched as thoroughly as many others have been.

### **3.2. Forest Biodiversity**

There are two other forest protected areas in South-east Asia which have World Heritage Status: the Thungyai-Huai Kha Kheng Wildlife Sanctuaries in Thailand (Tropical Dry Forest) and the Ujung Kulon National Park in Indonesia (Tropical Moist Forest). The 3.5 million ha.

Lorentz National Park has been nominated as World Heritage this year. This is the largest protected area in South-east Asia and includes one of the largest expanses of tropical forest in South-east Asia. The forest biodiversity values of Phong Nha, on its own, does not compare favourably with these existing and proposed sites. However, if the nominated area were linked with the Hin Namno karst ecosystem of Lao PDR, then this would constitute an area of high significance for forest biodiversity conservation. Adjoining forests in Lao PDR have been identified as priority areas for conservation and protect forest ecosystems, which exhibit high levels of species endemism. Such a trans-boundary protected area system would constitute the largest surviving area of karst forest in South-east Asia. It is thus recommended that such an expansion should be considered by the State Party in conjunction with the government of the Lao PDR.

#### 4. INTEGRITY

PNNR was established in 1986. By 1991, the reserve area had been expanded to the current total of 41,132ha, and a management plan has been approved for the reserve. The research summary of the plan, although adequate, highlights the lack of information on natural values within the nomination site.

The management board of the Reserve, responsible for protection of forest resources and biodiversity was set up in 1994. Cave conservation and the provision of a tourism service are the responsibility of the Phong Nha Historical Relic and Landscape Board. A total of 26 staff are engaged in management and protection of the reserve. The 1999 IUCN review mission noted a high standard of cave management and a dedicated and committed staff working in the reserve.

However, there are some major problems in relation to site integrity:

- ◆ Although considerable progress has been made in protection of the surface environment, the rugged nature of the country, difficulty of control, low income of many local families and relative shortage of resources for control purposes mean that wildlife poaching and illegal timber gathering will be extremely difficult to eliminate. Staff are making great efforts to progressively make the protection as strict as possible but this remains a challenging issue;
- ◆ IUCN is particularly concerned that road #20 traverses the site and provides ready access to core areas. It is also used for the movement of cattle and other domesticated animals, and so, in various ways, it seriously threatens the integrity of the site. Further, these is a proposal to upgrade this road and IUCN strongly suggests that an alternative route be found which by-passes the nature reserve; and
- ◆ The watershed is not included in the nomination, and as the integrity of any karst area is dependent upon quality and quantity of the water input, this is a matter of concern. More widely, the current boundary appears to be an arbitrary one, and needs to be reviewed, to ensure it can more effectively protect natural values.

#### 5. ADDITIONAL COMMENTS

The nomination names the site as *Phong Nha Caves*. However, the nomination document deals with the Phong Nha Nature Reserve as a whole, and it is clear that this is the intended site, It also gives special attention to biodiversity of the surface environment, which may well prove to be far more significant than the caves. Accordingly, we recommend that the nomenclature of the site be amended at an early stage to ensure consistency.

The IUCN mission noted the lack of research and knowledge of the PNNR. Topographic mapping was inadequate and significant errors were noted in the available maps. All published information on the area and the nomination itself described a relatively young karst system, with a single-generation cave development and a corresponding simple overall geology and biology. However, the IUCN mission discovered that the area contains a very complex and ancient karst system. In addition, there are large outcrops of sandstone, laterite and shale, which have a significant impact on both the landscapes and the flora and fauna of the area. Detailed geological maps were not available.

One indication of the problem is that the work in progress by Timmins *et al.* is the first to survey the important bat populations. Further species were still being located on a virtually daily basis right up to the end of the field work phase, suggesting that many species remain to be found. More importantly, many of the species which have been identified are considered to be extremely rare and little known.

## 6. APPLICATION OF WORLD HERITAGE NATURAL CRITERIA

Each of the four criteria are dealt with in turn below:

### Criterion (i): Earth's history and geological features

The nomination lists this as one of the criteria for inscription, but no real evidence was presented to support this. On inspection, it is now clear that the simple description of the area provided in the nomination document is an over-simplification; the evolution of the landscape and caves has been both discontinuous and complex. Unlike other karst areas in Vietnam, which generally consist of tower karst, Phong Nha is probably best described as part of a larger dissected plateau, which also encompasses the Ke Bang and Hin Namno karsts. Most importantly, the limestone is not itself continuous, but demonstrates complex interbedding with shales and sandstones. This, together with the capping of schists and apparent granites which has probably been thrust over the limestones and is now eroded to a remnant outcrop, has led to a particularly distinctive topography.

The caves alone demonstrate discrete episodic sequences of events, leaving behind various levels of fossil passages, some of them very high, and one of these in fact being near the summit of the plateau; formerly buried and now uncovered palaeokarst (karst from previous, perhaps very ancient, periods of solution); evidence of major changes in the routes of underground rivers; changes in the solutional regime; deposition and later re-solution of giant speleothems and unusual features such as sub-aerial stromatolites (speleothems which are shaped by interaction between blue-green algae and the deposition of calcite). In particular, the location and form of the caves suggests that they might owe much of their size and morphology to some as yet undetermined implications of the schists and granites which overlay the limestone and if so, this is an unusual feature in itself. There are also both re-sorted and layered schist-derived sands and granitic gravels in the caves.

On the surface, there is a striking series of landscapes, ranging from deeply dissected ranges and plateaux to an immense polje (a flat-floored and enclosed valley) This may be either a solutional or tectonic landform, but in the context of what is known about the geological history of the region, this suggests the karst system is an old and relatively mature one. There is evidence of at least one period of hydrothermal activity in the evolution of the karst. The plateau is probably one of the finest and most distinctive examples of a complex karst landform in SE Asia and, as already noted, has more in common with the Skocjan karst of Slovenia than with most other Asian karst landscapes.

Thus, there is, in brief, a large and unexpected amount of evidence of earth's history. Without further research, the significance of the site to science cannot be properly assessed. However,

it is potentially a site of very great importance for increasing our understanding of the geologic, geomorphic and geo-chronological history of the region. This is the highest priority for further research. IUCN considers this site has potential to meet criterion (i), however the potential value for World Heritage would be greater under criterion (i) if the nominated area was linked with the Hin Namno karst reserve in Lao PDR.

#### **Criterion (ii): Ecological processes**

The nomination document does not justify inscription under this criterion but given that the area is not well researched it is not possible to argue for inscription under this criterion at present.

#### **Criterion (iii): Superlative natural phenomena, scenic beauty**

Phong Nha is certainly a very large and spectacular cave system and is clearly of great significance at the national level. However, some of the claims made about size in the nomination are not accurate, and even if they were, size alone would not merit inscription. As noted above, even at the regional level, and given present knowledge, Phong Nha does not rival other caves in the region in terms of size or other significant characteristics.

But on turning to the site as a whole, the Nature Reserve is a superlative and distinctive example of mature karst. IUCN cannot identify other precisely comparable sites in the South-east Asian region. Taking the striking surface topography of the dissected plateau, the springs and rivers, the steadily developing quality of the forest and the striking beauty of the caves, all of which is based in the geomorphic and geological complexity of the site, it is a site of regional significance. IUCN considers that the nominated area does not have the necessary superlative features to warrant inscription under criterion (iii).

#### **Criterion (iv): Biodiversity and threatened species**

The nomination includes examples of the now rare tall lowland forest, which has almost disappeared from other countries in the region.

Although knowledge of the area is still limited, the number of identified species, in itself, is comparable with other South-east Asian rain forest, and in fact, better researched areas show even much greater diversity. However, more recent data made available (Timmins *et al*, in prep.) deals much more fully with the fauna and its status, particularly in relation to mammals and birds. It vividly demonstrates the impact of continuing and more intensive research. One problem is that this report included the Ke Bang area, and there are some difficulties in comparability - but bats and many of the larger mammals do not respect human boundary lines, and so many of the reported species probably do occur in Phong Nha. The currently known extent of endangered, or threatened species is detailed in the Table below.

