World Heritage Scanned Nomination

File Name: 1090.pdf **UNESCO Region:** EUROPE AND NORTH AMERICA

SITE NAME: **Monte San Giorgio**

DATE OF INSCRIPTION: 5th July 2003

STATE PARTY: SWITZERLAND

CRITERIA: N (i)

DECISION OF THE WORLD HERITAGE COMMITTEE:
Excerpt from the Report of the 27th Session of the World Heritage Committee

Criterion (i): Monte San Giorgio is the single best known record of marine life in the Triassic period, and records important remains of life on land as well. The site has produced diverse and numerous fossils, many of which show exceptional completeness and detailed preservation. The long history of study of the site, and the disciplined management of the resource have created a well documented and catalogued body of specimens of exceptional quality, and are the basis for a rich associated geological literature. As a result Monte San Giorgio provides the principal point of reference, relevant to future discoveries of marine Triassic remains throughout the world.

BRIEF DESCRIPTIONS

The pyramid-shaped, wooded mountain (1,096 m above sea level), to the south of Lake Lugano in Canton Ticino is regarded as the best fossil record of marine life from the Triassic Period (245–230 million years ago). The sequence records life in a tropical lagoon environment, sheltered and partially separated from the open sea by an offshore reef. Diverse marine life flourished within this lagoon, including reptiles, fish, bivalves, ammonites, echinoderms and crustaceans. Because the lagoon was near to land, the fossil remains also include some land-based fossils including reptiles, insects and plants. The result is a fossil resource of great richness.

1.b State, Province or Region: Canton of Ticino

1.d Exact location: N45 55 00.0 E8 57 00.0

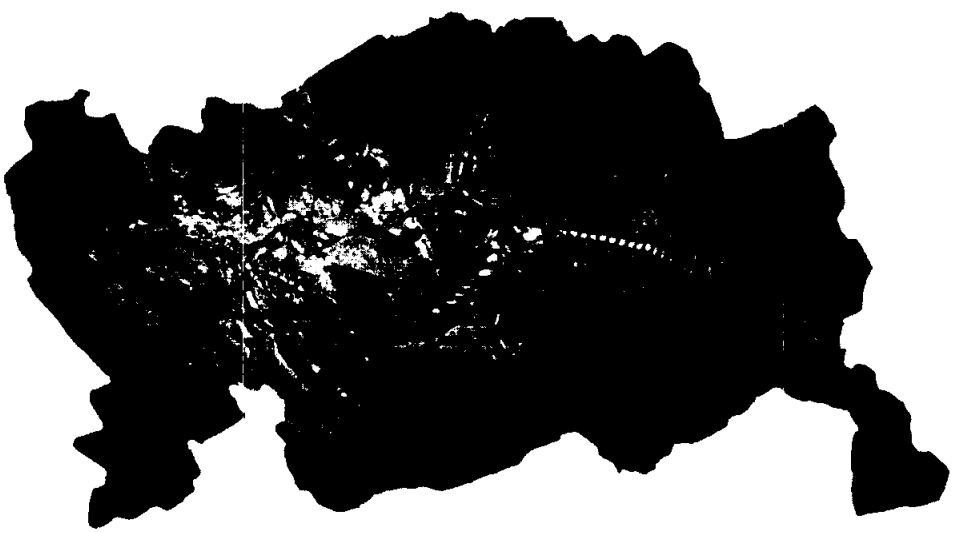
NOMINATION

of

MONTE SAN GIORGIO

for

INCLUSION on the WORLD HERITAGE LIST



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Front page: Ceresiosaurus calcagnii (Meride, Monte San Giorgio) (Photograph: Pal. Inst. Univ. Zurich)

SAEFL
15th January 2002/Kü

CONTENTS

NOMINATION of

Monte San Giorgio

for INCLUSION on the WORLD HERITAGE LIST

1. Identification of the Property

a. Country

Switzerland

b. State

Canton of Ticino

c. Name of property

Monte San Giorgio.

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

Monte San Giorgio separates the two southern branches of Lake Lugano. The mountain is pyramid-shaped, rising from the level of the lake (271 m above sea level) to an altitude of 1,096.7 m above sea level at the summit. The northern slope is relatively steep, while the southern slope, in conformity with its geological formations, dips gently towards the Po Valley.

The reference co-ordinate (lat. 45° 55', long. 8° 57') is located in the centre of the protection area.

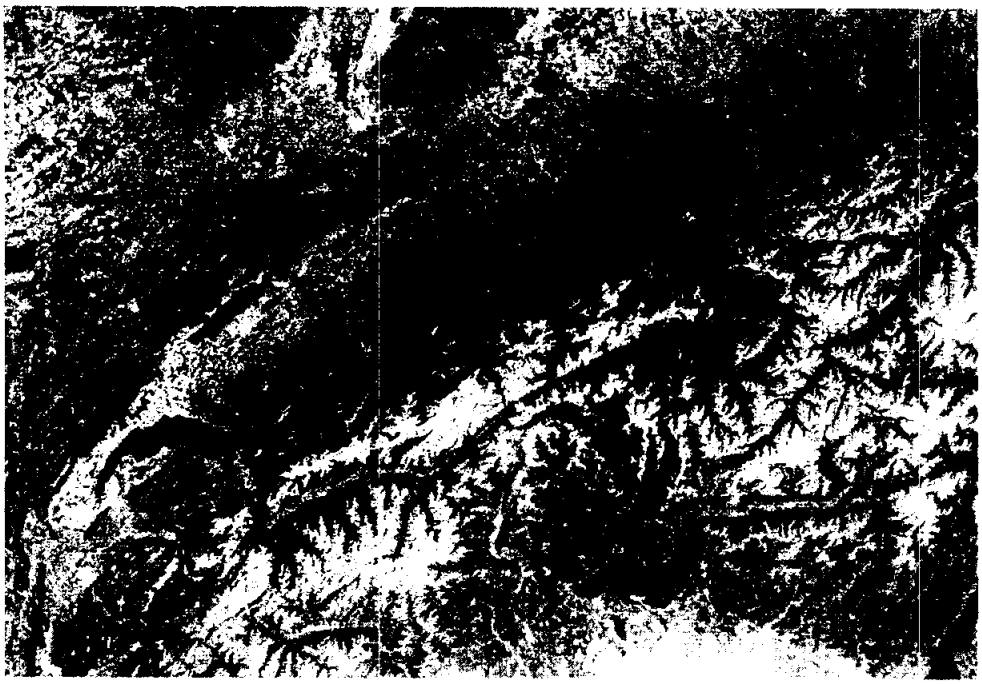

Fig. 1: Location of Monte San Giorgio

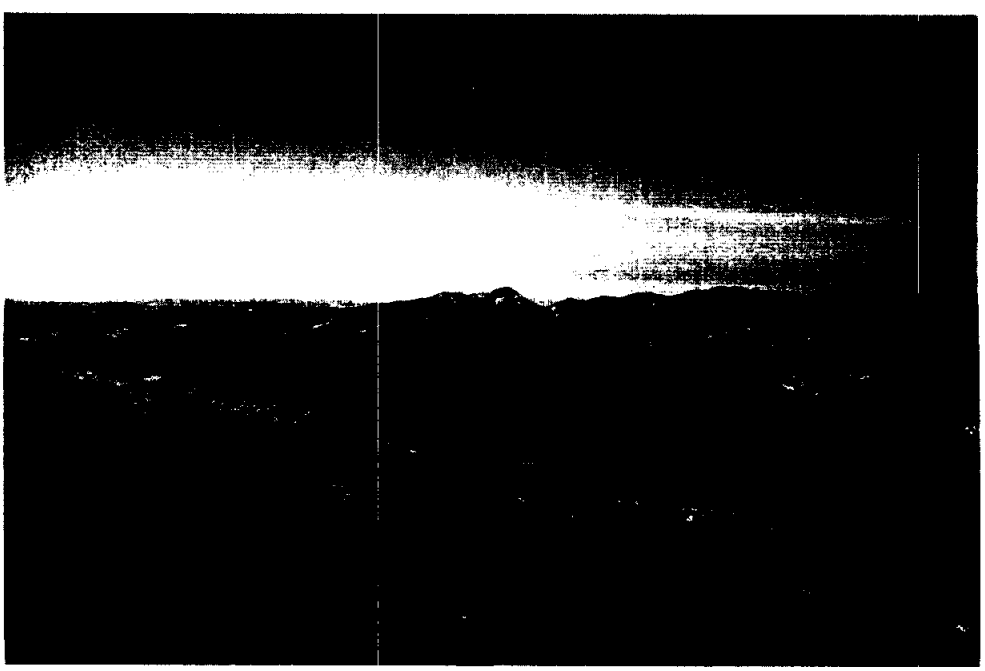

Fig. 2: Panoramic view of Monte San Giorgio (Photograph: M. FELBER)

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

Figure 3 (p. 4) shows the extent of the proposed **protection area** (coloured red) and the **buffer zone** (coloured green).

The limits of the protection area are defined in accordance with the fossil formations of the Middle Triassic Period. The buffer zone is more generally based on the stratigraphic series of Monte San Giorgio (Fig. 4, p. 5), which also includes older geological features (Permian and Pre-Carboniferous) and more recent geological formations (Jurassic).

f. Area of property proposed for inscription (ha.) and proposed buffer zone (ha.)

The total area of the site is 2,238 hectares, of which 849 hectares (38%) come within the protection area and 1,389 hectares (62%) form the buffer zone.

Area di protezione (area delle formazioni triassiche)
Zona tampone

SBMA, dicembre 2001

Fig. 3: Extent of the site proposed for registration (protection area red and buffer zone green), scale 34'000

LEGENDA

QUATERNARIO

Olocene	Unità postglaciale: depositi lacustri e fluviali, detrito di versante e colluvio, sui versanti frequentemente di scarso spessore (colore a barre), a copertura di unità precedenti o substrato subaffiorante
Pleistocene sup.	Allofomazione di Cantù: depositi glaciali, fluvio-glaciali e glacio-lacustri, frequentemente coperto da depositi dell'Unità postglaciale (colore a barre)
Pleistocene medio-sup.	Allogruppo di Besnate: depositi glaciali (prevalenti) e fluviali, spesso di scarso spessore (colore a barre)
Pleistocene sup. - Pliocene sup.	Conglomerato di Mendrisio: depositi fluviali e fluvio-glaciali
Pleistocene sup. - Pliocene sup.	Allogruppo della Colma: depositi glaciali (prevalenti) e fluviali

GIURASSICO

Dogger - Liassico sup.	Radiolariti, Rosso ad Aptici, Rosso Ammonitico lombardo indifferenziati
Liassico	Breccia "*Macchia vecchia*", Calcare di Besazio, *Strati di Saltrio* e calcare del "*Broccatello*" indifferenziati

TRIASSICO

Retico	Calcari e dolomie in parte marnose, in parte oolitiche
Norico	Dolomia Principale
Carnico	Marne del Pizzella (o Strati di Raibl)
Ladinico Anisico	Calcare di Meride e Dolomia dell'Albiga indifferenziati Zona Limite Bituminosa (o Formazione di Besano)
Scitico (?)-Anisico	Formazione di Bellano (o Servino)

PERMIANO

	Vulcaniti indifferenziate (andesiti e riolitì), frequentemente coperte da depositi quaternari (colore a barre)

Faglia

Faglia presunta

Fig. 4: Geological map of Monte San Giorgio (Source: FELBER et al 2000), scale 1:25'000

2. Justification for Inscription

a. Statement of significance

Monte San Giorgio is one of the most important fossil-bearing areas in the world, particularly as regards its palaeontological heritage from the Middle Triassic Period (approximately 245 to 230 million years ago). The outstanding value of the fossils contained in the Middle Triassic carbonate formations of this mountain is determined by the following factors:

- ***Palaeontological diversity**:* scientific excavations have brought to light **more than 10,000 fossil specimens** (Fig. 11), mostly complete, including the fossils of:
  - approximately **thirty species of marine and land-based reptiles**,
  - approximately **eighty different species of fish**,
  - **hundreds of species of invertebrates** (bivalves, ammonites, echinoderms, crustaceans, insects, etc.), and
  - **many plant species**.

A large proportion of the fossils are perfectly preserved, many are large in size (up to 7 metres long) and, because they are of considerable aesthetic value, are displayed, mainly in the form of casts, in museums all round the world.

- ***Rare and even unique specimens:*** many vertebrate and invertebrate fossils have been found for the first time and/or exclusively in the rocks of Monte San Giorgio. They are therefore **unique discoveries**. The attribution of scientific names based on toponyms in the Monte San Giorgio area confirms this fact. Examples are: *Ceresiosaurus*, *Serpianosaurus, Ticinosuchus*, *Meridensia meridensis*, *Ticinepo mis*, *Neusticosaurus serpianensis, Luganoia, Tintorina meridensis, Sangiorgio saurus,* etc.

- ***An abundance of "fauna":*** one of the most significant aspects of Monte San Giorgio's palaeontological heritage is undoubtedly the presence of a **continuous sedimentary succession** in the Middle Triassic documenting a geological history of about 15 million years. Unlike other palaeontological deposits of international importance – which usually have just one fossil level attributable to a particular moment in geological history – **Monte San Giorgio has at least five quite distinct, superimposed fossil levels.** This makes it possible to carry out evolutionary studies, over several million years, of particular groups of organisms in the same environment (Fig. 10). Marine reptiles, fish and some invertebrates

(e.g. ammonites and the bivalve *Daonella*) have been the subject of specific studies in this field.

- ***Geology:*** the Middle Triassic fossil-bearing formations of Monte San Giorgio are **a key component in the longer geological history of the Southern Alpine Series (Sudalpino)** (Fig. 7), comprising rocks which extend from approximately 350 million years ago to the present day. The best-known localities, situated in a very restricted area around Monte San Giorgio, or on the mountain itself, include:
  - the Carboniferous formations of Manno,
  - the Permian formations of Arosio-Mugena and the base of Monte San Giorgio itself,
  - the other Lower, Middle and Upper Triassic formations in the Lugano area and on Monte San Giorgio itself,
  - the Jurassic series of the Tremona-Arzo-Besazio-Rancate area, which all falls within the buffer zone around the fossil-bearing levels (Fig. 4) of Monte San Giorgio,
  - the contemporaneous formations of Monte Generoso and the Gole della Breggia (Castel San Pietro, Balerna, Morbio superiore and Morbio inferiore),
  - the latter locality also includes Cretaceous and Tertiary rocks,
  - the Pliocene formations of Castel di Sotto (Novazzano),
  - recent glacial and fluvial deposits of the Quaternary period.

These unusual features of Monte San Giorgio, complementing as they do the Middle Triassic fossil-bearing deposits, are a **significant bonus** from both a scientific and an educational point of view. This is reflected in the proposal that a buffer zone will be established around the protection area in order to set the Middle Triassic features in a broader geological environment.

- ***State of conservation of the fossils:*** as a result of the fossilisation processes involved, the palaeontological specimens are **exceptionally well preserved**, especially in terms of the completeness of the skeletons and fossil remains generally, and of the details of their morphological characteristics.
- ***Protection of the deposits in the past:*** Unlike other fossil-bearing sites, palaeontological research on Monte San Giorgio has always been the exclusive preserve of the Palaeontological Institute and Museum of the University of Zurich, the Department of Earth Sciences of the University of Milan, and the Milan Museum of Natural History. For this reason, the scientific world is in possession of

a complete, well-preserved, catalogued and studied palaeontological heritage, not scattered among private collections.