	Listed in nomination document	Further species listed by Timmins <i>et al</i>	Total species
Mammals (excl. bats)	26	4	30
Bats	-	11	11
Birds	12	10	22
Reptiles and Amphibians	11	-	11

**Table 1** - Species listed in the Red Books as vulnerable, rare, threatened or endangered, or otherwise very rare (hence recognised as data deficient)

Thus, the nominated area (and neighbouring lands) continue to support at least 73 important species, several of which are endemic to the limestone massif of which Phong Nha is part. In particular, it includes the total world population of François' Langur. However, the Nature Reserve is too small to provide adequately for protection of biodiversity, particularly of larger species such as the tiger, and so the moves to establish the larger Phong Nha/Ke Bang National Park must be seen as an urgent requirement. Similarly, the proposed trans-boundary integration with Hin Namno karst reserve of Laos, which will cover the whole of the Limestone plateau, is vital and urgent.

IUCN considers that the nominated area does not by itself meet World Heritage criterion (iv). However, if the area were to include the larger Phong Nha/Ke Bang National Park then this revised area would have strong potential for World Heritage under criterion (iv). The further addition of the Hin Namno Karst reserve, and other significant areas, in Lao PDR would also considerably enhance the status of this area as World Heritage.

#### **7. RECOMMENDATION FROM THE TWENTY-THIRD ORDINARY SESSION OF THE BUREAU: JULY, 1999**

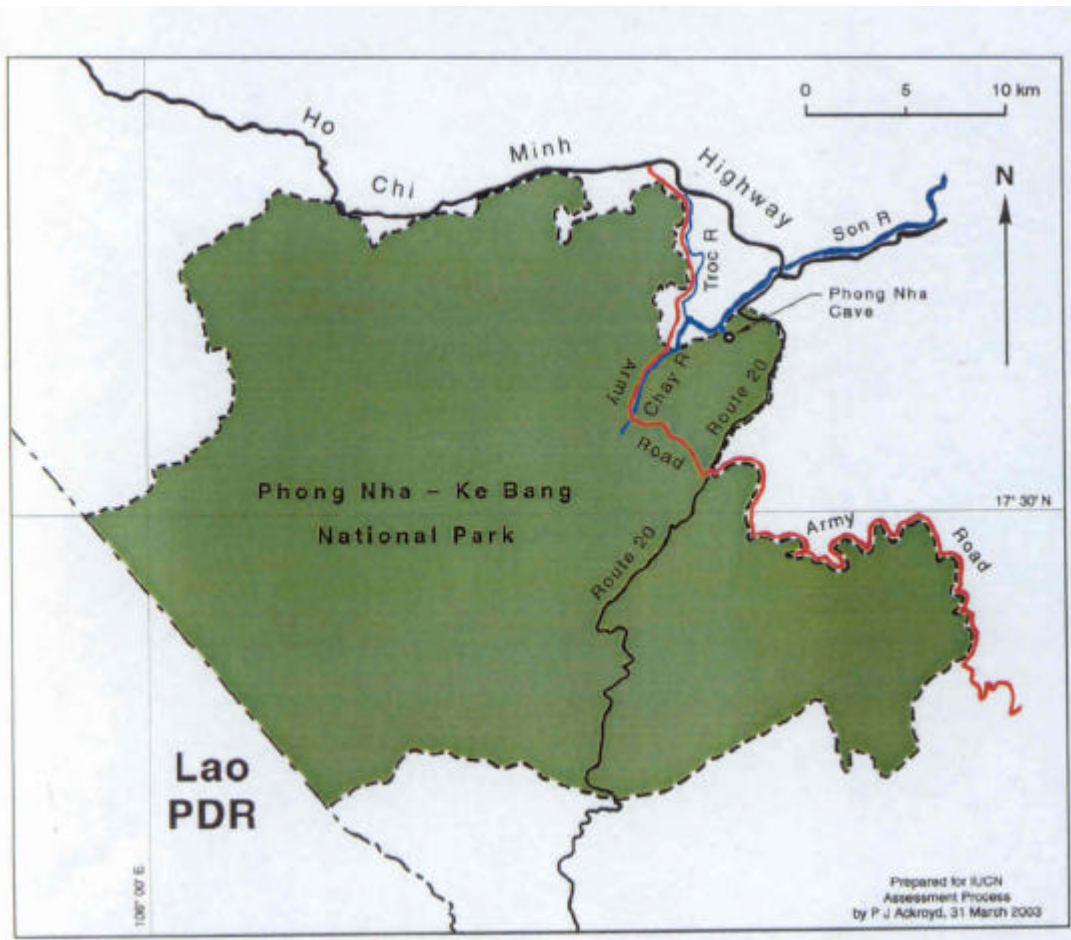
At its twenty-third ordinary session, the Bureau noted that the nominated area has potential value as a World Heritage site under criteria (i) and (iv) on the condition that it was expanded to include the larger Phong Nha/Ke Bang National Park with an associated fully integrated management structure. The Bureau decided to **defer** a decision on the site, pending review of the possibility of expanding the boundaries of the site as proposed. It is also strongly recommended that there be discussions with the Lao PDR State Party with a view to further expanding the boundaries of the site, at a later stage, to include the Hin Namno Karst reserve of Lao PDR and any other relevant areas.

On 4 September, the Vietnam National Commission for UNESCO notified the World Heritage Centre of the State Party's intention to expand the nominated area to include the larger Phong Nha-Ke Bang National Park and establish a fully integrated management structure for the site.

Map 1: General Location of Site



**Map 2: Detailed Map of Site**



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## CANDIDATURE AU PATRIMOINE MONDIAL - ÉVALUATION TECHNIQUE DE L'UICN

### PARC NATIONAL DE PHONG NHA – KE BANG (VIETNAM) – ID N° 951Rev

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**Rappel:** La Réserve naturelle de Phong Nha a été proposée pour inscription sur la Liste du patrimoine mondial pour la première fois en 1998 et l'UICN a réalisé sa mission d'inspection sur le terrain en janvier/février 1999. Le rapport complet de l'évaluation de l'UICN est joint en annexe A.

À sa 23e session ordinaire (juillet 1999), le Bureau a pris la décision suivante:

*«Le Bureau a noté que le site proposé pour inscription a une valeur potentielle de site du patrimoine mondial sur la base des critères naturels (i) et (iv) à condition qu'il soit élargi pour comprendre les sites de Phong Nha et du Parc national de Ke Bang, avec une structure de gestion pleinement intégrée. Le site fait partie d'un plateau karstique extrêmement complexe et ancien et bénéficie d'une grande diversité géologique qui englobe également les zones karstiques de Ke Bang et Hin Namno. La réserve est en grande partie recouverte de forêt tropicale dotée d'un haut niveau de diversité biologique et d'espèces endémiques. L'absence de recherche indique que l'on ne peut totalement évaluer la véritable importance de la biodiversité et de la géologie de cette région. La région par elle-même n'est pas considérée comme satisfaisant aux critères du patrimoine mondial. Toutefois, s'il était proposé en commun avec l'écosystème karstique de Hin Namno en République démocratique populaire lao, l'ensemble associé des deux sites constituerait la plus vaste aire de forêt karstique d'Asie du Sud-Est et il pourrait mériter le statut de patrimoine mondial.»*

*Le Bureau a décidé de **différer** sa décision sur le site, en attendant une étude des possibilités d'élargir les limites comme proposé. Il est également fortement recommandé que des discussions aient lieu avec l'État partie de la République démocratique populaire lao, dans le but d'élargir encore, par la suite, les limites du site à la Réserve karstique de Hin Namno en République démocratique populaire lao et à d'autres aires concernées.»*

Le site a ensuite fait l'objet d'une proposition révisée, présentée en 2000, afin d'inclure une zone beaucoup plus grande. À cette époque, toutefois, l'État partie a également fait part de la construction de la route principale nord-sud Ho Chi Minh ainsi que d'une route de raccordement, entre la route principale et la route 20, qui couperait une partie de la zone centrale de la Réserve naturelle de Phong Nha. Lorsque le gouvernement du Viet Nam a fait connaître ses plans de construction d'une route dans la réserve, plusieurs organisations (notamment l'UICN et Flora and Fauna International) ont conseillé la plus grande prudence et ont informé le gouvernement des incidences possibles des routes sur les valeurs de conservation de la région pouvant entraîner, en particulier, la perte de valeurs exceptionnelles. La proposition n'a donc pas été examinée à l'époque.

Des informations supplémentaires ont été fournies en mai 2002, annonçant la décision du Premier Ministre du Viet Nam (décembre 2001) de transformer la Réserve naturelle de Phong Nha-Ke Bang en Parc national de Phong Nha-Ke Bang avec une superficie totale de 85 754 ha; il y avait aussi des informations sur des projets de conservation et de mise en valeur du parc et des cartes révisées. Dans la nouvelle proposition révisée, le site était beaucoup plus petit que dans la proposition de 2000 mais encore relativement plus grand que dans celle de 1998. La superficie de la zone proposée dans chacune des trois propositions varie, comme on le voit dans le tableau qui suit.



1998	Réserve naturelle de Phong Nha	41 132 ha
2000	Parc national de Phong Nha-Ke Bang	147 945 ha
2002	Parc national de Phong Nha-Ke Bang	85 754 ha

Tableau 1. Superficie de la zone proposée dans chaque proposition, nouvelle ou révisée

## 1. DOCUMENTATION

- i) **Fiches techniques UICN/WCMC:** 13 références
- ii) **Littérature consultée:** Bien des références citées dans l'évaluation de 1999 restent valables, seules celles qui sont directement ou récemment utilisées sont répétées ici. Wikramanayake, E.D. et al., 2002, **Terrestrial Ecoregions of the Indo-Pacific: A conservation Assessment**. Island Press; Cao Van Sung & Le Quy An (eds.) . 1998. **Environment and Bioresources of Vietnam**, Gioi Publishers; WWF, *LINC*. 1998. **Linking Hin Namno and Phong Nha through Parallel Conservation**; Timmins, R.J., Do Tuoc & Trinh Viet Cuong. 1999 **A preliminary assessment of the conservation importance and conservation priorities of the Phong Nha - Ke Bang proposed national park, Quang Binh Province, Vietnam**. Flora and Fauna International. Hanoi; Meijboom, M. & Ho Thi Ngoc Lanh. 2002. **He Dong – Thuc Vat / O Phong Nha – Ke Bang Va Hin Namno**. Phong Nha-Ke Bang National Park with WWF; Gilmour, D.A. & Nguyen Van San. 1999. **Buffer Zone Management in Vietnam**. IUCN Vietnam; Pham Khang. 1985. The development of karst landscapes in Vietnam. **Acta Geologica Polonica** 35 (3-4). pp 305-319; Anon. 1999. Geology of the Phong Nha – Ke Bang Area. Unpublished Paper; Do Tuyet. 1998. Overview on Karst of Vietnam, in Daoxian, Y & Zaihua, L. (eds.) **Global Karst Correlation, Science Press, Beijing**. pp. 179-192; Drew, D. & Hotzl, H. (eds.) 1999. **Karst Hydrogeology and Human Activities: Impacts, Consequences and Implications**. Balkema; Nguyen Quang My & Limbert, Howard. 2002. **Ky Quan Hang Dong Vietnam** (Merveilles des grottes vietnamiennes). Trung Tam Ban Do Va tranh Anh Giao Duc.
- iii) **Consultations:** cinq évaluateurs indépendants. D'autres consultations ont eu lieu avec le personnel de Fauna and Flora International; de nombreux spéléologues; des cadres du Département de conservation et de muséologie (Viet Nam); des géologues du Groupe d'étude du karst de l'Institut de recherche sur la géologie et les ressources minérales; le personnel du parc et des cadres de nombreuses branches du Comité provincial du peuple de Quang Binh; les présidents, entre autres, des communes de Son Trach et Xuan Trach.
- iv) **Visite du site:** E. Hamilton-Smith. Janvier 2003. E. Hamilton-Smith et H. Friederich. Janvier-février 1999.

## 2. RÉSUMÉ DES CARACTÉRISTIQUES NATURELLES

Le Parc national de Phong Nha-Ke Bang (PNKB) couvre une superficie totale de 85 754 ha et comprend trois zones:

une zone intégralement protégée	64 894 ha
une zone de restauration écologique	17 449 ha
une zone de services administratifs	3411 ha

Il est limité à l'ouest par la République démocratique populaire (RDP) lao et se compose d'un plateau et de collines calcaires. La province calcaire rejoint le karst de Hin Namno et Khammoune en RDP lao. Les deux secteurs présentent de nombreuses grottes de grandes dimensions, souvent spectaculaires et importantes sur le plan scientifique.

Le karst de Phong Nha-Ke Bang a évolué depuis le Paléozoïque (il y a environ 400 millions d'années) et c'est donc la plus ancienne grande région de karst d'Asie. Elle a subi de profonds changements d'origine tectonique et comprend une série de types de roches interstratifiées de manière complexe. Il y a sans doute au moins sept niveaux majeurs de formation du karst issus du relèvement tectonique et de changements dans le niveau des mers. En conséquence, le paysage karstique du PNKB est extrêmement complexe et présente une haute géodiversité et de nombreuses caractéristiques géomorphologiques d'importance considérable. Comme une bonne partie du Viet Nam, il a subi de profonds changements d'origine tectonique et les calcaires de Phong Nha sont interstratifiés avec plusieurs autres roches. Tout indique aussi que la dissolution sulfureuse et l'action hydrothermale ont joué un rôle important dans la formation du paysage en général et des grottes en particulier mais cela n'a pas encore été correctement évalué.

L'intégration de la forêt de Ke Bang dans le parc ajoute une dimension très importante. Ce secteur compte de nombreuses grottes «fossiles» de niveau élevé qui se forment lorsque la nappe phréatique et les rivières baissent de niveau. Comme beaucoup de grottes de ce genre, celles-ci contiennent sans doute de nombreuses caractéristiques scientifiques d'intérêt paléontologique et géomorphologique. Très peu ont été visitées à ce jour mais, avec le peu d'information disponible, on peut dire que certaines contiennent des gisements d'importance géologique, d'autres possèdent des formations minérales de calcite (et peut-être d'autres formations minérales) inhabituelles et d'autres encore accueillent des populations de chauves-souris ainsi qu'une diversité d'invertébrés adaptés aux grottes qui n'ont pas encore été suffisamment étudiés.

L'évaluation de la biodiversité du site pose des problèmes particuliers. Il s'agit d'un exemple de l'écorégion annamite septentrionale, une des écorégions les plus importantes de l'Indo-Pacifique (Wikramanayake *et al.*). Un grand nombre d'espèces de la faune (568 vertébrés) et de la flore (876 plantes vasculaires), y compris plusieurs espèces endémiques dans le site (13 espèces de plantes et 7 espèces de primates) sont mentionnées dans le texte de la proposition de 2000. Toutefois, l'évaluation systématique a commencé il y a seulement cinq ans et la collecte de spécimens est limitée. L'analyse statistique du taux de recensement de nouvelles espèces de la faune indique que la découverte et l'identification d'espèces se poursuivront. Les chercheurs qui travaillent sur le terrain signalent aussi la découverte d'espèces qui ne sont pas encore décrites. Par exemple, Timmins *et al.*, entre autres, ont localisé de nouvelles espèces presque chaque jour jusqu'à la fin de chaque campagne, ce qui suggère que beaucoup d'espèces restent à découvrir. Mais, surtout, parmi les espèces identifiées, beaucoup seraient extrêmement rares et peu connues.

Il convient de noter que la connaissance du PNKB est extrêmement limitée, ce qui a constitué une entrave, tant pour la préparation du document de proposition que pour l'évaluation de l'UICN.

### **3. COMPARAISON AVEC D'AUTRES SITES**

#### **3.1. Régions karstiques et géomorphologie**

La plupart des 41 biens du patrimoine mondial qui présentent des caractéristiques karstiques sont situés en zone tempérée. Ils comprennent : les grottes de Skocjan (Slovénie); les grottes du Karst Aggtelek et du Karst slovaque (Hongrie/Slovaquie); le Parc national des lacs Plitvice (Croatie); les Parcs canadiens des montagnes Rocheuses et le Parc national Nahanni (Canada); le Parc national de Mammoth Cave et le Parc national du Grand Canyon (États-Unis); Te Wahipounamu (Nouvelle-Zélande); Huanglong et la vallée de Jiuzhaigou (Chine); la Zone de nature sauvage de Tasmanie et les Sites fossilifères de mammifères (Australie); et le Bien du patrimoine mondial d'East Rennell (Îles

Salomon) qui est un site tropical insulaire dans le Pacifique sud. Aucun ne peut être comparé à Phong Nha car ils sont très différents du point de vue géologique, géomorphologique, climatique et biologique.