- ***Scientific studies:*** Monte San Giorgio is **one of the most thoroughly studied palaeontological sites in the world**. Over the last 150 years, it has been the subject of some 800 scientific and more popular publications on palaeontological, geological and geomineral topics (see Appendix **A**), including no less than **360 scientific books and papers devoted to its fossil heritage**. As well as these, there have been many texts of a more popular character, about the history of mining activity and quarrying.

- ***Relationship between human settlement and territory:*** the fossil-bearing formations of Monte San Giorgio have **close links with the life of the local people**:

  - in the past, the bituminous shales of the area were mined for the extraction of Ichthyol; there was also quarrying (for the production of gypsum peat and lime) and cutting of ornamental stone (Arzo "marble", Broccatello, etc.);
  - nowadays, the local population is fully involved in the preservation and management of its palaeontological heritage (Meride Fossil Museum, other fossil museums on the Italian side, publications, ad hoc municipal committees, work groups, etc.).

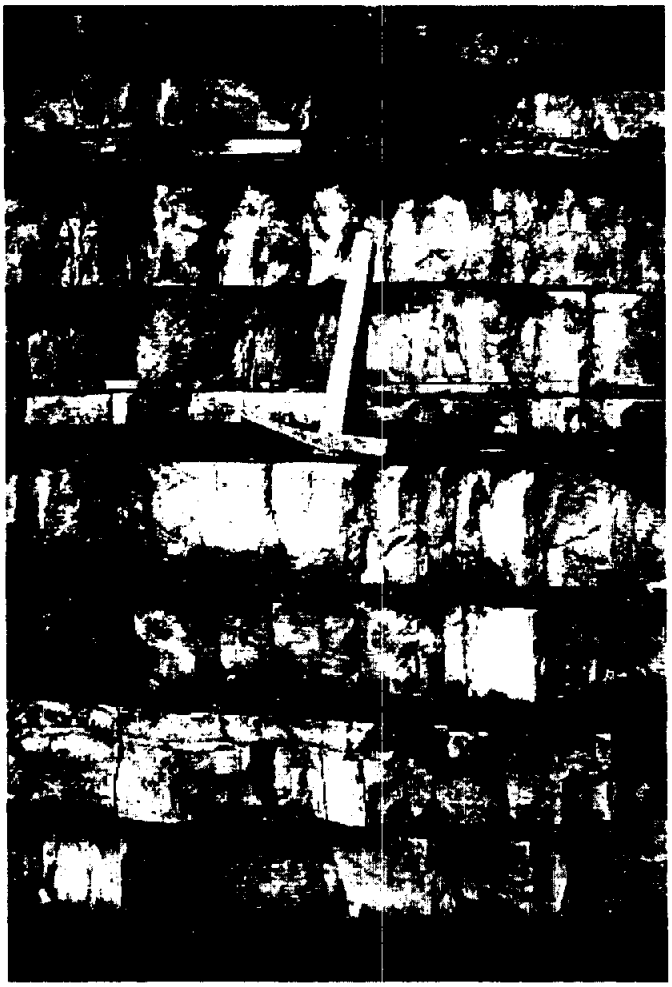

Fig. 5: Layers of dolomite alternating with bands of bituminous shale (Point 902, Monte San Giorgio) (Photograph: Pal. Inst. Univ. Zurich)

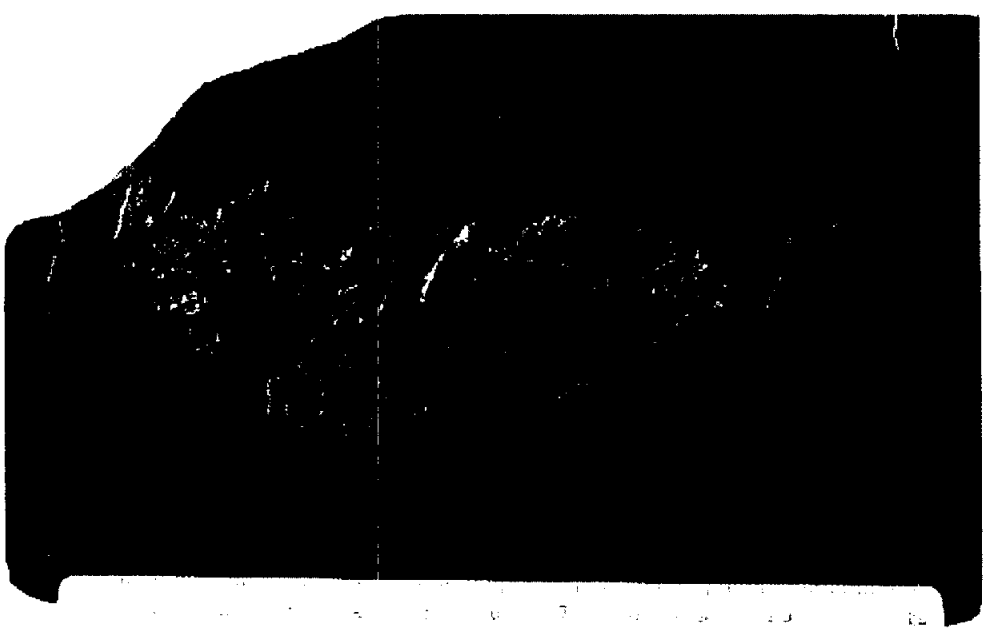

Fig. 6: Perleidus altolepis (Val Mara, Meride, Monte San Giorgio) (Photograph Dept. Earth Sc., Univ. Milan)

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

The Triassic palaeontological heritage of Monte San Giorgio **is unique**; a comparative analysis with other identical or similar sites is therefore not possible. The state of conservation, research history and number of publications relating to a single fossil-bearing site; the dimensions, rarity and variety of the fossil remains (in particular the fish, marine and land-based reptiles); and the number of fossil levels have no parallel elsewhere. The Permo-Jurassic setting is an additional factor in the uniqueness of Monte San Giorgio.

There are, of course, other internationally renowned Triassic fossil-bearing sites in other parts of Europe and the rest of the world. These include the "Muschelkalk formation" in Germany, the "Otter Formation" in England, Middle Triassic formations in France, Spain and Turkey, South Africa and Angola, the "Ischigualasto-Talampaya Formation" in Argentina, and the "Gosford Formation" in Australia. However, the fossils found in these places do not bear comparison with those of Monte San Giorgio, because they are fragmentary, less diverse, less numerous and in a poor state of preservation.

In particular, Monte San Giorgio has taken on a new and special significance with the recent discovery in Guizhou Province (Southern China) of marine reptiles similar to those found at the Swiss site. Phylogenetic, palaeoclimatic, palaeo-ecological and palaeobiogeographical comparisons of the fauna of the two sites could be of vital importance in reconstructing the palaeogeographic conditions of the Tethys Sea. This gives Monte San Giorgio an **important role as the point of reference for Middle Triassic marine fauna**.

Monte San Giorgio has already been granted recognition as **one of the world's five or six principal Fossil Lagerstätten** (fossil bonanzas). It is therefore comparable, to the Jurassic palaeontological sites of Holzmaden (D) and Solnhofen (D), and the Tertiary sites of Green River (USA), Monte Bolca (I) and Messel (D). The last of these already features on UNESCO's WHL as a palaeontological site exemplifying the evolution of mammals during the Eocene Period, between 57 and 36 million years ago.

A wide spectrum of scientific opinion bears witness to the international importance and uniqueness of the Monte San Giorgio fossil-bearing deposits (see Appendix **O**).

c. Authenticity/integrity

Monte San Giorgio is a mountainous pyramid in which geological formations from the Permian to the Jurassic periods – including Triassic formations (Fig. 4) – are more or less regularly superimposed. The fossil-bearing Triassic sediments are roughly 1000 meters thick and occupy the central part of the stratigraphic succession (Fig. 7). The rocks of the five fossil-bearing levels of Monte San Giorgio are listed below, from old to young:

- the "Grenzbitumenzone" (or Besano Formation),
- the Cava Inferiore (lower quarry) beds,
- the Cava Superiore (upper quarry) beds,
- the Cassina beds, and
- the "Kalkschieferzone"

150 years of scientific research have resulted in detailed mapping of the various strata and their contours, in particular the extent of the fossil-bearing levels. However, further discoveries have been made in recent times as a result of a more systematic, modern and global approach involving different disciplines and using new investigatory techniques, such as geo-chemistry, sedimentology, taphonomic and microfacies analysis, etc.

Disciplined management of scientific excavations, co-ordination in the preparation and study of the palaeontological specimens discovered (also see chapters **2.a.** and **3.e.**) and on-going collaboration between the university institutes and the regional, cantonal and local authorities concerned provide an absolute guarantee that the outcrops will be adequately preserved and protected in the future.

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

Monte San Giorgio's application to be included in UNESCO's world natural heritage list fulfils the criteria set out in the *"Operational Guidelines for the Implementation of the World Heritage Convention"*. In particular, the Triassic fossil-bearing formations of Monte San Giorgio qualify as assets and objects of universal value because they are eminently representative of great events in the Earth's history, providing evidence, among other things, of the development of life on Earth and geological processes [*4a (i)*].

Monte San Giorgio fulfils the relevant conditions of integrity because the Triassic fossil-bearing formations represent

- a continuous succession within the geological period in question and are part of a wider succession and geological context,
- they are the subject of careful planning, and
- they are subject to clear legal regulation.

3. Description

a. Description of property

GEOLOGY

The Middle Triassic fossil-bearing succession of Monte San Giorgio needs to be considered and "read" in the context of the history of the Southern Alps, which – along an axis of about 30 km from Lugano to Chiasso – includes significant geological events occurring between the Carboniferous period and the present.

Taken in this context, the Triassic carbonate formations of Monte San Giorgio occupy a place between the volcanic rocks (andesites and rhyolites) of the Permian period (exposed on the northern slope of the mountain) and the Jurassic rocks of the Arzo-Tremona-Besazio-Rancate area.

More particularly, the Triassic formations display a great wealth of lithological features: continuous changes in the conditions of sedimentation, due to successive phases of transgression and regression and the formation of different environments, have resulted, at different periods, in the deposition of rocks of various kinds:

- conglomerates and sandstones belonging to the Scythian-Anisian stages (Bellano or Servino Formation),
- reef limestones, dolomites and bituminous shales belonging to the Anisian and Ladinian stages [Salvatore Dolomite, "Grenzbitumenzone" or Besano Formation, San Giorgio Dolomite, Cava inferiore beds, Cava superiore beds, Cassina beds, Meride limestone and "Kalkschieferzone"],
- marls, limestones and gypsum (Pizzella marls or Raibl beds),
- massive dolomites belonging to the Norian stage (Principale Dolomite) and, finally,
- more or less dolomitised oolitic limestones belonging to the Rhaetian stage (Tremona beds).

These sedimentary formations are superimposed one on the other, from North to South, forming a Triassic rock complex more than 1000 m thick.

The present inclination of the beds at Monte San Giorgio is due to the Alpine orogeny. The mountain now appears as a dip slope with beds emerging in a south/south-westerly direction. It disappears, in the region of Rancate-Ligornetto-Stabio, under sediments of the Tertiary period and the even thicker Quaternary deposits of the Po Valley.

Fuller details of the geology of Monte San Giorgio can be found in the publications of KUHN-SCHNYDER (1963), BERNOULLI AND WIEDENMAYER (1967), KÄLIN and TRÜMPY (1977), the CANTONAL MUSEUM OF NATURAL HISTORY (1990) and in FELBER et al. (2000).

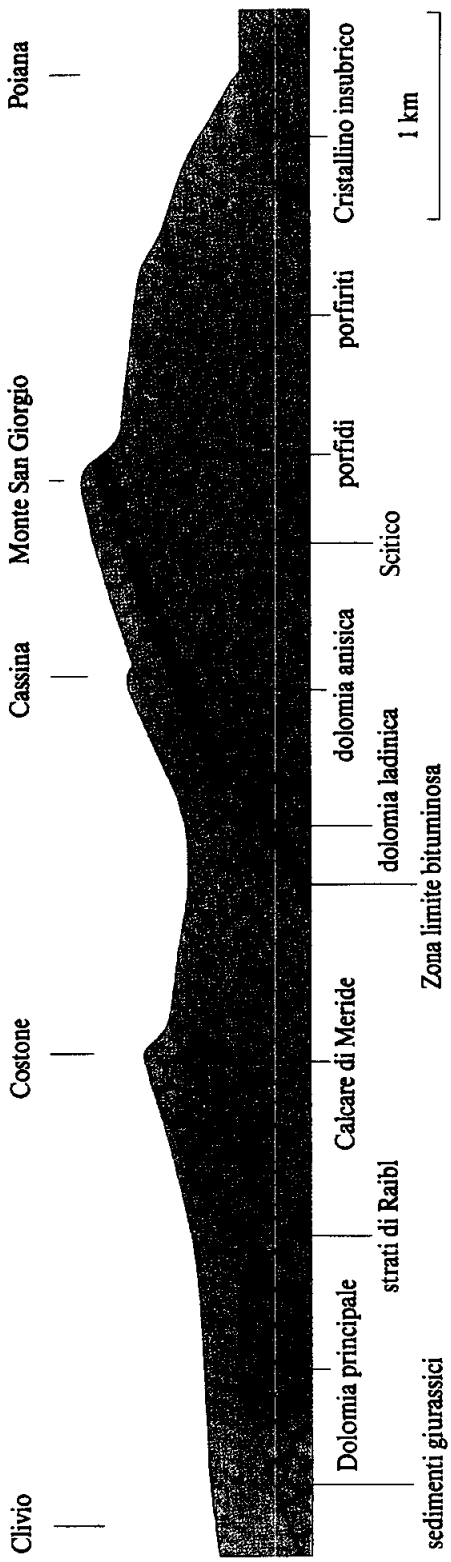

Fig. 7: Geological section of Monte San Giorgio (from KUHN-SCHNYDER 1963, mod.).

PALAEONTOLOGY

The Middle Triassic formations of Monte San Giorgio consist of 5 different fossil-bearing levels, superimposed one on another (see chapters **2.a.**, **2.c.** and Fig. 10).

The best-known horizons are those of "Grenzbitumenzone" (or Besano Formation), which was the first to be studied (as early as 1800), and was exploited industrially for the production of Ichthyol during the second half of the 19th century and, more intensively, in the first half of the 20th century. Most of the spectacular palaeontological discoveries have been made in the "Grenzbitumenzone", which has yielded the largest and most visually attractive specimens. The specimens found in the four younger horizons as the Cava inferiore, Cava superiore, Cassina beds and the "Kalkschieferzone" have been less spectacular but are nevertheless of great scientific interest (mainly fish and small reptiles including embryos, but also insects).

The first scientific treatise on the fossil vertebrates of the San Giorgio area was published in 1847 by GIULIO CURIONI, who was special interested in fish. Since that time, almost 800 publications have appeared dealing with the wealth of vertebrate and invertebrate fossil fauna to be found in the locality (see appended bibliography).

The most interesting discoveries occurred later, following excavations undertaken in the Besano area by the Italian Society of Natural Sciences and the Milan Civic Museum in 1863, under the direction of ANTONIO STOPPANI, and an 1878 campaign in the same area, funded largely by the Milan Civic Museum and led by EMILIO CORNALIA. These campaigns resulted in the recovery of the remains of various ichthyosaurs, many fish, ammonites and bivalves. The Besano ammonoids were studied in 1882 by E. MOJSISOVICS. In 1886, BASSANI described two new reptiles *Ichthyosaurus cornalianus,* now called *Mixosaurus cornalianus,* and *Tanystropheus longobardicus.*

Fig. 8: Scientific excavation at Point 902, c. 1960 (Monte San Giorgio), *(Photograph: Pal. Inst. Univ. Zurich)*

			Middle-Triassic fossil-bearing levels of Monte San Giorgio				
				Meride limestones			
Excavation site	**Research institute**	**Period**	**"Grenzbitu-menzone"**	**Cava Inferiore beds**	**Cava Superiore beds**	**Cassina beds**	**"Kalkschiefer-zone"**
Besnasca/Ca' del Frate)	DISTMI	1990-1999					x
Rio Ponticelli sopra Besano	MSNMI	1975-1984	x				
Selva Bella mine at Besano	MSNMI	1930s	x				
Besano-Rio Vallone	MSNMI	1863, 1878	x				
Sasso Caldo sopra Porto Ceresio	MSNMI	In progress since 1985	x				
Crocifisso-Acqua ferruginosa	PIMUZ	1936-1938		x			
Crocifisso-Road to Serpiano	PIMUZ	?				x	
Serpiano-Tre Fontane mine	PIMUZ	1924, 1927	x				
Valle Stelle	PIMUZ	1983-1989	x				
Monte San Giorgio-Point 902/Mirigioli	PIMUZ	1950-1968	x				
Val Porina mine	PIMUZ	1924, 1925, 1929-1933	x				
Bassa Val Porina	PIMUZ	1930, 1941		x			
Cassina	PIMUZ	1933, 1937, 1971-1973, 1975					
Val Serrata-Don Luigi	PIMUZ	1930	x	x			
Val Serrata-Cassinello	PIMUZ	1938	x	x			
Val Serrata-Bögia	PIMUZ	1927, 1935, 1976				x	
Crocifisso-Acqua del Ghiffo 1, lower quarry	PIMUZ*	1927 1995-1996*		x			
Crocifisso-Acqua del Ghiffo 2, upper quarry	PIMUZ*	1928 1997-2001*			x		
Val Mara (Roggio I)	PIMUZ*	1994					x
Val Mara (Roggio II)	PIMUZ*	1994					x
Val Mara (Roggio III)	PIMUZ*	1971, 1994*					x
Meride-Val Mara (sup.)	DISTMI*	1996-2001					x

* in collaboration with the MCSNLU

MSNMI Museo civico di storia naturale di Milano (Milan Civic Museum of Natural History)
PIMUZ Palaeontological Institute and Museum of the University of Zurich
DISTMI Dipartimento di Scienze della Terra dell'Università di Milano (Department of Earth Sciences, University of Milan)
MCSNLU Museo cantonale di storia naturale di Lugano (Cantonal Museum of Natural History, Lugano)

Fig. 9: List of fossil-bearing localities on Monte San Giorgio, subdivided by excavation site [Data reprocessed; source: GENTILINI in FELBER et al., 2000, and PIMUZ (FURRER and RIEBER, unpublished)]

This work was followed by several geological and palaeontological studies, mainly by researchers from Northern Italy: REPOSSI and TARAMELLI (1902), DE ALESSANDRI (1910, 1913), AIRAGHI (1912, 1915). Exploitation of bituminous shales at the Tre Fontane mine, begun in 1907, brought to light further fossil remains of marine saurians, fish and molluscs.

Unfortunately, all this fossil material was lost in the destruction of the Milan Museum of Natural History, which was bombed in 1943. All that was saved of these historical collections were a few specimens that had fortunately been loaned for study purposes to the Zurich Museum.

On the Swiss side, as part of the 1919 annual conference of the Swiss Society of Natural Sciences, a visit was organised to the Ichthyol production plant at the Spinirolo factory. To their amazement, the visitors saw that the bituminous material ready for processing contained some very interesting fossil remains. This triggered a series of research and excavation campaigns, undertaken by BERNHARD PEYER from the University of Zurich, to investigate the outcrops of the "Grenzbitumenzone" on Swiss territory and the bituminous levels of the Meride Limestone formation. These have continued from 1924 to the present day, with more than 50 excavation campaigns undertaken at twenty or so different sites.

On the Italian-facing slope of Monte San Giorgio, the Milan Civic Museum began a new phase of palaeontological research at Besano in the 1950s, and subsequently at Rio Ponticelli (1974) and Sasso Caldo (1985), while the Department of Earth Sciences of the University of Milan began investigating the Ca' del Frate deposit (Viggiù) in the 1980s.

The palaeontologist BERNHARD PEYER from the University of Zurich was the first person to undertake research in the area of Serpiano and Meride. In 1924, he discovered a specimen of *Cyamodus hildegardis* (Placodontia) and several complete *Mixosaurus* (Ichthyosauria) skeletons at Valporina, within the "Grenzbitumenzone". In the same year, a 4-meter long skeleton of *Paranothosaurus amsleri* (Sauropterygia) was found at the Tre Fontane ("Grenzbitumenzone"). Later, in 1927, PEYER found another ichthyosaur, 2.5 metres in length at the Tre Fontane ("Grenzbitumenzone"), and in 1933 the same mine yielded a "long-necked saurian", *Tanystropheus longobardicus* (Protorosauria), 4.2 meters in length. 1933 also saw the sensational discovery of a land-based saurian, *Ticinosuchus ferox* (Thecodontia) at Valporina ("Grenzbitumenzone") and a specimen of *Ceresiosaurus calcagnii* (Sauropterygia),

2.3 metres in length, at the Cassina site (lower levels of the Meride Limestone). In 1936, a complete specimen of *Paraplacodus broilii* (Placodontia) was dug from the Tre Fontane mine ("Grenzbitumenzone") and, the following year, a skeleton of *Askeptosaurus italicus* (Thalattosauria) was discovered at the same site.

Excavations at the Mirigioli site, also known as Point 902 (or simply P. 902), were begun in 1950, with annual campaigns continuing until 1968 under the leadership of EMIL KUHN-SCHNYDER. Over an area of 240 m^2, some thirty fossil-bearing bituminous levels alternating with dolomite were studied, to a total depth of approximately 16 metres. These yielded an extraordinary quantity and variety of specimens. For instance, in stratum n. 113, which was 8.5 cm thick, the researchers discovered 62 *Mixosaurus* skeletons, about eighty small bony fish and some larger ones, such as *Saurichthys, Colobodus*, *Birgeria* and remains of coelacanths (Crossopterygii). The most interesting fossil reptiles have been studied by WILD (1974), RIEPPEL (1989), SANDER (1989) BRINKMANN (1998), fish by SCHWARZ (1970), RIEPPEL (1981), BÜRGIN (1992) and MUTTER (1999).

In other beds, many bivalves of the genus *Daonella* genus (attributed to seven species) were discovered, showing how they had evolved over a period of at least one million years (RIEBER 1969). From a study of ammonoids, which are fairly common in the dolomite strata od the "Grenzbitumenzone", it was possible to define the border between the Anisian and Ladinian Triassic stages (RIEBER and BRACK 1993).

In 1994 the Palaeontological Institute and Museum of the University of Zurich, in collaboration with the Cantonal Museum of Natural History (Lugano), began a new series of excavations in the Val Mara below Meride and at Crocifisso, working in the "Kalkschieferzone" and the Meride Limestone strata (BÜRGIN, 1995; FURRER, 1995).

In the same area, and as a part of the same joint project, in 1996 the Department of Earth Sciences of the University of Milan investigated the upper Meride Limestone strata (the so-called "Kalkschieferzone"). These excavations on Swiss territory are a follow-up to similar investigations carried out on the Italian side in the area of Ca' del Frate. They will complete our palaeontological knowledge of the characteristics and extent of this formation, which has not received so much attention as others.

These recent campaigns have yielded many important fossils, though not so many spectacular discoveries of large saurians. As well as thousands of fish belonging to some twenty different species, discoveries during the campaigns in the Val Mara and

at Acqua del Ghiffo between 1994 and 2001 have included the first fossil insects found on Monte San Giorgio (KRZEMINSKI and LOMBARDO, 2001), a young *Ceresiosaurus* (HÄNNI, in prep.) and a *Saurichthys* with embryos (BÜRGIN, in prep.). On the Italian side, the excavations at Ca' del Frate, carried out by the University of Milan in the bituminous levels of the "Kalkschieferzone", have also brought to light some *Lariosaurus* embryos, (RENESTO et al. in prep.); but perhaps more significant are a large number of fossil fish exhibiting complex and varied palaeobiological features (TINTORI et al., 1985; TINTORI, 1992), which make an interesting comparison with those found in Switzerland (TINTORI et al., 1999; LOMBARDO and TINTORI, 1997; LOMBARDO, 1997).

Middle Triassic levels	Crustaceans	Marine reptiles	Land-based reptiles	Cephalopods	Bivalves	Fish	Insects	Land-based plants
"Kalkschieferzone"	+++	+				+++	+	+++
Cassina beds		++		+		+		+
Cava Superiore beds		++		+		+	+	+
Cava Inferiore beds		++		+	+++	+		+
"Grenzbitumenzone"	+	+++	+	+++	+++	++	+ ?	+++

+++ very abundant
++ abundant
+ rare

Fig. 10: Distribution of most important fossil groups in the five fossil-bearing levels of Monte San Giorgio.

REPTILES	FISH	*Dipteronotus ornatus*
		Dipteronotus olgiatii
Placodontia	**CHONDRICHTHYES**	*Luganoia lepidosteoides*
Cyamodus hildegardis	*Acronemnus tuberculatus*	*Peltopleurus lissocephalus*
Paraplacodus broilii	*Hybodus* cf. *plicatus*	*P. rugosus*
Helveticosaurus zollingeri	*Acrodus georgii*	*P. notocephalus*
	Asteracanthus cf. *reticulatus*	*P. nuptialis*
	Palaeobates angustissimus	*Peltopleurus. n.* sp. B
Ichthyosauria		*Peltopleurus. n.* sp. C
Mixosaurus cf. *cornalianus* Type A	**OSTEICHTHYES**	*Peltopleurus. n.* sp. D
Mixosaurus cf. *cornalianus* Type B	**Sarcopterygii**	*Peltopleurus. n.* sp. E
Mixosaurus cf *nordenskioeldii*	*Ticinepomis peyeri*	*Peripeltopleurusto vacillipinnis*
Ichthyosaurus gen. Indet	cf. *Holophagus picenus*	*P. hyposimosus*
Mikadocephalus gracilirostris	Coelacanthidae gen. et sp. indet.	*Peripeltopleurus* sp.
Mixosaurus kunhnschnyderi		*Cephaloxenus macropterus*
Phalorodon fraasi	**Actinopterygii**	*Habroichthys minimuss*
Wimanius odontopalatus	*Gyrolepis* sp.	*H. griffthi*
Cymbospondylus buchseri	*Aneurolepis macroptera*	*Habroichthys* sp.
Besanosaurus leptorhynchus	*Acronemus* sp.	
	Ptycholepis barboi	**Neopterygii**
Prolacertiformes	*P. priscus*	*Eosemionotus* n. sp. A
Tanystropheus longobardicus	*P. schaefferi*	*Eosemionotus* n. sp. B
Macrocnemus bassanii	*P. magnus*	*Eosemionotus* n. sp. C
	Bobasatrania ceresiensis	*Eosemionotus* n. sp. D
Archosauria	*Saurichthys costasquamosus*	*Archaeosemionotus* n. sp. A
Ticinosuchus ferox	*S. curionii*	*Archaeosemionotus* n. sp. B
	S. macrocephalus	*Archaeosemionotus* n. sp. C
Sauropterygia	*S. paucitrichus*	*Allolepidotus bellotti*
Lariosaurus sp.	*Saurichthys* sp.	*Allolepidotus nothosomoides*
Neusticosaurus peyeri	*Birgeria stensiöi*	*Archaeosemionotus* sp.
N. pusillus	*Pholidopleurus ticinensis*	*Placopleurus minimus*
N. edwardsii	*Gracilignatichthys microlepis*	*P. primus*
Ceresiosaurus calcagnii	*Platysiagum minus*	*P. besanensis*
Paranothosaurs amsleri	*Perleidus altolepis*	*Placopleurus* n. sp. A
Nothosaurus sp.	*Perleidus sp.*	*Placopleurus* n. sp. B
Lariosaurus buzzii (= L. valceresii)	*Daninia spinosa*	*Eoeugnathus megalepis*
Silvestrosaurus buzzii	*Gen n. A sp. n.*	*Broughia* sp.
Serpianosaurus mirigiolensis	*Colobodus bassanii*	Parasemionotidae n. g. e n. sp
	Meridensia meridensis	*Furo* sp.
Thalattosauria	*Aetheodontus besanensis*	*Legnonotus obtusus*
Askeptosaurus italicus	*Ctenognathichthys belottii*	Macrosemiidae n. g. e n. sp.
Clarazia schinzi	*Peltolerperleidus bellipinnis*	Ophiopsidae *n.* g. e n. sp.
Heschleria rübeli	*P. elongignathus*	*Ophiopsis* cf. *lepturus*
	P. macrodontus	Pholidophoridae n. g. e n. sp.
	P. triseries	*Prohalecites porroi*
		Neopterygii n. g. &. n. sp.