Toutefois, la comparaison avec les karsts des tropiques humides d'Asie du Sud-Est est réaliste. Beaucoup de ces régions, comme Phong Nha, se situent sur de grands plateaux calcaires spectaculaires et les grottes n'ont bien souvent été reconnues et explorées que depuis quelques années. Certains ont fait l'objet de recherches scientifiques considérables et leur importance à été prouvée selon de nombreux critères. Trois régions ont récemment été inscrites sur la Liste du patrimoine mondial.

- Le Bien du patrimoine mondial et Parc national de Gunung Mulu en Malaisie qui présente des grottes et des réseaux de rivières souterraines dont l'importance internationale est nettement plus élevée que celle du PNKB. Il recèle une riche biodiversité mais qui correspond à une province faunique totalement différente de celle de Phong Nha.
- Le Parc national de la rivière souterraine de St-Paul à Palawan, aux Philippines, qui possède également une grande rivière souterraine mais qui est relativement jeune (en termes géologiques) et qui est un système simple.
- Le karst massif de la rivière Baliem dans le Bien du patrimoine mondial et Parc national Lorentz dans l'ouest de l'Irian Jaya, en Indonésie, est encore moins étudié que le PNKB mais de caractère totalement différent car il a été influencé par des glaciers et il est associé à des sédiments océaniques métamorphosés datant du Crétacé et de l'Éocène.

Parmi les autres sites karstiques remarquables de l'Asie du Sud-Est, on note de grands sites du Viet Nam et de la Chine; les grottes Niah et Gomantong dans l'est de la Malaisie qui présentent chacune une grande biodiversité et une grande importance paléontologique/archéologique; de nombreuses zones karstiques d'Indonésie, notamment le célèbre site de Gunung Sewu à Java – un des archétypes des formes de relief karstique tropical; les vastes réseaux de grottes et de rivières souterraines de Papouasie-Nouvelle-Guinée tels qu'Atea Kanada, Mamo Kanada, Selminum Tem et les montagnes de Nakanai en Nouvelle-Bretagne; beaucoup des parcs nationaux de Thaïlande et de grandes régions karstiques encore peu explorées de RDP lao.

Beaucoup de ces sites sont toutefois plus jeunes et beaucoup moins complexes et ne rivalisent pas avec le PNKB du point de vue de leur contribution à la connaissance de l'histoire géologique de la région. Le seul qui rappelle beaucoup le PNKB est le karst voisin, en RDP lao, de Hin Namno et Khammoune.

Selon des critères généraux, qui tiennent compte de la totalité du système karstique, le PNKB doit être vu comme un des sites karstiques les plus importants de l'Asie du Sud-Est. Cependant, comme pour bien d'autres aspects du site, il y a une absence de connaissances et de travaux de recherche menés à bien, de sorte que l'importance du site ne sera totalement établie et démontrée que lorsqu'il aura été étudié avec autant de rigueur que beaucoup d'autres sites.

### **3.2 Biodiversité**

Il existe, en Asie du Sud-Est, trois autres aires protégées de forêts qui ont le statut de bien de patrimoine mondial: les sanctuaires de faune de Thungyai-Huai Kha Kheng en Thaïlande (forêt tropicale sèche); le Parc national d'Ujung Kulon en Indonésie (forêt tropicale humide); et le Parc national Lorentz, avec ses 3,5 millions d'ha, en Indonésie (province de Papouasie occidentale). Ce dernier est la plus grande aire protégée d'Asie du Sud-Est et comprend une des forêts tropicales les plus vastes de la région. Les valeurs de biodiversité forestière du PNKB telles qu'elles sont actuellement connues sont probablement moins riches que celles des trois sites concernés. Toutefois, si la région proposée était agrandie, notamment pour assurer le lien avec les écosystèmes karstiques de

Hin Namno et Khammoune, en RDP lao (qui sont toutes deux des aires protégées), il s'agirait alors d'une région d'importance extrêmement élevée pour la conservation de la biodiversité forestière. Les forêts contiguës en RDP lao ont été considérées comme des zones prioritaires pour la conservation et protègent des écosystèmes forestiers qui présentent des niveaux élevés d'endémisme des espèces. Un tel système d'aires protégées transfrontière constituerait l'une des plus grandes zones survivantes de forêts karstiques d'Asie du Sud-Est sur une superficie de 317 754 ha.

## 4. INTÉGRITÉ

### 4.1 Intégrité du site

Bien que des progrès considérables aient été faits pour protéger le milieu de surface, la nature déchiquetée du paysage, la difficulté d'assurer la surveillance, le faible revenu de nombreuses familles locales et la pénurie relative de ressources nécessaires au suivi font qu'il est difficile d'éliminer le braconnage de la faune sauvage et la récolte illicite du bois. Le personnel a fait de grands efforts pour améliorer le régime de protection mais cela reste un enjeu important, notamment si l'on considère la demande commerciale en expansion de «viande d'origine sauvage».

### 4.2 Construction de routes

Dans le rapport d'évaluation de 1999 (annexe A), l'UICN ne cachait pas ses graves inquiétudes concernant l'intégrité du site en raison du projet de construction de routes. Le projet comprend deux éléments différents: la route principale Ho Chi Minh et la route de raccordement entre la route principale et la route 20 (voir carte ci-jointe).

- La route principale Ho Chi Minh se justifie, de toute évidence; elle est correctement située, en dehors et au nord du site proposé. En outre, elle a été construite avec beaucoup d'égards pour l'environnement. Elle sera bénéfique pour le Parc national, car elle ouvrira des points de vue et donnera accès à la zone forestière de Ke Bang. Elle améliore aussi beaucoup la circulation annuelle du nord au sud du pays dans son ensemble, avec les avantages que cela apporte.
- Malheureusement, c'est une toute autre histoire pour la route qui relie la route principale et la route 20. Il est probable qu'elle soit peu fréquentée et qu'elle serve surtout à déplacer le bétail et autres animaux domestiques, ce qui soulève la question de son utilité. Il est très peu probable qu'elle apporte un quelconque bénéfice en compensation de l'immense coût économique et environnemental de sa construction. Son positionnement, à travers les zones centrales naturelles du site, non seulement ne tient aucun compte de l'environnement mais est aussi totalement inapproprié, car la route suit la vallée du Chay, détruisant des habitats d'importance stratégique pour la faune sauvage et coupant à travers les formes de relief géomorphologiques dominantes du parc. La construction de nouvelles routes dans les aires protégées a des incidences négatives bien connues (empiétement, coupe de bois et prélèvement de produits forestiers non ligneux, chasse et commerce de la faune sauvage accrus), qui alourdissent considérablement les tâches et les activités de suivi des gestionnaires du parc.

La construction de cette route de raccordement a inévitablement rencontré des difficultés considérables, qui ont donné lieu à de graves impacts environnementaux. Le contraste est saisissant quand on considère les soins apportés à la construction de la route principale. Les impacts principaux sont les suivants:

- d'importants habitats pour la faune ont été détruits et la destruction de la végétation a été massive ;
- la destruction des formes de relief et de la qualité géomorphologique est considérable (dans une lettre à l'UNESCO datée du 15 décembre 2000, Fauna and Flora International indiquait que 4,5 tonnes d'explosifs au kilomètre seraient nécessaires pour cette construction);

- les considérations esthétiques ont été ignorées;
- l'érosion des sols, à grande échelle, le long de la route, a entraîné la sédimentation du système d'eaux souterraines et des cours d'eau de surface qui émergent du plateau, c'est-à-dire dans la grotte de Phong Nha. Sans doute y aura-t-il non seulement des modifications dans le mouvement des eaux souterraines et l'évolution du système de grottes mais aussi des impacts majeurs sur la biodiversité dans les eaux souterraines et, en conséquence, dans les cours d'eau émergents.