Fig. 11: List of fossil vertebrates found in the Middle Triassic formations of Monte San Giorgio [Source: BÜRGIN, 1998; TINTORI, 1998; FURRER (unpublished catalogue), various publications]

Fig. 12: Ticinosuchus ferox (Val Porina, Monte San Giorgio) (Photograph: Pal. Inst. Univ. Zurich)

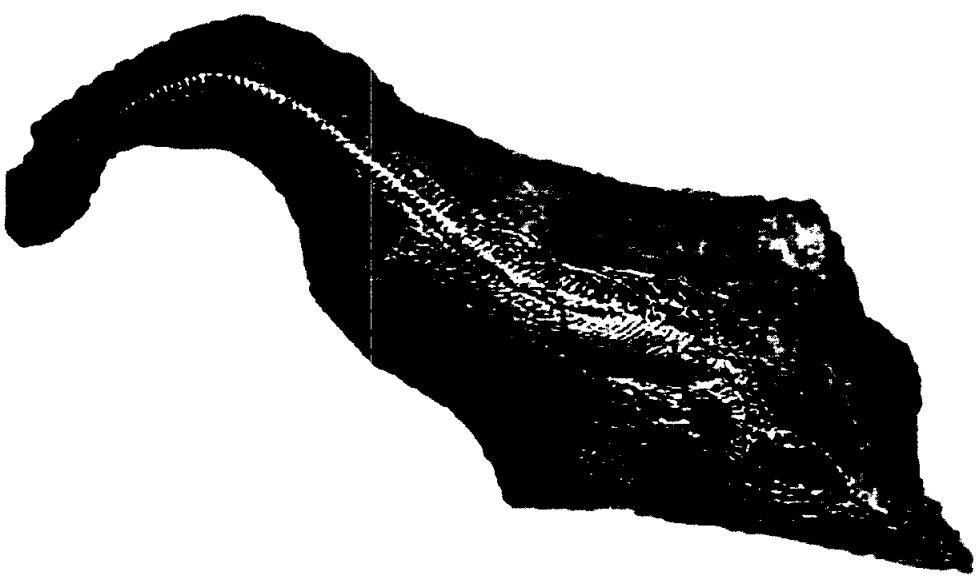

Fig. 13: Mixosaurus cornalianus (Point 902, Monte San Giorgio) (Photograph: Pal. Inst. Univ. Zurich)

Fig. 14: Neusticosaurus sp. (Acqua del Ghiffo, Meride, Monte San Giorgio) (Photograph: Pal. Inst. Univ. Zurich)

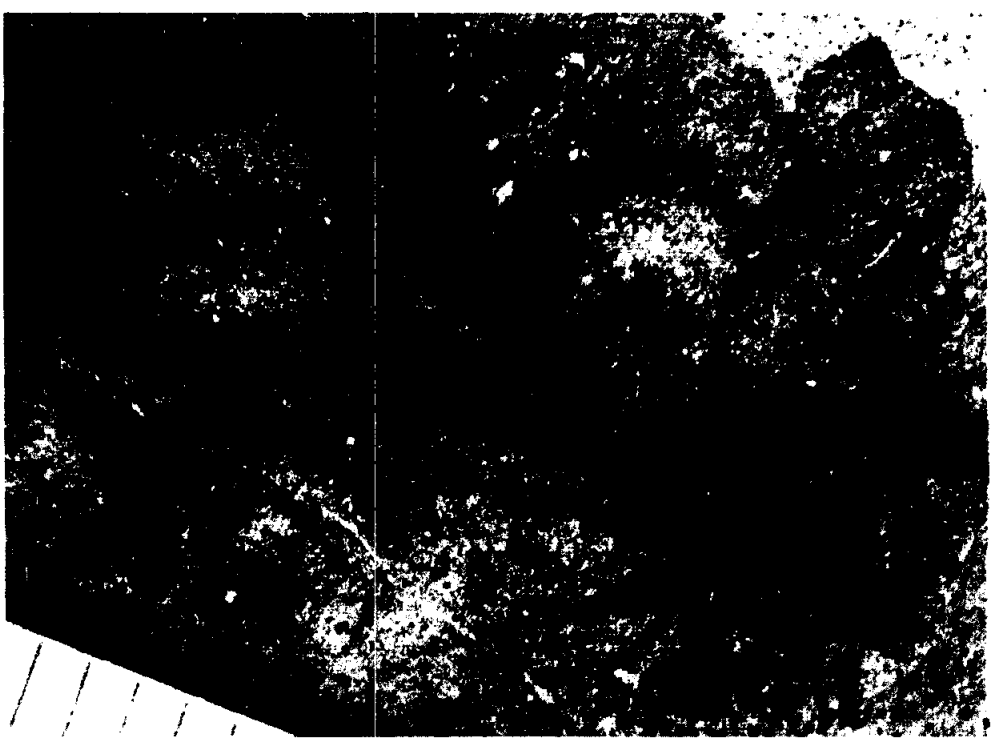

Fig.15: "Mosquito" Tintorina meridensis (Val Mara, Meride, Monte San Giorgio) (Photograph: Dept. Earth Sc., Univ. Milan)

KARST PHENOMENA

The carbonate rocks of Monte San Giorgio exhibit many Karst features (COTTI and FERRINI, 1961). The area includes some thirty caves, which affect the hydrology of the mountain. Most of these caves are found in the dolomitic rocks of the Middle Triassic and therefore come within the protection area. A smaller number are situated in the buffer zone, where limestone rocks from the Jurassic period, some bearing more chert, predominate.

These Karst phenomena, together with the lithology of the sub-soil, have a strong influence on the distribution of flora (see chapter on "flora and vegetation"). They have also been significant in the human settlement of the territory, as attested not only by legend but also by items found in some of the caves in the Tremona area.

TI	Name	Commune	Alt.	Dev.	Depth	Coordinates
8	Bögia	Meride	750	350		717.600/084.400
9	Fornett I	Tremona	590	17		718.270/082.520
10	Tana Bögiana	Rancate	470	6		718.500/081.700
13	Tana del Beato	Meride	1095	70		717.250/085.850
16	Grotta del Mago	Rancate	360	24		718.800/082.450
27	Böcc da la Ratategna	Tremona	600	19		718.240/082.375
28	Fornett II	Tremona	500	20		718.560/082.440
36	Grotta dei Cugnoli	Meride	1010	48	-27	717.350/085.550
37	La Palüscera	Meride	935	40	-24	717.650/084.900
43	Buco della Fonte	Meride	900	10		717.175/085.050
44	Böcc da la Vaca	Meride	920	6	-6	717.150/085.090
56	Fornet III	Tremona	500	20		718.700/082.220
67	Grotta del Tufo	Rancate	450	24	-9	718.450/082.900
90	Crepacci di Tremola	Tremona				718.175/082.600
106	Grotta alla Cava Caverzasio	Arzo	565	70	-12	716.160/081.820
107	Grotta delle Cantine Superiori	Tremona	590	50		718.250/082.490
108	Fornet IV	Tremona	600	20	-12	718.260/082.900
109	Cavernetta del Torrione	Tremona	610	6		718.210/082.570
110	Buco della Cascata	Riva S.Vitale	305	8		718.560/083.520
111	Buco della Bustorgna	Meride	930	7	-7	717.600/085.025
113	Tana del Lüff	Arzo	500	7		716.700/081.650
121	Mitra del Vescovo I	Rancate	460	35	-12	718.680/082.485
122	Mitra del Vescovo II	Rancate	470	20	-9	718.670/082.500
148	Antro delle Streghe	Tremona	635	73	-13	718.120/082.750
149	Antro del Castello	Tremona	630	136	-29	718.130/082.750
150	Antro della Castellana	Tremona	620	121	-46	718.100/082.540
155	Böcc da la Ratategna II	Tremona	605	13	-4	718.235/082.385
165	Pozzo di alta Val Serrata	Meride	940	22	-6	717.050/085.300

Fig. 16: List of Karst caves on Monte San Giorgio (Source: BAUMGARTNER 2001, unpublished)

Fig. 17: Distribution of Karst caves on Monte San Giorgio (from BAUMGARTNER 2001, unpublished); numbers according to the Ticino land register

Fig. 18: Grotta della Bögia (Meride, Monte San Giorgio) (Photograph: S. BAUMGARTNER)

FLORA AND VEGETATION

The territory we are concerned with is subject to climatic conditions of the Insubric type (high exposure to sunshine, mild winters with few frosty days, high rainfall in summer), which favour the development of a sub-Mediterranean type of vegetation. Because of the dual nature of the pedogenetic subsoil – acidic on the northern slope (rhyolites) and alkaline on the southern slope (mainly dolomites and limestones) – the vegetation of Monte San Giorgio includes both acid and lime-loving plants. Due to the favourable climatic conditions and its pedogenetic diversity, Monte San Giorgio is particularly interesting from a botanical point of view, unique in the Canton of Ticino.

The acidic soils support stands of *Castanea sativa* (Sweet chestnut) and *Quercus petraea* (Sessile oak), accompanied by *Fraxinus excelsior* (Ash) in locations of variable humidity with fairly rich soil.

The lime-rich soils support:

- mixed broadleaf woodland of *Carpinus betulus* (European hornbeam) and *Ostrya carpinifolia* (Hop-hornbeam) on damp soils of medium depth,
- mixed broadleaf woodland of warmth-loving sub-Mediterranean type, consisting of Hop-hornbeam, *Quercus pubescens* (Pubescent oak) and *Fraxinus ornus* (Flowering or Manna ash) on dry shallow soils;
- mixed woodland of *Tilia spp.* (Lime) and *Asperula taurina* on dry-to-damp soils.

The thickets of warmth-loving sub-Mediterranean trees are undoubtedly the most unusual feature, in terms of physical appearance and diversity of species.

The Inventory of Ticino dry meadows lists no less than 18 sites covering an area of 25 hectares. These are meadows associated with dry to very dry limestone sub-soils, which are home to plant populations found nowhere else in Switzerland and in some cases not found in the entire Italian southern-Alpine zone. These meadows are dominated by *Carex humilis* (dwarf sedge) or *Molinia arundinacea* (tall moor grass). There is a high level of botanical diversity, with approximately 30 species to 30 m². More than a hundred plant species have been recorded in total, 38 of which are rare, endangered or protected at cantonal or national level. Those most noteworthy include:

- *Adenophora liliifolia* ("lady bells"), which in Switzerland is only found on Monte San Giorgio;
- *Gladiolus imbricatus*, which in Switzerland is only found on Monte San Giorgio and the Poncione d'Arzo;
- *Iris graminea* (plum-scented iris) the main Swiss population of which is found on Monte San Giorgio;
- *Dorycnium herbaceum* and *Danthonia alpina*, for which Monte San Giorgio is one of the main Swiss sites.

Since 1991, the dry meadows of Monte San Giorgio have been very carefully cared for by the Ticino authorities, with financial support from the Federal Government (see chapter **4.g.**).

FAUNA (see also Appendix **C**)

Vertebrates

102 species of vertebrate are found in the Monte San Giorgio area (6 amphibians, 8 reptiles, 63 birds and 23 mammals), and this figure rises to 109 if we also consider the neighbouring lakeside sites (7 amphibians, 9 reptiles, 66 birds and 27 mammals). Of these, 37 are included in the Red List of species recognised as endangered at national level (categories 1-4, see Fig. 19), and 21 are absolutely protected under the Berne Convention (Fig. 19). For *Pitymys Savii* (Savi's pine vole), Monte San Giorgio is the only known habitat in Switzerland. The area was once also home to *Rhinolophus ferrumequinum* (the lesser horseshoe bat), a species now threatened with extinction throughout Switzerland.

The Monte San Giorgio area is especially important for the reproduction of amphibians and reptiles, since it includes six of the listed sites of national importance:

- AN 241: Meride - Stagno Roggio (2 species: an exceptional population of *Bufo bufo* and a good population of *Rana temporaria*);
- AN 343: Meride - Stagno Guana (2 species: an exceptional population of *Bufo bufo* and a good population of *Rana temporaria*);
- AN 344: Besazio/Rancate - Pozza Pavù Ronco (3 species: *Hyla intermedia*, *Rana dalmatina*, *Bufo bufo*);
- RN 83: Arzo - Cava di marmo (8 species);
- RN 87: Meride - Campagna (6 species);
- RN 90: Ligornetto - Pre Murin (5 species).

Invertebrates

The invertebrate fauna, though known only in part, reflects the diversity of environments found on Monte San Giorgio. Some of the most representative and best-known groups are listed below.

58 species of mollusc have been recorded to date, 18 of which are included in the Red List of species recognised as endangered at national level (categories 1-4). There are 63 species of day-flying butterflies and moths (Hesperiidae and Rhopaloceri), one third of all the species recorded in Switzerland. Particularly rare and endangered is

Pyrgus armoricanus (Oberthur's Grizzled Skipper), which inhabits the driest and most arid south-facing meadowlands. There are 85 species of Apioid Hymenoptera (wild bees), 111 species of Carabid Coleoptera (ground beetles), and 47 species of Orthoptera (crickets and grasshoppers), of which *Euchorthippus declivus* and *Pholidoptera littoralis insubrica*, found only in the Ticino region of Switzerland, are included in category 1 of the Red List.

Monte San Giorgio is home to more than half of the spider species observed in the dry meadows of Ticino. At the end of the 1980s, surveys found 13 that had never preciously been recorded in Ticino, 12 never before recorded in Switzerland, and 3 that were totally unknown to science. The environments harbouring the most species are uncultivated areas that have not been invaded by trees and bushes.

Mention should also be made of the large population of crayfish (*Astacus pallipes*) found in the Gaggiolo. Due to the extensive and deep Karst phenomena, especially on the southern side of the mountain, invertebrates can penetrate a large number of caves, of which the best known is the Bögia in Val Serrata, a gallery running roughly 250 m into the mountain. It harbours unique cave-dwelling populations of crustaceans and millipedes.

	RED LIST (cats. 1-4)	PROTECTED SPECIES	NOTES
Amphibians			
Salamandra salamandra	3	Berne Conv. III	
Triturus vulgaris	2	Berne Conv. III	
Triturus carnifex	3	Berne Conv. II	
Hyla intermedia	2	Berne Conv. II	
Rana dalmatina	3	Berne Conv. II	
Bufo bufo	3	Berne Conv. III	
Reptiles			
Podarcis muralis	3	Berne Conv. II	
Lacerta viridis	3	Berne Conv. II	
Natrix natrix	3	Berne Conv. III	
Natrix tessellata	2	Berne Conv. II	
Coluber viridiflavus	3	Berne Conv. II	
Elaphe longissima	3	Berne Conv. II	
Coronella austriaca	3	Berne Conv. II	
Vipera aspis	3	Berne Conv. III	
Birds			
Accipiter gentilis	3	Berne Conv. II	
Accipiter nisus	3	Berne Conv. II	
Falco tinnunculus	3	Berne Conv. II	
Coturnix coturnix	3	Berne Conv. III	
Phasianus colchicus	3	Berne Conv. III	
Streptopelia turtur	3	Berne Conv. III	
Cuculus canorus	3	Berne Conv. III	
Caprimulgus europaeus	2	Berne Conv. II	
Apus melba	3	Berne Conv. II	

Jynx torquilla	3	Berne Conv. II	
Phoenicurus phoenicurus	3	Berne Conv. II	
Saxicola torquata	3	Berne Conv. II	
Monticola saxatilis	3	Berne Conv. II	1980s (Lardelli)
Hippolais polyglotta	3	Berne Conv. II	1980s (Lardelli)
Oriolus oriolus	3	Berne Conv. II	1980s (Lardelli)
Emberiza cirlus	2	Berne Conv. II	
Mammals			
Muscardinus avellanarius	3	Berne Conv. III	
Crocidura suaveolens	3	Berne Conv. III	
Talpa caeca	4	-	
Mustela nivalis	3	Berne Conv. III	
Pitymys multiplex	3	-	
Pitimys savii	4	-	Only habitat in Switzerland
Lepus europaeus	3	-	

Fig. 19: Vertebrate species included in the Swiss "Red List" (degree of endangerment at national level: cats. 1-4; DUELLI et al., 1994) and listed in appendixes II and III of the Berne Convention.

FUNGI

The Monte San Giorgio area is of such enormous interest from a mycological point of view that experts refer to it as a "mycological sanctuary".

Of the 554 (!) species of fungi found to date on the mountain, no less than 130 come only from this part of Ticino, while 5 (*Boletus xanthocyaneus*, *Cortinarius boudieri* v. *pseudoarcuatus*, *Cortinarius pelargoniobtusus*, *Lepiota forquignoni*, *Lycoperdon velatum*) are found in Switzerland only at Meride. Of these 554 species, 2 (*Hygrocybe calyptriformis, Verpa conica*) are protected by the Federal Ordinance on the Protection of Nature and Preservation of National Heritage and 19 feature in the provisional Red List of Switzerland's endangered macromycota species (Fig. 20). The latter are associated with warmth-loving broadleaf woodland on basic soils, poor grassland and the alder species *Alnus glutinosa*. Specially significant is the wealth of *Boletus* species: an exhibition of fungi held in the 1970s featured no less than 44 species from the Serpiano area alone (some 130 species have been described for Europe as a whole), including such rare species as *Boletus dupainii*, which is typical of warmth-loving broadleaf woodland on basic soils and fruits only every 4-5 years, and *Xerocomus moravicus*, a species included in the Red List.

It is also worth mentioning that, in 1979, a species previously unknown to science (*Tricholoma basirubens*) was discovered at Meride.

Species	Habitat
Aleurodiscus disciformis (DC.: r.) Pat	elm trunk
Boletus queletii Schulzer	broadleaf, basic soil
Calocybe ionides (Bull.: Fr.) Donk	broadleaf, basic soil
Cortinarius bibulus Quél	*Alnus glutinosa* litter
Cortinarius cumatilis Fr.	broadleaf woodland
Cortinarius orellanus Fr.	broadleaf woodland
Entoloma bloxamii (Berk. & Broome) Sacc.	poor grassland
Guepiniopsis buccina (Pers.: Fr.) L.L. Kenn.	broadleaf branches
Gyrodon lividus (Bull.: Fr.) Sacc.	*Alnus glutinosa*
Hericium erinaceum (Bull.: Fr.) Pers	broadleaf branch
Hygrocybe calyptriformis (Berk. & Broome) Fayod	poor grassland
Hygrocybe intermedia (Pass.) Fayod	poor grassland
Hygrocybe quieta (Kühner) Singer	poor grassland
Hygrocybe reidii Kühner	broadleaf, basic soil
Lactarius controversus (Pers.: Fr.) Fr.	broadleaf, basic soil
Pulcherricium caeruleum (Schrad.: Fr.) Parmasto	broadleaf branches
Tricholoma acerbum (Bull.: Fr.) Quél.	beech
Verpa conica Sw.: Pers.	broadleaf woodland
Xerocomus moravicus (Vacek) Herink	broadleaf, basic soil

Fig. 20: Species of fungi found on Monte San Giorgio which are included in the provisional Red List of Switzerland's endangered macromycota.

b. History and Development

This chapter is concerned with the history of human activity on Monte San Giorgio, from the Neolithic Period to the late Middle Ages, and with the quarrying, mining and scientific research activities of more recent times.

ARCHAEOLOGICAL NOTES

During the Neolithic Period, what is now the Canton of Ticino must have been densely wooded, supporting a wealth of wildlife. The area was slowly settled by human beings, who gradually developed from hunter gatherers – as they must have been 6,000 to 6,500 years ago – into sedentary farmers and herdsmen.

Archaeological finds indicate that humans have been present on Monte San Giorgio since Neolithic Times, and human settlement has continued to the present day.

There is documentary evidence that, in the early nineteenth century, an enormous quantity of flints was found near the lake at Riva San Vitale. This would seem to indicate that the area had been penetrated by groups of colonisers from the Po Valley, where there were already significant lake-side settlements.

Some of the items brought to light at Tremona are also from the Neolithic Period. Archaeological excavations in this area – begun in the 1990s at Castello – reveal a continuous pattern of settlement up to the late medieval period.

However, the most striking archaeological finds in the area date from Roman times. At Riva San Vitale, the discoveries include tombs, stones bearing inscriptions, locally produced bricks, and evidence that fishing and craft activities were carried on, as well as livestock farming. Artefacts from the Roman period have also been found at Besazio, Brusino Arsizio and Meride, though the circumstances in which they were used is not always clear.

As regards the early medieval period, Riva San Vitale is famous for its early Christian baptistery (5th century) and has also yielded a series of tombs containing grave goods. These include a gilded bronze Byzantine buckle, now kept in the Museo della Casa Arcipretale. A dig inside the parish church of Sant'Antonino at Besazio has also brought to light seven tombs from the Lombard period, containing brooches, belt buckles, ferrules and other items, now exhibited at the Castello di Montebello, Bellinzona (World Heritage Site). The tombs found at Arzo date from the late medieval period.

Ruins and place names – as at Brusino Arsizio, Meride or Tremona – are probable evidence of medieval strongholds, which have been destroyed or converted to other uses over the centuries.

THE BITUMINOUS SHALE MINES

The bituminous shales of the Monte San Giorgio area must have been known for centuries on account of their high oil content, which made them burn easily. However, it was not until the mid-eighteenth century that, as a result of a shortage of fuel for furnaces, the Milanese government encouraged a search for fossil fuels in the valleys of Lombardy. This was why, between 1774 and 1790, a certain VALSECCHI from Lecco resumed excavations in an old mine at Besano, on the Italian side. This is the earliest information we have of industrial mining activity in the rocks of Monte San Giorgio.

The first technical investigations of the bituminous shales, dating from 1830, were performed with a view to extracting gas to light the streets of Milan. But the excavations, carried out for this purpose above Besano, were soon abandoned. This initiative was followed by others, always with the aim of obtaining fuel, but all efforts were unsuccessful because the oil content was not high enough. The right to exploit the bituminous deposits discovered on the Swiss side was assigned by the cantonal government to ANTONIO DE MARTINI, a native of Como, in 1856. This was the beginning of a thirty-year saga of transfers of claims, renewals of licences, appeals, disputes and mistrust, but no concrete results.

The search for bituminous shales was given a decisive boost by the commercial success of Ichthyol (sulphoichthyolate of ammonia), obtained from oil extracted from the bituminous shales of Seefeld in the Austrian Tyrol, which was used for treating skin conditions (eczema). The pioneers of its production on Monte San Giorgio were GIUSEPPE RATTI then, in 1906, the chemist PIERO NERI SIZZO DE NORIS, who founded the Società Anonima Miniere Scisti Bituminosi di Meride e Besano [Meride and Besano Bituminous Shale Mining Company] and built the Spinirolo plant for distilling the shale oil and refining Saurol, a product akin to Ichthyol, supplied to the Milan and Basle pharmaceuticals markets.

By 1916, there were five mines operating in the Tre Fontane area, with a total development of 900 m; by the early 1940s, roughly 1,700 m of tunnels and risers had been dug. The average annual production of oil-bearing material was around 300-400 tons, equivalent to 22-30 tons of unrefined oil. Production of Saurol declined during World War II, but recovered in the post-war period, though only for a few years. At this time, the mining company employed about 30 miners and production staff. Eventually, there were few remaining customers, most of them in the veterinary pharmaceuticals sector overseas. Mining activities ceased in the early 1950s and the company went into liquidation soon afterwards.

All that remains of this industrial enterprise, in which the local population was closely involved (they were also employed in other mining activities, particularly in quarrying ornamental stone) are a few mine shafts in the Serpiano area and, above all, the old Spinirolo plant, a fine example of industrial architecture, now converted into a cultural and holiday centre.

Fig. 21: Label from a bottle of "Saurolo"

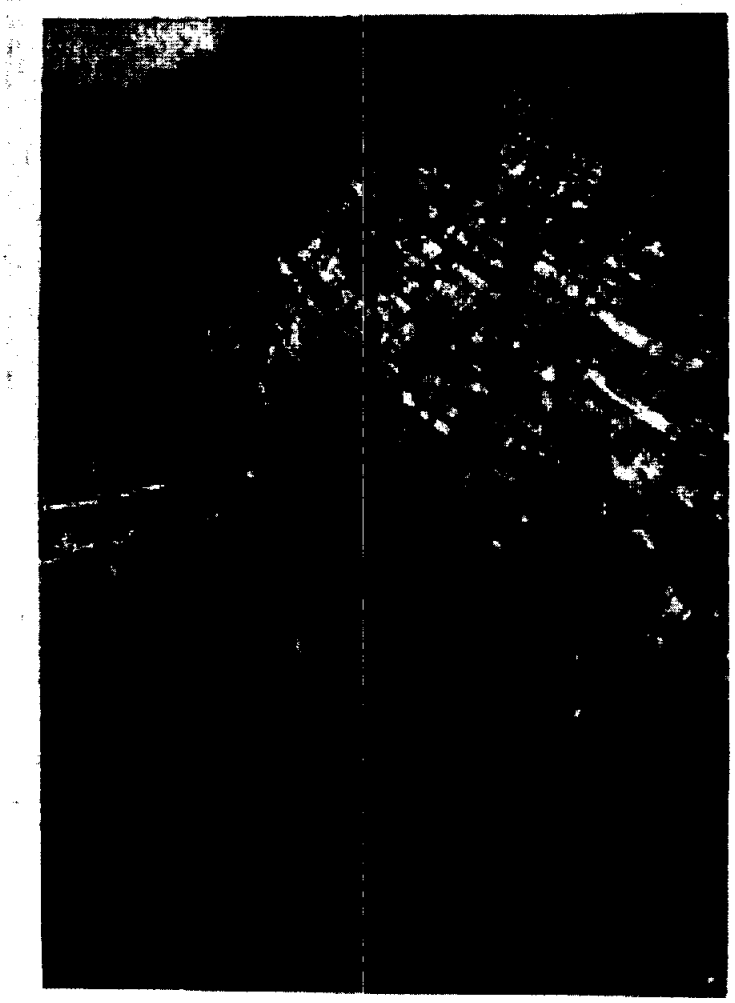

Fig. 22: Workmen at the Tre Fontane mine (Monte San Giorgio)

Fig. 23: Stone quarries at Serpiano (Monte San Giorgio)

Fig. 24: The Spinirolo plant at Meride (Photograph: M. FELBER)

THE HISTORY OF PALAEONTOLOGICAL EXCAVATIONS

Scientific investigations began at the same time as industrial activity in the area. There were sporadic excavations from as early as 1863, but it was not until 1924 that systematic scientific campaigns were undertaken in areas unconnected with mining. The excavations undertaken by the Palaeontological Institute and Museum of the University of Zurich, the Milan Museum of Natural History and the Department of Earth Sciences of the University of Milan are described in detail in the chapter on Palaeontology, as are some of the many sensational finds (see Fig. 8).

Since the early 1990s, further excavations have been undertaken in the less obviously fossil-bearing and less thoroughly investigated formations of Monte San Giorgio. Although these have not yielded large reptiles several meters in length, as in the past, they have resulted in the discovery of species unknown to science, especially fish and insects. At the same time, new investigatory techniques and a multi-disciplinary approach have improved understanding of the genesis and evolution of the fossil environments of the sedimentary sequence of Monte San Giorgio.

Only the approved university institutes are permitted to search for fossils on Monte San Giorgio; amateurs and the general public are forbidden to do so by law [Legislative Decree governing the collection of rocks, mineral and fossils (1974) and related Regulations regarding its implementation (1975, amended 1995)].

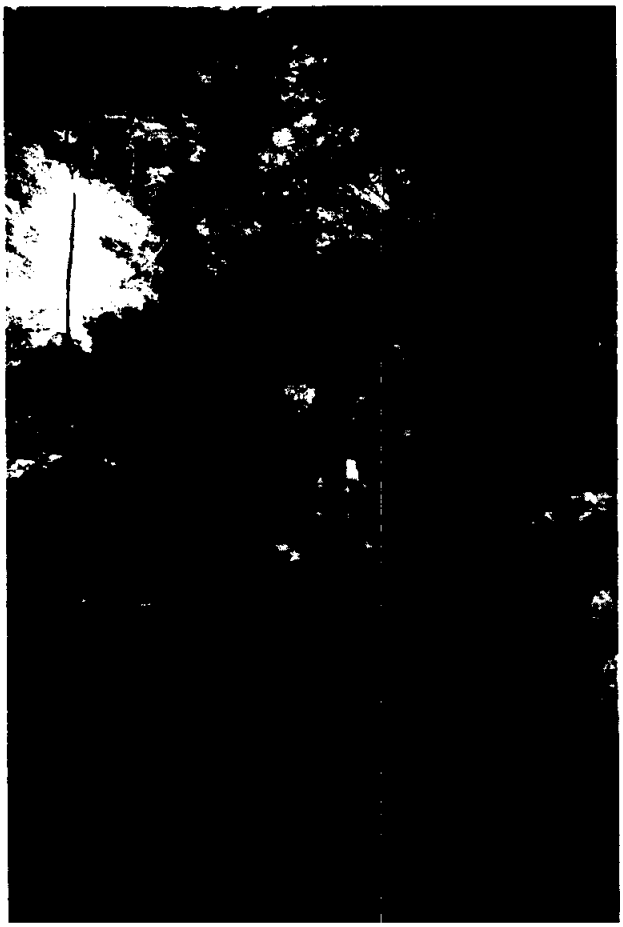

Fig. 25: Excavation undertaken in 2000 by the Department of Earth Sciences of the University of Milan in Val Mara (Meride, Monte San Giorgio) (Photograph: M. FELBER)

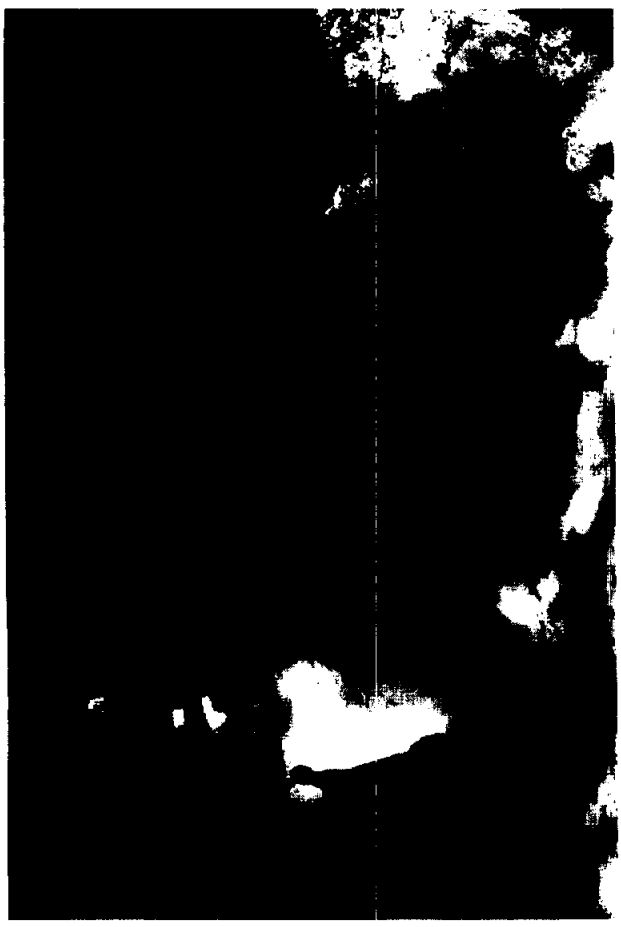

Fig. 26: Excavation undertaken in 2000 by the Palaeontological Institute and Museum of the University of Zurich at Acqua del Ghiffo (Meride, Monte San Giorgio) (Photograph: M. FELBER)

c. Form and date of most recent records of property

The wealth of scientific, educational and more popular literature relating to the site – almost 800 titles in all – is listed in a separate Appendix **A**. Study of the materials catalogued in the collections of the Zurich and Milan institutes, and in particular the new wave of excavations beginning in the early 1990s, have given rise to a new series of publications dealing with recent discoveries of new species and the evolution of particular species and groups.

Prominent among these works are the original scientific contributions published over the last decade or so by the universities of Zurich and Milan: BRACK and RIEBER (1993, 1996); BRINKMANN (1996, 1997); BÜRGIN (1990, 1992, 1995, 1998); BÜRGIN et al. (1989); FURRER (1995, 1999); Hänni (1999), KUHN-SCHNYDER (1990, 1994); LOMBARDO (1995, 1997, 1998, 1999); LOMBARDO and TINTORI (1997); LOMBARDO et al. (1998); Mutter (1998, 1999), PINNA (1990, 1991, 1992); PREMRU (1991); RENESTO (1990, 1991, 1993, 1994); RIEBER (1990); RIEPPEL (1989, 1995); RIEPPEL and KEBANG (1995); RIEPPEL and WILD (1996); SANDER (1989, 1990, 1997); SANDER and MAZIN (1993); TINTORI (1990, 1991, 1992, 1995, 1997, 1998, 1999); TINTORI and LOMBARDO (1998, 1999); TINTORI and BRAMBILLA (1991); TINTORI and RENESTO (1990, 1993); TINTORI et al. (1990, 1995); TSCHANZ (1990).