### 4.3 Limites

Le bassin versant n'est pas entièrement inclus dans la proposition et comme l'intégrité de toute région karstique dépend de la qualité et de la quantité de l'apport d'eau, c'est une question préoccupante. En outre, les limites actuelles semblent être arbitraires et doivent être révisées et agrandies pour garantir une protection plus efficace des valeurs naturelles, y compris de vastes régions nécessaires pour maintenir des populations viables d'espèces telles que le tigre et l'ours noir d'Asie.

Il est à noter que les dossiers de proposition de 2000 et de 2002 prévoyaient l'identification de zones tampons correctement délimitées. Toutefois, l'UICN n'a connaissance d'aucune étude sur les règlements et les procédures de gestion pour ces zones tampons.

L'UICN recommande à l'État partie d'examiner deux stratégies possibles pour traiter ces questions importantes:

- Agrandir les limites pour revenir à la proposition de 2000, à savoir une superficie de 147 945 ha pour le parc comme proposé par l'État partie à l'époque.
- Encourager la conclusion d'un accord transfrontière avec la RDP lao qui intégrerait le PNKB et Hin Namno, soit en tant que deux parcs fonctionnant selon des protocoles de gestion convenus et équivalents, soit avec une gestion pleinement intégrée. Naturellement, il s'agit d'un processus de longue haleine qui demande un supplément de ressources, tout particulièrement en RDP lao où la gestion sur le terrain en est encore à ses balbutiements. Mais si cette intégration avait lieu, elle aboutirait à la création de l'aire protégée karstique la plus importante d'Asie du Sud.

### 4.4 Gestion du tourisme

Il n'existe pas de plan de gestion du tourisme dans le site mais les informations obtenues durant la mission d'inspection sont préoccupantes. Elles suggèrent une mise en valeur plus ou moins opportuniste des points d'intérêt dispersés dans le parc et non une planification systématique de sites actuels et futurs de loisirs et de visite. De toute évidence, la grotte de Phong Nha est déjà une attraction majeure. La grotte absolument superbe de Hang Vom est sans doute la meilleure autre attraction (et la seule autre viable) pour les touristes en quête d'expérience spéléologique. Le caractère très différent de la région de Ke Bang offre la possibilité de mettre en place un programme d'écotourisme mais ce n'est pas envisagé dans le plan actuel.

Les autorités provinciales proposent également de mettre en place des centres d'intérêt associés et complémentaires à l'entrée du Parc de Phong Nha. Ceux-ci sont sans doute économiquement viables mais on ne voit pas très bien comment ils pourront remplir l'objectif de donner aux visiteurs l'envie de découvrir les valeurs du parc lui-même. Un jardin botanique, par exemple, serait beaucoup mieux situé à Dong Hoi, aux limites nord-est du parc et il vaudrait mieux consacrer le budget du parc à construire des chemins de bois et à aménager des points d'intérêt à l'intérieur du parc.

## 5. AUTRES COMMENTAIRES

Les immenses valeurs de conservation particulières du PNKB sont reconnues depuis de nombreuses années et, comme indiqué ci-dessus, la recherche a confirmé l'importance régionale et mondiale de la région. Reconnaissant la grande valeur de la région, l'État partie a soumis le site pour inscription sur la Liste du patrimoine mondial. Toutefois, comme mentionné ci-dessus, la route de raccordement entre la route principale Ho Chi Minh et la route 20 a été construite et semble avoir causé de graves dommages aux valeurs clés du PNKB, dommages qui, à la lumière de l'évaluation actuelle, seront difficiles à réparer si l'on veut rendre à la région son état écologique et géomorphologique d'origine. Le fait que cela se soit produit pendant la période de révision de la proposition d'inscription et de révision du nom du PNKB porte malheureusement à remettre en question l'engagement de l'État partie à maintenir les valeurs de patrimoine mondial si le site était inscrit.

## 6. APPLICATION DES CRITÈRES DU PATRIMOINE MONDIAL

Le PNKB est proposé au titre des critères naturels (i) et (iv).

### Critère (i) : histoire de la terre et processus géologiques

L'UICN réitère sa recommandation présentée dans le rapport d'évaluation de 1999 (voir annexe A) «*ce site pourrait potentiellement répondre au critère (i), cependant son importance pour le patrimoine mondial en serait renforcée si le site désigné pouvait être relié à la réserve karstique de Hin Namno au Laos*».

### Critère (iv) : diversité biologique et espèces menacées

Comme mentionné dans le paragraphe 2, l'information issue de la recherche sur la flore et la faune du site met en lumière son importance pour la conservation de la biodiversité. Toutefois, le site proposé, bien qu'il soit plus grand que le site proposé en 1998 est encore trop petit pour fournir une protection adéquate à des espèces menacées telles que le tigre et l'ours noir d'Asie. En conséquence, l'UICN considère que le site proposé ne remplit pas, à lui seul, ce critère. Toutefois, si le site est agrandi, il est possible que la région révisée puisse remplir ce critère. La possibilité de créer un site transfrontière avec les aires protégées de Hin Namno et Khammoune, en RDP lao, augmenterait considérablement le potentiel du site à remplir le critère (iv).

Comme mentionné dans les paragraphes 4 et 5, le site proposé ne remplit pas les conditions d'intégrité.

## 7. RECOMMANDATIONS

7.1 L'impact de la construction de la route de raccordement à travers le Parc national de Phong Nha-Ke Bang est un facteur nouveau et important dans l'évaluation du site proposé pour inscription en 1998 et à nouveau en 2000. En conséquence, l'UICN recommande que le Comité du patrimoine mondial **diffère** sa décision concernant le Parc national de Phong Nha-Ke Bang.

L'UICN recommande au Comité de prier l'État partie d'entreprendre une évaluation indépendante des impacts de la construction de la route de manière à:

- déterminer la nature précise et l'étendue des impacts de la construction de la route de raccordement sur la biodiversité, le paysage et les valeurs géomorphologiques karstiques du site;

- déterminer s'il est possible d'atténuer les impacts identifiés et de restaurer les valeurs du site, et comment le faire ;
  - évaluer si, du point de vue de la viabilité et de l'intégrité de la proposition d'inscription sur la Liste du patrimoine mondial, il serait envisageable d'exclure du Parc national de Phong Nha-Ke Bang la zone touchée par la construction de la route de raccordement, au cas où il serait impossible de prendre des mesures de restauration/atténuation.
- 7.2 L'UICN recommande aussi que le Comité renouvelle la demande faite à l'État partie, dans l'évaluation de 1999, à savoir de réviser les limites de la proposition comme noté au paragraphe 4.3 ci-dessus, de manière à fournir une couverture plus complète des valeurs naturelles et des processus géomorphologiques karstiques.
- 7.3 L'UICN recommande que le Comité demande à l'État partie de préparer et de soumettre:
- un plan de gestion du tourisme ;
  - des informations sur les règlements applicables à la gestion de la zone tampon;
  - des informations sur les mesures d'application et autres mesures qui seront prises pour lutter contre le braconnage.
- 7.4 L'UICN recommande que le Comité renouvelle la demande faite en 1999 à l'État partie de poursuivre le dialogue concernant un accord transfrontière avec l'État partie de la RDP lao afin d'intégrer Phong Nha-Ke Bang et l'Aire de conservation naturelle de Hin Namno, soit en deux parcs fonctionnant selon des protocoles de gestion convenus et équivalents soit dans le cadre d'une gestion intégrée. Cela pourrait être la base d'un bien transfrontière potentiel du patrimoine mondial.