The palaeontological investigations and interpretation of the evolution of the Middle Triassic environment of Monte San Giorgio have also been supported by research in the fields of sedimentology, geochemistry and geomineralogy: BERNASCONI (1991, 1992, 1994); BERNASCONI and RIVA (1990); BIONDA (1996); BRACK and RIEBER (1990); BRACK et al. (1996); FURRER (1995), MUNDIL et al. (1994); NERI et al. (1996); NERI and ROSSI (1993); OPPIZZI et al.(1999), ROEHL et al. (2001).

The educational and popularising contributions include articles by FELBER (1991); FELBER et al. (1997) and FURRER (1991, 1995, 1996, 1998), and in particular the GEO-GUIDE to Monte San Giorgio (see Appendix **L**), the first of its kind in Switzerland, by FELBER, GENTILINI, FURRER and TINTORI (2000).

Recently produced inventories and lists of plant and animal species (1990-2000) are appended separately (Appendix **C**).

d. Present state of conservation

The legal provisions governing the protection of the area and planning matters are set out in chapters **4.b.** and **4.f.** below.

The state of conservation of the site is satisfactory and no part of the protection area is threatened by immediate or foreseeable dangers. Human pressures on the natural environment of Monte San Giorgio – in particular the palaeontological components – are minimal and do not give rise to any particular conflicts, because the area is largely in its natural state and uninhabited, and is subject to a variety of protection measures.

A vital aspect of such protection is the Legislative Decree governing the search for and collection of rocks, minerals and fossils (1974), whereby a cantonal authorisation is required in order to collect rocks, mineral and fossils. Under the Regulations implementing this decree, permission to carry out research may only be granted to university institutes or scientific researchers with a proven track record. Since the law came into force, there have been no departures from these stipulations, and permits have been granted only to the Palaeontological Institute and Museum of the University of Zurich and the Department of Earth Sciences of the University of Milan, so as to avoid any dispersion of the important fossil remains in question.

For this reason the Middle Triassic palaeontological heritage of Monte San Giorgio has been preserved and catalogued almost in its entirety in the collections and exhibition of the Paleontological Institute and Museum of the University of Zurich, whose Museum is the main point of attraction. However, the discoveries made during recent campaigns are kept at the Cantonal Museum of Natural History in Lugano. Finds made on the Italian side are conserved in museums in Milan, Induno Olona and Besano.

Only a very small percentage of the fossils from Monte San Giorgio (estimated figure 1-2%) have found their way to other Swiss, European or overseas museums. This makes the Middle Triassic palaeontological deposits of Monte San Giorgio quite exceptional in international terms.

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

The university institutes and their related museums (the Zurich Institute and Museum of Palaeontology; the Milan Civic Museum of Natural History; and the Lugano Museum of Natural History, representing the Ticino Department of Land Use and Environment),

in conjunction with the local authorities, are now making a major effort to co-ordinate their excavation campaigns and to disseminate scientific information acquired on the ground, which would otherwise only be available to a restricted circle of specialists.

In addition, the regional museums of Meride, Besano and Induno Olona, wanting to promote greater awareness of their areas, have recently shown considerable commitment to making the palaeontological heritage of Monte San Giorgio better known locally. A good example of this work is the publication of a GEO-GUIDE to Monte San Giorgio (see below) which combines factual information, interviews and geopalaeontological and geomineral historical documentation, some of which was obtained as a result of an employment programme organised by the Cantonal Museum of Natural History.

This wealth of data, supplemented with contributions from the Meride Fossil Museum, the Varese provincial authorities, the universities of Zurich and Milan, the Milan Museum of Natural History and the people of Meride, is soon to be published in **illustrated book** form by the earth science magazine GEOLOGIA INSUBRICA. It will be an important source of historical, technical and scientific information, documenting the development of stone quarrying in the area and the palaeontological excavation campaigns.

Many other collaborative ventures are also under way, involving cross-border organisations seeking to achieve common objectives in the cultural, educational and tourism fields. These include improving the information provided by local museums, establishing data-exchange networks, publishing geo-guides, laying out educational nature trails on specific themes, opening up excavations sites for public visits, recovering and exhibiting mining equipment and other aspects of industrial archaeology (furnaces, old quarries, etc.), guided tours, training courses, conferences, etc.

With this in mind, in May 2001 the local authorities in the Swiss part of Monte San Giorgio (Meride, Brusino Arsizio, Arzo, Tremona, Riva San Vitale, Rancate, Besazio, Ligornetto and Stabio), those on the Italian side (Besano, Porto Ceresio, Viggiù, Saltrio and Clivio) and a number of private and public-sector organisations (Friends of the Mountain Park [Associazione Amici del Parco della Montagna], the provincial government of Varese, the Valceresio Mountain Community [Comunità Montana Valceresio] and the Varese Tourism Board) signed a *"**Draft agreement** (...) to define a joint programme of integrated development to promote the environmental, historical,*

economic and touristic aspects of the area, (...) and to put into effect an organic plan for this purpose (...)".

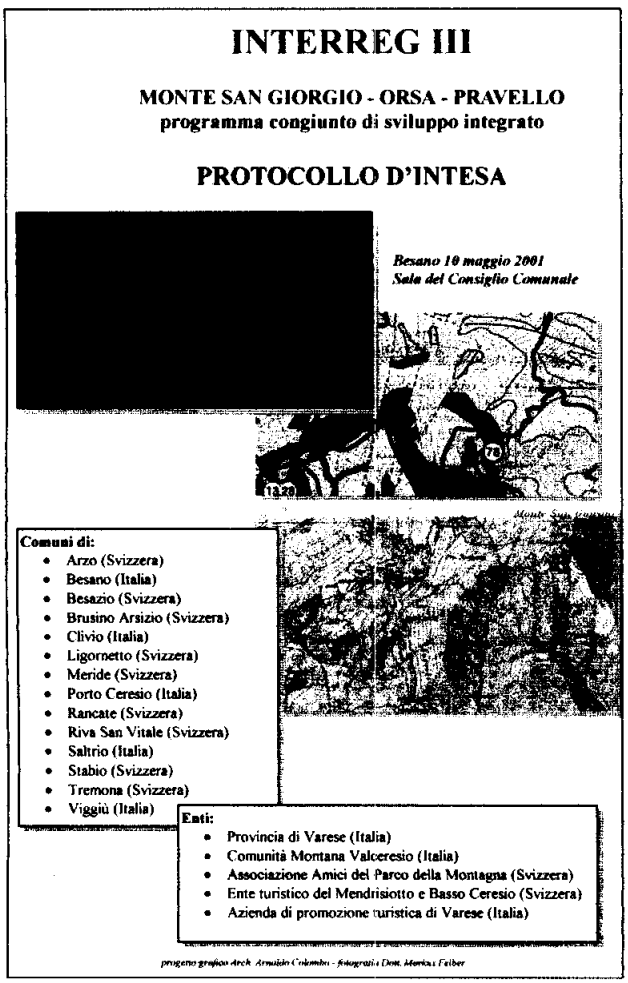

Fig. 27: Draft agreement Interreg III

An **educational trail** (Appendix **M**), illustrating the main geological and palae ontological features of the mountain, has been established in 1980 as a result of co-operation between the Institute of Palaeontology of the University of Zurich, the League for the Protection of Nature [Lega per la protezione della natura] (now Pro Natura) and the Mendrisiotto and Lower Ceresio Tourism Board. Information displays have been set up at intervals along the trail, presenting the area's physical phenomena, fauna and flora.

The following public and private-sector organisations are active locally:

- **The Meride Fossil Museum** (Appendix **N**). The museum was inaugurated in 1974 as a result of an initiative by the Palaeontological Institute and Museum of the University of Zurich and a number of local supporters, including the League for the Protection of Nature (now Pro Natura). Roughly fifty fossils, representing the main types found in the Middle Triassic formations of Monte San Giorgio, are

systematically displayed, with explanatory texts, in a single room. There is also a slide show illustrating the excavations, the main fossils found on Monte San Giorgio and their preparation. There are plans to enlarge and renovate this small museum, which is destined to play the local management role in respect of the region's palaeontological heritage. The enlarged museum will be able to house a larger number of exhibits and cover other themes connected with the geology of the area, such as the mining activities of the last century. It will also benefit from modern audio-visual facilities. The Museum is currently managed by a joint scientific committee, appointed by the local authority. This committee publishes information and is responsible for planning the new facilities. It is intended that, in future, the Meride Fossil Museum be managed by a public body (involving local-authority, cantonal and scientific representatives and sponsors), possibly having Trust status.

Fig. 28: Guide to the Monte San Giorgio nature trail

- **The Associazione Amici del Parco della Montagna [Friends of the Mountain Park],** based at Arzo, was established in 1990 with the purpose of protecting and promoting the natural, landscape, environmental, cultural and historical heritage of the mountain areas of Monte San Giorgio and Poncione d'Arzo (known together as La Montagna). Membership is open to public and private bodies, as well as individuals. Aware that the development of Western civilisation has been based on the appropriation and speculative exploitation of natural resources, the Association is militant in support of the concept of *sustainable development*, starting with the realities of daily life. Working in harmony with other environmental groups, it

intervenes in processes which determine the fate of local territorial and environmental resources. The Association's aims are: 1) to work for the establishment of a Natural Park in the area defined by the Federal Inventory of Landscapes of National Importance; 2) to contribute to the balanced and co-ordinated integration of human settlement and activities (cultural landscape) with the natural features of the area (natural landscape); 3) to safeguard, protect and promote the natural, landscape, environmental, cultural and historical heritage of the area; 4) to encourage good management of the territory through study and research, and by raising the awareness of local people and organisations; and 5) to press for co-ordination in planning matters between the local authorities in the region, and between these authorities and their neighbours in both Switzerland and Italy. The Association organises lectures, excursions, meetings, debates and study groups to deepen people's knowledge of the area and stimulate new ideas for environmentally friendly management. It proposes ways of achieving a balanced and harmonious relationship between humans and their natural environment. It is locally active in putting forward its own independent initiatives and adopting positions with respect to political and economic decisions affecting the territory.

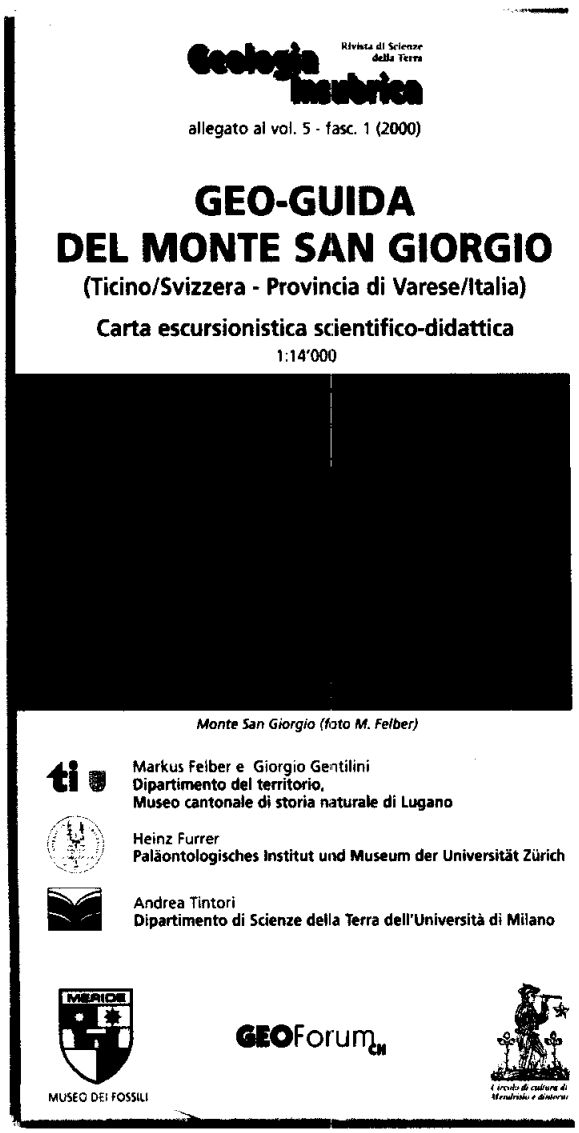

Fig. 39: GEO-GUIDE to Monte San Giorgio

The **GEO-GUIDE to Monte San Giorgio** (Appendix **L**), the first of its kind in Switzerland, is a collaborative venture between the local authorities and organisations active in the area. The publication, of which 6,000 copies were printed, is helping to improve people's knowledge of the palaeontological heritage of Monte San Giorgio, and also of the geological setting and the mining activities, techniques and traditions associated with quarrying. The Geo-Guide should provide a stimulus for other local initiatives: improving the network of nature trails for educational purposes, promoting industrial archaeology, opening the main palaeontological sites to the general public, publishing educational works, etc. (see also the section on cross-border initiatives between the nine local authorities in the Swiss area of Monte San Giorgio and the five on the Italian side).

To provide the necessary technical and political support for the many on-going and planned initiatives, the Committee of the Meride Fossil Museum, in consultation with the municipal authorities, has set up a **support committee**, made up of representatives of the academic, political and cultural worlds with an interest in the natural heritage of Monte San Giorgio.

4. Management

a. Ownership

The protection area part of the site is divided between the local authorities (communes) of Meride, Riva San Vitale and Brusino Arsizio. Most of the land, particularly the wooded areas, is owned by the Patriciates of Riva San Vitale, Brusino Arsizio e Besazio. Private ownership is limited to the cultivated areas of land and dwellings in the vicinity of Meride and Riva San Vitale. A total of 9 local authorities – Arzo, Besazio, Ligornetto, Rancate, Stabio, Tremona, in addition to the 3 mentioned above – are represented in the buffer zone.

	Commune	Area (ha)	
Protection area	Brusino Arsizio	57	
	Meride	571	
	Riva San Vitale	221	**849**
Buffer zone	Arzo	280	
	Besazio	85	
	Brusino Arsizio	326	
	Ligornetto	28	
	Meride	170	
	Rancate	68	
	Riva San Vitale	268	
	Stabio	7	
	Tremona	157	**1389**
Total area			**2238**

Fig. 30: Area of the individual communes involved (protection area and buffer zone)

b. Legal status

c. Protective measures and means of implementing them

At the federal level, the entire site (protection area and buffer zone) has been included since 1977 in the **Federal Inventory of Landscapes, Sites and Natural Monuments**. In the description (Appendix **D**) of item no. 1804 of this Inventory – Monte San Giorgio – the importance of the site is expressed in the following terms: *"Geologically very interesting mountain in southern Ticino, with Triassic deposits containing exceptional fossil saurians. The natural landscape is still unspoilt, with*

southern Alpine flora rich in rare species. Ticino villages typical of the Sottoceneri district (Lombard style)."

This Inventory is based on article 5 of the **Federal Law on the Protection of Nature and Preservation of National Heritage (LPN)** of 1 July 1966 and the Ordinance concerning the Federal Inventory of Landscapes and Natural Monuments of National Importance (IFP). According to article 6 of the same law, the listing of an item of national importance in a federal inventory means that it is especially worthy of being preserved intact or, in any case, respected as much as possible.

Federal inventories of items of national importance bind the federal authorities in the performance of their duties. The same constraints apply when such federal duties are delegated to the cantons, for instance the issuing of permits to build outside areas earmarked for development, the granting of permits to bring land under cultivation, or where subsidised works are concerned. In the event of potential conflict, the Federal Commission for the Protection of Nature and Landscape must be called in to provide an expert opinion.

The dwellings of Meride, part of which falls within the protection area, and Arzo, all of which comes within the buffer zone, are also listed in the **Inventory of Swiss Heritage Sites of National Importance (ISOS)**. This Inventory, which is adopted for the purposes of the Cantonal Development Plan (see chapter **4.f.**), obliges local authorities to define planning regulations and measures to protect the settlements concerned.

At cantonal level, the Monte San Giorgio area is at present classified as a Landscape Protection Zone under the **Protected Areas** scheme (Fig. 31). This scheme was drawn up by the Office for the Protection of Nature based on the Cantonal development Plan and the Federal inventories. It has been adopted for the purposes of the **Cantonal law on nature protection**. That law was approved by Parliament on 12th December 2001.

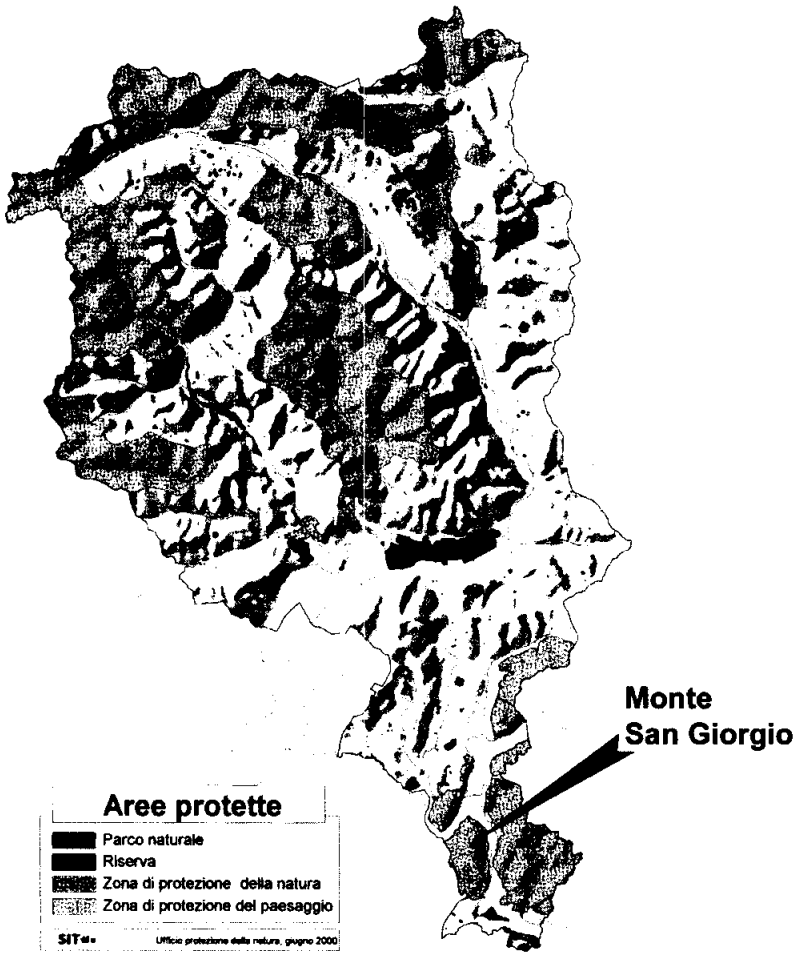

Fig. 31: Protected areas in the Canton of Ticino (source: Ufficio protezione della natura, 2000)

Under the **Cantonal Regulations for the protection of flora and fauna** (1975, Appendix I), the whole mountain is designated as an area of special interest from the point of view of its wildlife and landscape. In practical terms, this means a ban on interfering with plants or capturing invertebrates.

Under the **Legislative Decree governing the search for and collection of rocks, minerals and fossils** (1974, Appendixes **J**, **K**), a cantonal permit must be obtained in order to collect specimens (see chapter **3.d.**).

Other features of the Monte San Giorgio area are also listed in federal and cantonal inventories: dry meadows (of which there are more than 30 on the summit of the mountain and in other open areas), amphibian breeding sites, reptile habitats and caves.

In accordance with federal and cantonal laws concerned with conservation, these inventories are binding on the authorities and also, to some extent, private individuals.

Monte San Giorgio is also included in the draft Inventory of Geotopes of National Importance and, together with the "Glarner Überschiebung" site, has been proposed for listing with over 400 sites that have been surveyed and recognised as being of international value.

Finally, because much of the Mountain is wooded, it also enjoys a degree of protection under federal and cantonal forestry legislation (**Federal Law on forests**, **Cantonal Law on forests**).

Generally speaking, all the protection, management and development measures are the responsibility of the cantons. The Confederation gives the cantons technical and scientific support and bears some of the costs, granting substantial subsidies.

d. Agency/agencies with management authority

Swiss Confederation	Swiss Agency for the Environment, Forests and Landscape Nature Division CH-3003 Berne
Canton of Ticino	Dipartimento del territorio Ufficio protezione della natura Viale S. Franscini 17 CH-6500 Bellinzona
	Museo cantonale di storia naturale Viale C. Cattaneo 4 CH-6900 Lugano

e. Level at which management is exercised (e.g., on property, regionally) and name and address of responsible person for contact purposes

Depending on the level at which protection is exercised (Confederation, canton, local authority), responsibility is fairly divided. Therefore, no single person bears full responsibility.

Contact addresses:

Canton

Marco Molinari
Dipartimento del territorio
Sezione dei beni monumentali e ambientali
Viale S. Franscini 17
CH-6500 Bellinzona

Confederation

Meinrad Küttel
Head of Section "Protected Areas"
Swiss Agency for the Environment, Forests and Landscape
CH-3003 Berne

f. Agreed plans related to property (e.g., regional, local plan, conservation plan, tourism development plan)

Under the **Cantonal Development Plan** – an instrument co-ordinating territorial development at cantonal level – the whole of Monte San Giorgio is designated as a nature reserve. The co-ordination document covering the area (scheda di coordinamento n. 1.2. (Appendix **E**) is binding on the cantonal and local authorities. In particular, the local authorities are required to ensure co-ordination in planning matters, incorporating the directions of the Cantonal Plan into their own Local Development Plans or conforming to a Cantonal Land-use Plan.

The **Local Development Plans (LDPs)** covering the Monte San Giorgio protection area contain the following provisions:

- Meride LDP: the summit of the Mountain forms part of an area of special natural interest and a protected area; the remainder is classified as a forest area; the whole area of countryside overlooked by the village is classified as a landscape protection area;
- Riva San Vitale LDP: the Mountain forms part of a nature reserve;
- Arzo LDP: the Poncione forest area forms part of a nature reserve.

The relevant extracts from the landscape sections of the Meride, Riva San Vitale and Arzo LDPs are reproduced in Appendixes **F**, **G**, **H**.

g. Sources and levels of finance

It is extremely difficult to quantify the total costs involved in managing the site.

First of all, there are the costs involved in looking after the area: management and cleaning of woodland, management of dry meadows (in the last 8 years, the Confederation and the Canton have invested more than CHF 500,000 in features of national importance on the mountain), maintenance of footpaths, etc.

Where research (excavations) and the dissemination of scientific information regarding the palaeontological heritage is concerned, the costs are borne mainly by the university institutes and museums involved.

Money is also spent on initiatives to promote Monte San Giorgio (nature trail, symposia, conferences, publications, GEO-GUIDE, Meride Fossil Museum, etc.).

Finally, the costs of employing staff to protect and manage the mountain (federal and cantonal officials, forestry workers, local authority managers, etc.) should not be underestimated.

h. Sources of expertise and training in conservation and management techniques

The staff of the federal and cantonal departments responsible for protecting the natural environment and landscape hold academic qualifications (from universities or federal institutes of technology) in natural sciences, geography and geology.

i. Visitor facilities and statistics

There is no visitors' centre as such. However, the Meride Fossil Museum is very active (11,000 visitors a year) and plans are being drawn up to restructure and enlarge the existing facilities (see chapter **3.e.**).

Public visits to excavation and research campaigns on Monte San Giorgio are organised from time to time for people with interest in fossils.

Because there is no visitor's centre capable of keeping accurate statistics, it is difficult to estimate the number of day visitors and people coming to see the natural features of the mountain. However, a reasonable guess would be between 80,000 and 100,000 visitors a year.

j. Property management plan and statement of objectives (copy to be annexed)

A management plan for the palaeontological components of the site has not yet been drafted. It is in preparation.

k. Staffing levels (professional, technical, maintenance)

No staff are as yet employed by the national or cantonal authorities **exclusively** to protect, manage or oversee the site. All the people involved also do other jobs.

5. Factors Affecting the Property

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

First of all, a distinction has to be drawn between human activities in the protection area and those carried on in the buffer zone.

In the former, regarded to all intents and purposes as an "area of absolute protection" for the Triassic formations, the possibility of development pressures is minimal. The area is almost entirely wooded, apart from a few clearings managed for the purposes of extensive agriculture. The legislation currently in force (see chapter **4.b.**) affords the site sufficient protection from the development of any agricultural, pastoral or forestry activities which might be incompatible with the purposes of protection.

Where human habitation is concerned, in particular the restructuring of existing buildings or construction of new ones, any authorisations would have to comply with higher legislation and the objectives of safeguarding the landscape. In fact, the only dwelling (at Meride) included in the protection area features on the Inventory of Swiss Heritage Sites of National Importance (ISOS).

The development of a tourism infrastructure in the area is practically unthinkable; the prevalent form of tourism is of the "soft" kind associated with day trips and leisure activities in natural surroundings.

There are no plans to allow further mining and quarrying activities in the protection area. The only exceptions are scientific excavations to investigate the area's palaeontological heritage, and these are regulated by a special Decree (see chapter **3.d.**).

The same is generally true for the buffer zone: existing legislation and the plans adopted at cantonal and local authority level (see chapter **4.f.**) ensure adequate control over the development of human activities.

Special mention needs to be made of the existing quarrying activities (at Arzo). The current agreements governing exploitation of the rocks for artisan purposes envisage the continuation and maintenance of a centuries-old tradition (see chapter **3.b.**), which has made the ornamental rocks of Monte San Giorgio famous in Switzerland and abroad. These agreements are the yardstick for the management of such activities within so valuable a landscape setting. Adequately regulated, this kind of activity is not in conflict with the objective of protecting the future buffer zone.

Other types of activity (agriculture, forestry, tourism, the building of dwellings, etc.), which are in any case strictly controlled in this area, are not likely to seriously endanger the site, in particular the geological and fossil-bearing formations.

b. Environmental pressures (e.g., pollution, climate change)

The geological formations and fossil-bearing deposits are not significantly threatened by natural phenomena or environmental processes.

From a hydrogeological point of view, Monte San Giorgio is not generally affected by such phenomena as erosion, landslides or rock falls, largely because it is so well wooded. According to the Cantonal Register of Areas of Natural Danger, only in a few limited locations on the eastern side of the mountain and near the Poncione di Arzo, are there unstable slopes, and these have no connection with the fossil-bearing deposits. In any case, occasional exceptional instances of land slip would not be incompatible with the aims of managing the protection area, because they might uncover new geological outcrops.

The site is not threatened by other types of natural disaster such as avalanches (the summit of Monte San Giorgio is only 1,096.7 m above sea level) or flooding.

Atmospheric pollution, in particular the emissions generated by human activity in the densely settled area of the lower Ticino, transport and the concentration of photo-oxidants (ozone) during the summer season, does undoubtedly have repercussions on the vegetation of the mountain.

No one has yet made an analysis of this phenomenon and its consequences.

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

Apart from forest fires, the prevention of which is provided for in the woodland management programmes of the competent cantonal services, there are no other potential natural disasters, as previously stated in chapter **5.b.**.

d. Visitor/tourism pressures

Monte San Giorgio's capacity to receive visitors is clearly limited by its topography, lack of access routes, and scarcity of tourism infrastructure.

These factors are in fact favourable, in that they ensure that the number of visitors (80,000 to 100,000 a year) is not excessive and no harm is done to the more delicate aspects of the environment.

If the site is listed, and consequently becomes internationally well known, it is to be expected that the number of tourists and visitors will increase.

In this case, it will be necessary to regulate the flow of visitors, in particular by introducing measures to improve access to the mountain (park and ride schemes), create a network of educational trails (some initiatives of this kind are already being taken, see chapter **3.e.**), providing tourists with appropriate information, and improving signposting.

e. Number of inhabitants within property, buffer zone

Approximately 150 people live within the protection area. Altogether, 11,500 people are resident in the nine local authority areas associated with Monte San Giorgio – i.e. not only within the buffer zone but, in the case of the lowland villages, beyond its confines.

f. Other

We do not believe there to be any other factors likely to endanger the site.

6. Monitoring

a. Key indicators for measuring state of conservation

At the present time, there is no overall instrument for monitoring the state of conservation of the site at regular intervals.

However, on-going monitoring of the most important components of the site – i.e. the geological and palaeontological features, the outstanding quality of which have motivated this application – is and will continue to be ensured by strict application on the part of the cantonal authorities of the Legislative Decree governing the collection of rocks, minerals and fossils, and by careful management of palaeontological excavations in conjunction with the recognised research institutes (see chapter **6.b.**).

The existing planning regulations are also a key factor in ensuring the conservation of the site, particularly as the Cantonal Development Plan and individual Local Development Plans are regularly reviewed and updated.

Of the 9 local authorities with an interest in the Monte San Giorgio area, 8 are already in the process of revising their LDPs.

b. Administrative arrangements for monitoring property

All matters pertaining to the palaeontological heritage of Monte San Giorgio are already subject to regular monitoring by the Cantonal Government, not least because the State is the exclusive owner of all fossil finds.

The Canton – acting through the Department of Land Use and Environment's Cantonal Museum of Natural History – has special responsibility for supervising the palaeontological excavations, verifying new discoveries, deciding how they should be used and exhibited and stipulating agreements with the parties concerned (university institutes and museums) as regards scientific publications.

In other words, management of the palaeontological heritage of Monte San Giorgio and the related research activities is the responsibility of the cantonal authorities.

The recognised research institutes have competence in purely scientific matters.

c. Results of previous reporting exercises

There are no earlier reports on the state of conservation of the site.

7. Documentation

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

See Appendix **B**. A CD ROM with slides will be prepared.