## Annexe A - Rapport d'évaluation de l'UICN, 1999

## RAPPORT D'ÉVALUATION TECHNIQUE DE L'UICN, 1999

## GROTTE DE PHONG NHA (VIET NAM)

## 1. DOCUMENTATION

- i) **Fiches techniques UICN/WCMC** (13 références).
- ii) **Littérature consultée:** Deharveng, L. 1999. **Phong Nha Cave Biodiversity**. Unpublished Report. 3p; Gouvernement de la République socialiste du Viet Nam et Fonds pour l'environnement mondial 1994. **Biodiversity Action Plan for Vietnam**. Hanoi; Dillon, T.C. & Wikramanayake, E.D. 1997. **A Forum for Trans-boundary Conservation in Cambodia, Laos and Vietnam**. WWF, Hanoi et Washington. Projet VIE/91/G31-1994; Limbert, H. 1992. The caves of Phong Nha and Hang Toi, Quang Binh Province, Vietnam. **The International Cave**. Vol. 2. pp 49; Limbert, H. 1992. Vietnam 1992, Return to the river caves of Quang Binh. **The International Caver**. Vol. 5. pp 19-25; Limbert, H. 1994. **Vietnam 1994**. The 1994 British/Vietnamese Speleological Expedition Report. Privately published; Limbert, H. 1994. Vietnam: A Caver's Paradise. **The International Caver**. Vol. 12. pp 3-9; Limbert, H. 1997. Vietnam '97. **The International Caver**. Vol. 20. pp 11-18; WWF, *LINC*. 1998. **Linking Hin Namno and Phong Nha through Parallel Conservation**. Programme du WWF pour l'Indochine. Hanoi; Nguyen Quang My & Vu Van Phai. n.d. **Cavern Tourism in Vietnam**; Pham Khang. 1985. The development of karst landscapes in Vietnam. *Acta Geologica Polonica* 35 (3-4). pp 305-319; Nguyen Van Thang, ed. 1997. **Danh gia hien trang moi trung khu bao ton thien Phong Nha nam 1996-1997**; divers auteurs. 1997. **Report of Field surveys on biodiversity in Phong Nha - Ke Bang Forest** Mimeo Report. Hanoi. 84 p; Quang Binh Peoples Committee. 1998. **Investment Project: Establishment National Park Phong Nha-Ke Bang, Quang Binh**. Mimeo report; Timmins, R.J., Do Tuoc & Trinh Viet Cuong. in prep. **A preliminary assessment of the conservation importance and conservation priorities of the Phing Nha - Ke Bang proposed national park, Quang Binh Province, Vietnam**. Rapport préliminaire, à publier par Flora and Fauna International. Hanoi; Vermeulen, J. & T. Whitten. eds. en prép. **Impacts of industrial use of limestone resources on biodiversity and cultural heritage (in East Asia)**. Rapport préliminaire du projet conjoint Banque mondiale-UICN, avec divers documents historiques; Watson, J. *et al.* 1997. **Guidelines for Cave and Karst Protection** UICN.
- iii) **Consultations:** 5 évaluateurs indépendants. Personnel : du CNRS, France; des Grottes de Gunung Mulu, Malaisie; du WWF Viet Nam; de l'Université de Sydney; de l'Université technologique de Nottingham; de la Société géologique d'Australie. Spéléologues et historiens indépendants. Cadres supérieurs du Département de la conservation et de muséologie (DOCAM), Viet Nam. Responsables des parcs et cadres des organes suivants: Comité populaire de la Province de Quang Binh; Département des sciences, de la technologie et de l'environnement; Programme Phong Nha / Ke Bang; Office pour la protection de la forêt de Phong Nha; Conseil de gestion du patrimoine et paysages au sein du Département de la culture et de l'information; Département des relations internationales de la Province; Département des sciences, de la technologie et de l'environnement.



- iv) **Visite du site** : janvier-février 1999. Elery Hamilton-Smith, et Hans Friederich.

## 2. RÉSUMÉ DES CARACTÉRISTIQUES NATURELLES

La Réserve naturelle de Phong Nha (PNNR) est située à l'extrémité du plateau calcaire de Phong Nha/Ke Bang au centre du Viet Nam. Elle ne représente qu'une partie de l'ensemble du plateau, qui s'étend à la région karstique voisine de Hin Namno au Laos. Phong Nha compte de nombreuses grottes, dont 17 ont été explorées et cartographiées par des membres de la British Cave Research Association, en collaboration avec l'Université de Hanoi. De nombreuses grottes sont de grande taille et spectaculaires, et elles s'étendent (d'après les connaissances actuelles) sur environ 65km. Cependant, à ce jour la recherche s'est contentée de faire un relevé de l'étendue de ces grottes ce qui, en soi, est déjà un énorme travail.

Le paysage karstique de la PNNR est extrêmement complexe et ancien, très divers du point de vue géologique et présente quelques caractéristiques géomorphologiques d'importance considérable.

La Réserve est en grande partie recouverte d'une forêt tropicale gravement touchée par le feu pendant la guerre mais qui s'est remise rapidement et se trouve, aujourd'hui, dans un état satisfaisant. Elle présente un haut niveau de diversité biologique et de nombreuses espèces endémiques. Les données indiquent également une grande diversité faunique. Le document de candidature précise:

- actuellement 735 espèces de plantes vasculaires ont été décrites, réparties en 413 genres et 140 familles;
- des recensements préliminaires de la faune ont permis d'identifier 461 espèces de vertébrés, dont 65 de mammifères, 260 d'oiseaux, 53 de reptiles, 22 d'amphibiens et 61 de poissons d'eau douce.

En résumé, il faut souligner que l'on a des connaissances extrêmement limitées de la région de Phong Nha, ce qui a rendu difficile tant la préparation de la demande d'inscription que l'évaluation de l'UICN.

## 3. COMPARAISON AVEC D'AUTRES AIRES PROTÉGÉES

### 3.1 Régions karstiques et diversité géologique

À ce jour, ce sont les grottes, parmi toutes les caractéristiques karstiques, qui ont retenu l'attention. Cependant, les caractéristiques superficielles, et tout spécialement le grand polje (dépression à fond plat entourée de collines calcaires escarpées), sont jugées plus importantes.

La plupart des biens du patrimoine mondial présentant des caractéristiques karstiques sont situés dans les régions tempérées. Il s'agit notamment des grottes de Skocjan (Slovénie), des grottes du Karst Aggtelek et du Karst Slovaque (Hongrie/Slovaquie), du Parc national de Plitvice (Croatie), des Parcs canadiens des montagnes Rocheuses et du Parc national Nahanni (Canada), des Parcs nationaux de Mammoth Cave et du Grand Canyon (États-Unis), de Te Wahipounamu (Nouvelle-Zélande), de Rennell Est (îles Salomon), de Huanglong et de Vallée de Jiuzhaigou (Chine) et enfin, de la Zone de nature sauvage de Tasmanie et les Sites fossilifères de mammifères (Australie).

Aucun de ses sites ne peut véritablement être comparé avec Phong Nha, étant donné leurs conditions géologiques, géomorphologiques, climatiques et biotiques très différentes. Il est intéressant de noter que la topographie de surface à Phong Nha n'est pas sans rappeler celle de Skocjanske (origine du terme karst et généralement considéré comme le site karstique classique), bien que la structure et les processus géologiques y soient très différents. La baie de Ha Long, au Viet Nam, offre un exemple exceptionnel de tourelles karstiques partiellement submergées; le site est fondamentalement différent de Phong Nha. L'UICN évalue également d'autres régions karstiques pour 1999, notamment le Parc national Alejandro de Humboldt et le Système de terrasses marines du Cap Cruz et Maisi, tous deux à

Cuba. Mais ni l'un, ni l'autre ne sont directement comparables avec Phong Nha. Ces deux sites font partie d'un écosystème insulaire et n'offrent pas la même complexité et ni la même diversité en matière de géomorphologie karstique.

Quant aux systèmes karstiques des tropiques humides de l'Asie du sud-est, ils se prêtent déjà mieux à une comparaison. Comme Phong Nha, plusieurs de ces sites font partie de grands plateaux calcaires spectaculaires, et souvent les grottes n'y ont été repérées et explorées que récemment. Cependant, nombre de ces sites ont fait l'objet d'une recherche scientifique considérable, et se sont révélés importants au titre de nombreux critères. Trois de ces sites sont en train d'être évalués en vue d'une inscription au patrimoine mondial :

- En Malaisie orientale, les grottes de Gunung Mulu ont le statut de Parc national; leurs réseaux de rivières sont nettement plus importants que ceux de Phong Nha, et l'on y trouve les salles souterraines et les passages les plus grands du monde;
- Le Parc national de la rivière souterraine de St Paul, à Palawan aux Philippines; enfin
- L'immense karst fluvial du Parc national de Lorentz, en Irian Jaya, Indonésie.

Quelques autres sites karstiques remarquables en Asie :

- de nombreuses régions de Chine, particulièrement au sud, notamment le remarquable karst à tourelles de Guangxi, présentent des systèmes karstiques immenses et complexes;
- les grottes Niah, en Malaisie orientale, offrent une grande diversité biologique et d'importantes ressources paléontologiques ou archéologiques;
- Gomantong, également en Malaisie orientale, présente des caractéristiques géomorphologiques remarquables, dont notamment des passages souterrains de plus de 200m de haut et une grande diversité biologique;
- de nombreuses régions karstiques se trouvent en Indonésie, dont le célèbre site de Gunung Sewu à Java, archétype des formations karstiques tropicales;
- en Papouasie-Nouvelle-Guinée voisine, qui en est aux balbutiements pour ce qui est de la gestion environnementale, l'on trouve d'importants réseaux de grottes et de rivières souterraines, comme à Atea Kanada, Mamo Kanada, Selminum Tem et dans les montagnes Nakanai en New Britain.
- nombre de Parcs nationaux thaïlandais comprennent des systèmes de grottes. Il existe quelques milliers de grottes identifiées et documentées, dont nombre sont immenses et souvent richement et superbement décorées, et d'autres dont la diversité biologique a été bien étudiée, et qui contiennent des sites archéologiques importants;
- d'importantes régions karstiques restent largement inexplorées au Laos.

Cependant, tous ces systèmes karstiques sont moins complexes, et nombre d'entre eux probablement plus récents, que celui de Phong Nha. Bien que la proposition d'inscription insiste sur la grande taille et la beauté des grottes de Phong Nha, celles-ci ne sont pas plus remarquables que d'autres sites d'Asie du Sud-Est. Dans certains cas, elles sont même moins remarquables. En revanche, si l'on adopte des critères plus larges, pour tenir compte de l'ensemble du système karstique, le site de Phong Nha peut probablement être considéré comme l'un des sites karstiques les plus remarquables d'Asie du Sud-Est. Les connaissances et la recherche étant très sommaires sur pratiquement tous les aspects du site, l'importance de ce site ne pourra être établie et documentée de façon probante que quand la Réserve naturelle aura fait l'objet de recherches aussi détaillées que nombre des autres sites.

### 3.2. Diversité biologique de la forêt

Il existe en Asie du Sud-Est deux sites forestiers protégés inscrits sur la Liste du patrimoine mondial: les Sanctuaires de faune de Thung Yai-Huai Kha Khaeng en Thaïlande (forêt tropicale sèche) et le Parc national d'Ujung Kulon en Indonésie (forêt tropicale humide). Le Parc national de Lorentz, avec ses 3,5 millions d'ha, est candidat à la Liste du patrimoine mondial pour cette année. Il s'agit de la plus importante aire protégée d'Asie du Sud-Est, comprenant l'une des zones de forêt tropicale les plus étendues de cette région. La seule diversité biologique forestière de Phong Nha ne saurait être comparée à ces biens existants et proposés. Cependant, si le site désigné pouvait être relié à l'écosystème karstique de Hin Namno en République démocratique populaire lao, il représenterait alors une zone d'importance majeure pour la conservation de la diversité biologique forestière. Les forêts du Laos voisin sont considérées comme prioritaires pour la conservation; elles abritent des écosystèmes forestiers contenant de nombreuses espèces endémiques. Un tel réseau d'aires protégées transfrontières représenterait la dernière grande forêt karstique d'Asie du Sud-Est. Il est, en conséquence, recommandé que l'État partie examine l'opportunité d'une telle expansion, de concert avec le gouvernement de la RDP lao.

## 4. INTÉGRITÉ

La Réserve PNNR a été établie en 1986. En 1991, la zone protégée atteignait sa superficie actuelle de 41'132ha, et un plan de gestion a été approuvé. Le résumé de la recherche inclus dans le plan de gestion, s'il est correctement établi, n'en souligne pas moins le manque d'informations sur les caractéristiques naturelles du site désigné.

Le conseil de gestion de la Réserve, chargé de la protection des ressources forestières et de la diversité biologique, a été établi en 1994. La conservation des grottes et la mise à disposition de services touristiques sont du ressort du Conseil du patrimoine et des paysages historiques de Phong Nha. Le personnel de gestion et de protection de la réserve compte 26 personnes. La mission d'évaluation de l'UICN en 1999 a constaté que les grottes étaient bien gérées et a souligné la motivation et l'engagement du personnel de la réserve.

Cependant, l'intégrité du site pose quelques problèmes majeurs :

- Bien que de grands progrès aient été réalisés dans la protection de l'environnement en surface, le terrain accidenté, les difficultés de contrôle, le bas revenu de nombreuses familles locales ainsi que le manque relatif de moyens de contrôle, font que le braconnage et la récolte illicite de bois vont être très difficiles à éliminer. Le personnel fait tout son possible pour rendre la protection de plus en plus stricte, mais cela reste un grand défi.
- L'UICN est particulièrement préoccupée de ce que la route #20 traverse le site, offrant un accès aisé aux zones centrales. Cette route est également utilisée pour déplacer les troupeaux de vaches et autres animaux domestiques, et menace donc gravement l'intégrité du site à plusieurs titres. De plus, il est proposé de rénover cette route, et l'UICN recommande fortement de trouver un itinéraire de contournement de la réserve naturelle; enfin
- Le bassin versant n'est pas pris en considération dans la demande d'inscription, ce qui est préoccupant étant donné que l'intégrité de toute région karstique dépend de la qualité et de la quantité des ressources en eau. Plus globalement, la limite actuelle semble arbitraire et devrait être réexaminée pour assurer une meilleure protection des ressources naturelles.

## 5. AUTRES COMMENTAIRES

Dans la proposition d'inscription, le site est dénommé *La Grotte de Phong Nha*. Cependant, le document concerne l'ensemble de la Réserve naturelle de Phong Nha, et il est évident que c'est là le

site que l'on entend inscrire. La proposition accorde une attention particulière à la diversité biologique de l'environnement en surface, qui pourrait se révéler nettement plus remarquable que les grottes elles-mêmes. C'est pourquoi nous recommandons que le nom du site soit rapidement corrigé pour éviter toute confusion.

La mission de l'UICN a constaté le manque de recherche et de connaissances sur la réserve PNNR. La cartographie topographique est inadéquate, et d'importantes erreurs ont été constatées sur les cartes existantes. Toutes les informations publiées sur cette région, de même que la demande d'inscription elle-même, décrivent un système karstique relativement récent, avec un ensemble de grottes d'une même génération et des caractéristiques géologiques et biologiques relativement simples. Or la mission de l'UICN a découvert que cette région présente un système karstique extrêmement complexe et ancien. En outre, il existe d'importants affleurements de grès, de latérite et de schistes, d'un impact certain tant sur le paysage que sur la faune et la flore de cette région. Aucune carte géologique détaillée n'était disponible.

L'une des indications de ce problème est que les travaux en cours par Timmins *et al.* sont les premiers à recenser l'importante population de chauves-souris. D'autres espèces continuaient à être découvertes pratiquement tous les jours jusqu'à la fin de la mission sur le terrain, ce qui semblerait indiquer qu'il reste beaucoup d'autres espèces à identifier. Plus important encore, nombre des espèces identifiées sont considérées fort rares et méconnues.

## **6. CHAMP D'APPLICATION DES CRITÈRES NATURELS DU PATRIMOINE MONDIAL**

Chacun des quatre critères est traité séparément ci-dessous :

### **Critère (i): Histoire de la Terre et processus géologiques**

La demande le cite comme l'un des critères d'inscription, mais sans preuves tangibles à l'appui. Inspection faite, il est désormais évident que la description de la région qui est faite dans la demande est simplifiée à outrance; l'évolution du paysage et des grottes est discontinue et complexe. Contrairement aux autres régions karstiques du Viet Nam, généralement constituées de piliers de calcaire, Phong Nha correspond plutôt à une partie d'un plateau plus étendu qui englobe également les zones karstiques de Ke Bang et de Hin Namno. Plus important encore, le dépôt calcaire n'est pas continu: on constate une interstratification complexe avec des schistes et des grès. Avec la chape de schistes et de granits apparents, qui recouvrait probablement le calcaire est s'est érodée pour n'être plus qu'un affleurement, tout cela donne une topographie très particulière.

Les grottes elles-mêmes témoignent d'événements qui se sont produits en épisodes distincts et séquentiels et qui ont laissé divers étages fossilifères, parfois très élevés (l'un d'eux est même près du sommet du plateau); elles présentent un paléokarst anciennement recouvert et maintenant à l'air libre (karst de périodes de solution antérieures, peut-être très anciennes), des preuves d'importants changements de direction des cours d'eau souterrains, de changement du régime de solution; elles témoignent enfin de dépôts, puis de la re-solution de spéléothèmes géants et autres caractéristiques inhabituelles comme des stromatolites (spéléothèmes formés par l'interaction entre une algue bleu-vert et un dépôt de carbonate de chaux). En particulier, la situation et la forme des grottes semble indiquer qu'elles doivent probablement beaucoup de leur taille et de leur morphologie à une intervention encore inconnue des couches de schiste et de granit qui recouvrent le calcaire; si c'est bien le cas, il s'agit là d'une caractéristique inhabituelle en elle-même. Dans les grottes, l'on trouve également des couches redistribuées de sable schisteux et de gravier granitique.

La surface présente un contraste saisissant de paysages allant de chaînes de montagne très découpées, à des plateaux, et à un énorme polje (vallée à fond plat entourée de rochers). Il peut s'agir d'une formation solutionnelle ou tectonique mais, étant donné ce que l'on sait de l'histoire géologique de la région, cela semblerait indiquer que le système karstique est ancien et relativement mature. Il y a des

preuves d'au moins une période d'activité hydrothermique dans l'évolution du karst. Le plateau est probablement l'un des plus beaux et plus singuliers exemples de formation karstique complexe en Asie du sud-est et, comme mentionné plus haut, il a plus de points communs avec le karst de Skocjan en Slovénie qu'avec la plupart des autres paysages karstiques d'Asie.

En résumé, le site présente suprenamment de nombreux témoins de l'histoire de la Terre. Sans poursuivre les recherches, il est impossible d'évaluer correctement l'importance scientifique de ce site. Cependant, il s'agit potentiellement d'un site d'une importance considérable pour améliorer nos connaissances de l'histoire géologique, géomorphique et géochronologique de la région. C'est là la priorité no. 1 pour toute recherche future. Selon l'UICN, ce site pourrait potentiellement répondre au critère (i), cependant son importance pour le patrimoine mondial en serait renforcée si le site désigné pouvait être relié à la réserve karstique de Hin Namno au Laos.

#### **Critère (ii): Processus écologiques**

La désignation ne justifie pas l'inscription du site sous ce critère mais, étant donné que le site n'est pas bien documenté, il est de toute façon impossible à ce stade de motiver son inscription à ce titre.

#### **Critère (iii): Phénomènes naturels ou beauté naturelle exceptionnels**

Phong Nha présente indéniablement un ensemble de grottes de grande dimension et spectaculaires, et revêt sans aucun doute une importance capitale à l'échelon national. Cependant, certains chiffres relatifs à la taille des grottes dans la demande d'inscription sont erronés; même s'ils étaient justes, la taille seule ne justifie pas l'inscription. Comme déjà mentionné plus haut, même à l'échelon régional, compte tenu des connaissances actuelles, Phong Nha ne peut rivaliser de taille et autres caractéristiques avec d'autres grottes de la région.

Mais si l'on considère l'ensemble du site, la Réserve naturelle est un exemple exceptionnel de karst mature. L'UICN n'a pu identifier d'autres sites exactement comparables en Asie du sud-est. La topographie saisissante du plateau découpé, les sources et les rivières, la qualité croissante de la forêt et l'exceptionnelle beauté des grottes, éléments qui procèdent tous de la complexité géomorphique et géologique du site, en font un site d'importance régionale. Selon l'UICN, ce site n'a pas les caractéristiques exceptionnelles nécessaires pour justifier son inscription conformément au critère (iii).

#### **Critère (iv): Diversité biologique et espèces menacées**

La demande d'inscription présente des exemples rares de haute forêt de plaine, qui a presque entièrement disparu des autres pays de la région.

Bien que la connaissance de cette région demeure limitée, le nombre même des espèces identifiées est comparable avec d'autres forêts humides du sud-est asiatique; d'ailleurs les régions mieux documentées affichent une diversité biologique encore plus grande. Cependant, des données plus récentes (récoltées par Timmins et al., en préparation) traitent de façon bien plus détaillée la faune et son statut, particulièrement en ce qui concerne les mammifères et les oiseaux. Cela démontre bien l'avantage de poursuivre et d'intensifier les recherches. L'un des problèmes est que ce rapport inclut également la zone de Ke Bang, ce qui rend difficile une analyse comparative; mais les chauves-souris et nombre des grands mammifères se moquent des frontières fixées par l'homme, si bien que nombre des espèces identifiées se retrouvent probablement bien à Phong Nha. L'étendue des espèces menacées, selon les connaissances actuelles, est détaillée dans le tableau ci-dessous.

	Répertoriées dans la demande d'inscription	Autres espèces répertoriées par Timmins <i>et al</i>	Totalité des espèces recensées
Mammifères (à l'exception des chauves-souris)	26	4	30
Chauves-souris	-	11	11
Oiseaux	12	10	22
Reptiles et amphibiens	11	-	11

**Tableau 1** – Espèces figurant sur les Listes rouges comme étant vulnérables, rares, menacées ou gravement menacées, ou rares à d'autres titres (donc considérées comme insuffisamment documentées)

Ainsi, le site désigné (et les zones voisines) abrite au moins 73 espèces importantes, dont nombre sont endémiques du massif calcaire dont Phong Nha fait partie. En particulier, ce site comprend toute la population mondiale de langurs de François. Cependant, la Réserve naturelle est trop petite pour assurer de façon adéquate la protection de la diversité biologique, particulièrement des plus grandes espèces comme le tigre, de sorte que les mesures visant à établir un Parc national plus étendu, comprenant les zones de Phong Nha et de Ke Bang, doivent être considérées comme prioritaires. De même, la proposition d'une intégration frontalière avec la réserve karstique de Hin Namno au Laos, qui regroupera l'ensemble du plateau calcaire, est vitale et urgente.

L'UICN estime qu'à lui seul, le site désigné ne répond pas au critère (iv) pour inscription au patrimoine mondial. Cependant, si ce site devait inclure un Parc national agrandi regroupant Phong Nha et Ke Bang, le nouveau site aurait un large potentiel pour inscription au patrimoine mondial conformément au critère (iv). L'adjonction de la réserve karstique de Hin Namno et d'autres zones remarquables en RDP lao, améliorerait également considérablement les chances de cette région de figurer au patrimoine mondial.

## 7. RECOMMANDATION DE LA VINGT-TROISIÈME SESSION ORDINAIRE DU BUREAU: JUILLET 1999

À sa vingt-troisième session ordinaire, le Bureau a noté que le site proposé pour inscription a une valeur potentielle de site du patrimoine mondial sur la base des critères naturels (i) et (iv), à condition qu'il soit élargi pour comprendre les sites de Phong Nha et du Parc national de Ke Bang, avec une structure de gestion pleinement intégrée. Le Bureau a décidé de **différer** sa décision sur le site en attendant une étude des possibilités d'en élargir les limites comme proposé. Il est également fortement recommandé que des discussions aient lieu avec l'État partie de la République démocratique populaire lao dans le but d'élargir encore, par la suite, les limites du site à la réserve karstique de Hin Namno, en République démocratique populaire lao et à d'autres aires concernées.

Le 4 septembre, la Commission nationale du Viet Nam pour l'UNESCO a avisé le Centre du patrimoine mondial de l'intention de l'État partie d'agrandir le site proposé pour inscription afin d'y inclure le Parc national de Phong Nha-Ke Bang et d'établir une structure de gestion totalement intégrée pour le site.

Carte 1 : Localisation du Site



Carte 2: Détail du Site