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

Appendixes **D**, **E**, **F**, **G**, **H**.

c. Bibliography

Appendix **A**.

d. Address where inventory, records and archives are held

Swiss agency for the Environment
Forests and Landscape (SAEFL)
CH-3003 Bern

Museo cantonale di storia naturale
Viale C. Cattaneo 4
CH-6900 Lugano

Commissione Museo dei Fossili di Meride
CH-6866 Meride

Dipartimento del territorio
Ufficio protezione della natura
Viale S. Franscini 17
CH-6500 Bellinzona

Palaeontological Institute and Museum of the University of Zurich
Karl Schmid-Strasse 4
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e. Nomination file

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Bern 15th January 2002

Swiss Agency for the Environment,
Forests and Landscape

Franz-Sepp Stulz
Head of Division "Nature"

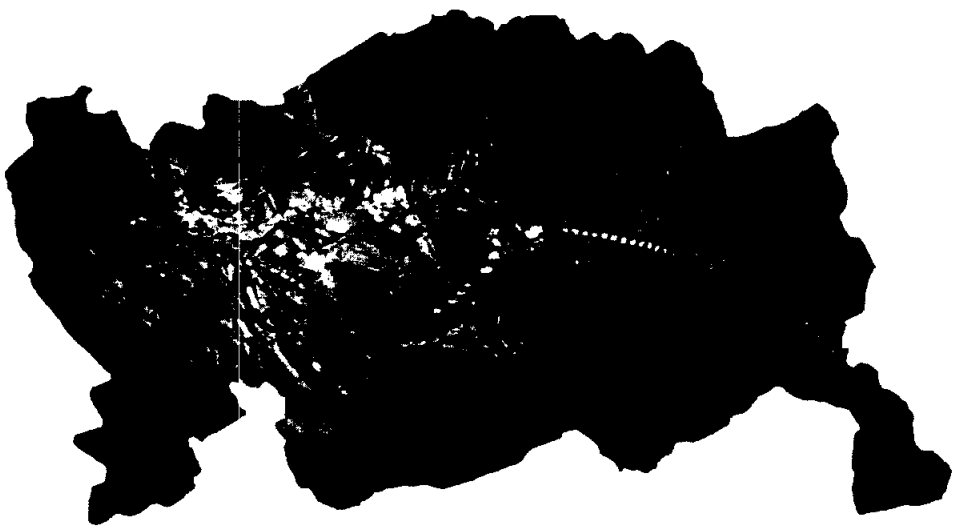
NOMINATION of MONTE SAN GIORGIO

for

INCLUSION on the WORLD HERITAGE LIST

Draft

Site management plan



NOMINATION of MONTE SAN GIORGIO

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Site management plan

Introduction

UNESCO's World Heritage Centre has examined the dossier regarding the candidature of Monte San Giorgio for inclusion on the World Heritage List, and has judged it "almost complete".

As part of the additional information required to complete the dossier, the Directors of the Centre have requested a copy of a draft site management plan. It is stated in the dossier itself that a management plan for the palaeontological components is already under study.

Given that a number of institutional bodies are taking an interest in Monte San Giorgio on various fronts (in particular, co-ordination of planning and territorial matters as part of the INTERREG III A community programme; feasibility study for a new Fossil Museum at Meride; Mendrisiotto and Basso Ceresio transport plan), this document is a preliminary model setting out the objectives and measures necessary for the prudent management of the site over time.

1. Management of the palaeontological components

All aspects of the palaeontological heritage of Monte San Giorgio are already subject to management and regular periodic monitoring by the State, if only because all the fossil remains are exclusively State property.

In particular, it is the task of the Canton – acting through the Cantonal Museum of Natural History of the Department responsible for the territory – to supervise palaeontological excavations, check the materials discovered and define how they should be used for exhibition purposes.

Until now, the Legislative Decree governing the search for and collection of rocks, minerals and fossils (1974) has played an essential role, making it obligatory to obtain a cantonal permit to collect rocks, mineral and fossils. To date, under the Regulations implementing this legislation (1975), research facilities have been granted only to university or scientific research institutes of proven validity.

For this reason, the Middle Triassic palaeontological heritage of Monte San Giorgio is almost perfectly preserved and catalogued in the collections and exhibition of the Institute of Palaeontology of the University of Zurich. However, items found during recent excavation campaigns are conserved at the Cantonal Museum of Natural History in Lugano. Finds made on the Italian side are kept in various Italian museums (Milan, Induno Olona and Besano).

Objectives

Disciplined management of scientific excavations, co-ordination of the preparation and study of the palaeontological finds made, and collaboration between the university institutes, cantonal authorities and local authorities involved must provide absolute guarantees of the future preservation and integrity of the fossil-bearing outcrops.

The conservation of the fossil remains and the exhibition of those most typical in recognised institutes and museums (local, regional, cantonal and national), together with scientific and popular publications concerning the site and its various components, must continue to ensure that the palaeontological heritage of Monte San Giorgio is accessible to specialists, students and the general public as important evidence of the Earth's history.

Measures

From a legal point of view, the new cantonal law on nature protection, which came into force on 1 March 2002, is the ideal instrument for ensuring prudent management of the palaeontological heritage of Monte San Giorgio. New Regulations governing the collection of rocks, minerals and fossils (currently being drafted and due for completion by the end of 2003) will cover the detailed application of this law in a modern, up-to-date way.

On the operational level, co-ordination between the scientific institutes will continue in accordance with the plan of excavations, research and publication of fossil remains drawn up by the Institute of Palaeontology of the University of Zurich and the Department of Earth Sciences of the University of Milan, with the collaboration of the Lugano Museum of Natural History.

2. The new Fossil Museum

A feasibility study is being conducted into plans for an new Fossil Museum at Meride. The existing museum facilities, and the paucity of the items on display, are no longer compatible with present needs and the growing scientific importance of Monte San Giorgio.

Objectives

The restructuring and rethinking of the purpose of the Fossil Museum at Meride must provide the local population, visitors and tourists with a centre for meeting, study and dissemination of scientific knowledge which reflects the value of the environmental and scientific heritage of Monte San Giorgio.

Measures

To plan for a new Fossil Museum which is both an exhibition centre and a place of organised activities and training. While focusing primarily on the area's palaeontological heritage, the new Museum should also feature other aspects of Monte San Giorgio, in

particular its environmental, landscape and historical/cultural interest, with the emphasis very much on the local area.

To facilitate management of the flow of visitors, the new Fossil Museum could become a "gateway" to Monte San Giorgio and function as a reception and information centre for visitors.

3. Management of the territorial aspects of Monte San Giorgio

Territorial planning and co-ordination

In May 2001, the local authorities (communes) on the Swiss side of Monte San Giorgio (Meride, Brusino Arsizio, Arzo, Tremona, Riva San Vitale, Rancate, Besazio, Ligornetto and Stabio), those on the Italian side (Besano, Porto Ceresio, Viggiù, Saltrio and Clivio) and a number of regional and local private and public bodies signed a Draft Agreement to prepare a joint integrated development plan for the environmental, historical, economic and tourist assets of the Monte San Giorgio area.

As part of the community INTERREG III A initiative, a number of common projects have been defined covering various sectorial areas, with particular emphasis on the co-ordination of territorial planning and the management of the components of Monte San Giorgio.

Objectives

Monte San Giorgio is a small geographical entity rich in geological and environmental assets, as well as cultural, social and economic features specific to the area.

The priority objective is to gain a thorough knowledge of the elements described above, with the purpose of formulating general territorial planning and management guidelines, adopting a co-ordinated approach at the inter-communal level.

Measures

The studies planned under the INTERREG III A initiative must make it possible to identify a conceptual model for the territorial organisation of the mountain, as a basis for

safeguarding its environmental and scenic features, protecting its culture and consolidating its social and economic life.

Cross-border co-operation is being promoted as a basis for identifying instruments and methodologies for territorial planning and management, with a view to the sustainable development of Monte San Giorgio.

Natural and landscape components

Existing federal, cantonal and communal legislation provides a high degree of protection for the environmental and landscape features of Monte San Giorgio.

Objectives

To ensure protection of the natural and scenic features of the mountain as a location for animal, plant and fungus species, and as a place where present and future generations can relax and enjoy contact with the natural world.

Measures

The competent authorities at the various levels will ensure that the laws and planning regulations governing the site are correctly implemented.

An example of a concrete initiative to protect the natural and landscape features of Monte San Giorgio is the management plan for dry meadows (approximately 30 individual sites) on the summit of the mountain. Combining the need for protection with agricultural activities, it has been possible to manage the way in which grass is cut for hay in these areas of special environmental interest, by drawing up agreements between the Canton, the Commune of Meride and agricultural and forestry organisations. Federal and cantonal funds are allocated under these agreements.

The most recent management plan for the dry meadows of Monte San Giorgio is of ten years' duration and came into effect in 2000.

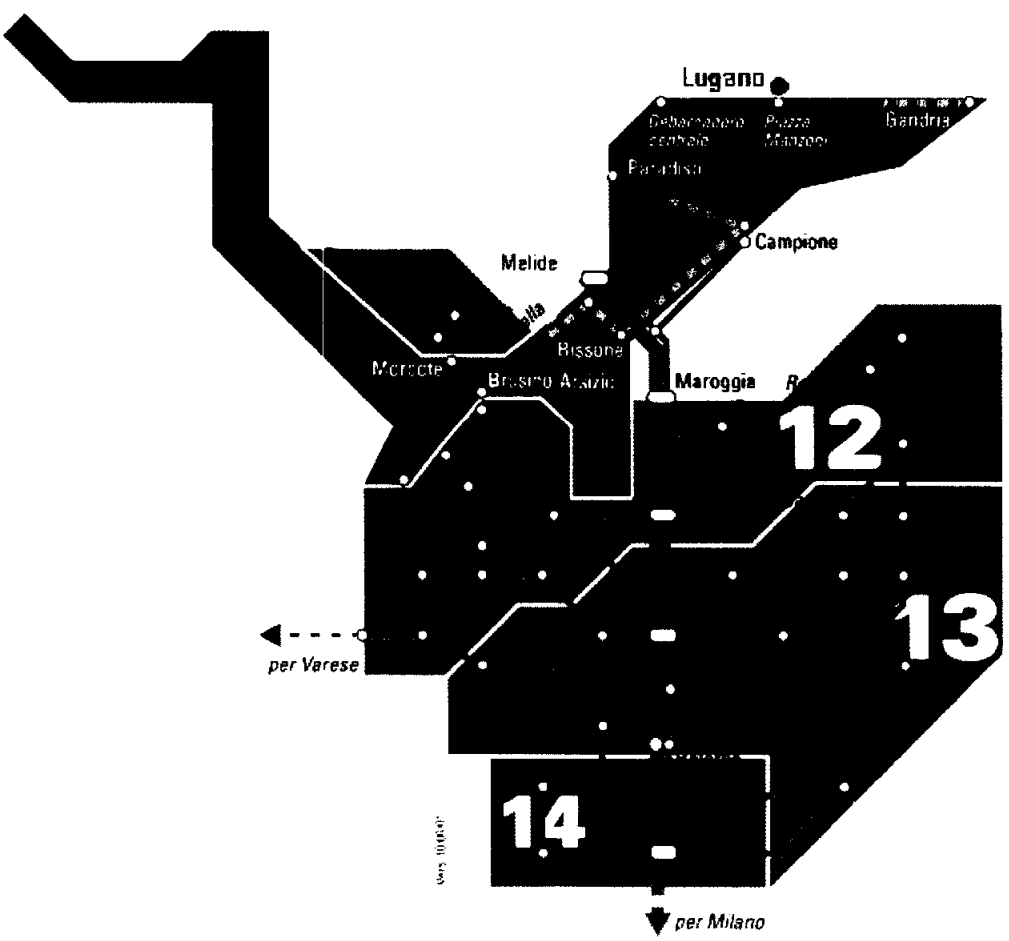
Transport and accessibility

On 26 February 2002, the Government of Ticino Canton adopted the Mendrisiotto and Basso Ceresio Transport Plan (MTP), which was integrated into the cantonal transport plan and, in particular, the overall cantonal development plan. The MTP defines some areas as strategic, others as sensitive. The latter include areas of special landscape and environmental importance, such as Monte San Giorgio.

Where the present provision of public road transport is concerned, the following services are currently available on the route Mendrisio-Arzo-Meride-Serpiano (see illustration below):

- Monday-Friday: 14 return services;
- Saturday: 9 return services;
- Sunday: 6 return services.

Mendrisio is also an important transport interchange, offering connections with other services and, in particular, trains running on the St. Gotthard railway line.



Objectives

To strengthen the public transport network, making public services competitive in relation to private cars.

Measures

The MTP provides for improvements to the road network and management measures to optimise public transport connections. For Monte San Giorgio in particular: identify areas where it is appropriate to restrict use of private cars; introduce traffic calming measures in certain places and orderly car-parking arrangements.

Where more leisurely methods of transport are concerned, there are plans to create a regional cycle track from Riva S. Vitale to Brusino Arsizio.

Existing pedestrian routes and the cantonal footpath network will be adapted to meet visitors' needs, particularly as regards signage.

Other activities

For information regarding the management of other sectorial activities (tourism, forestry, agriculture, mining, industry and craft activities, hunting and fishing, etc.), please refer to the objectives of the integrated project for co-ordinating the territorial planning and management of Monte San Giorgio, included in the INTERREG III A Italy-Switzerland programme.

4. Visitor facilities

The need for a reception and information centre for visitors and tourists coming to Monte San Giorgio is universally accepted.

It is currently envisaged that the Meride Fossil Museum will provide a suitable location for this sort of facility. Plans to enlarge and develop the Museum are under consideration (see chapter 2).

5. Promotion

Various initiatives to promote Monte San Giorgio and its geological, environmental and landscape features have already been launched or are in preparation.

A GEO-GUIDA has been published, and there is a wealth of scientific and popular literature available. A detailed website has been developed featuring Monte San Giorgio and the Meride Fossil Museum (**www.montesangiorgio.ch**), and in the near future the Italian-language radio and television service (Radio Televisione della Svizzera italiana) will be producing a documentary on the area.

Ways of promoting the mountain will also be investigated as part of the INTERREG III A project.

6. Organisation

All proposals relating to the management of Monte San Giorgio will need to be discussed by an organisational structure involving all the institutions concerned: the Confederation, the relevant cantonal departments, the local authorities and land-owners with an interest in the mountain, as well as academic partners, the cantonal and regional tourism boards, regional and local voluntary bodies, regional and local museums, and so on.

7. Funding

An efficient management plan for Monte San Giorgio requires not only the collaboration of all the bodies and persons concerned, but also adequate funding.

It would be premature to try to estimate costs at this stage.

21.05.2002/SBMA/Mol

Fig. 2: Panoramic view of Monte San Giorgio (Photograph: M. FELBER

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Appendix B

List of Ilustrations

Appendix C

Fauna List

Banque de données CSCF.
Périmètre: Monte San Giorgio (TI), coord. 715-718 / 083-086
ST : Liste rouge: 0 = éteinte, 1 = en danger d'extinction, 2 = très menacée, 3 = menacée, 4 = potentiellement menacée, 5 ou n = non menacées, 6 = espèce migratrice

CSCF/FC/18/09/01

INVERTEBRES

	ORDRE	FAMILLE	GENRE	ESPECE	ST
Mollusca	Actophila	Carychiidae	Carychium	tridentatum	5
Mollusca	Architaenioglossa	Cochlostomatidae	Cochlostoma	septemspirale	5
Mollusca	Hygrophila	Lymnaeidae	Galba	truncatula	5
Mollusca	Hygrophila	Planorbidae	Ancylus	fluviatilis	5
Mollusca	Neotaenioglossa	Aciculidae	Acicula	lineata	4
Mollusca	Neotaenioglossa	Aciculidae	Acicula	lineolata	3
Mollusca	Neotaenioglossa	Hydrobiidae	Graziana	lacheineri	4
Mollusca	Neotaenioglossa	Pomatiasidae	Pomatias	elegans	2
Mollusca	Stylommatophora	Agriolimacidae	Deroceras	agreste	5
Mollusca	Stylommatophora	Argnidae	Argna	ferrari	3
Mollusca	Stylommatophora	Arionidae	Arion	lusitanicus	5
Mollusca	Stylommatophora	Arionidae	Arion	silvaticus	5
Mollusca	Stylommatophora	Buliminidae	Chondrula	tridens	2
Mollusca	Stylommatophora	Buliminidae	Merdigera	obscura	5
Mollusca	Stylommatophora	Chondrinidae	Chondrina	generosensis	4
Mollusca	Stylommatophora	Chondrinidae	Chondrina	megacheilos	5
Mollusca	Stylommatophora	Chondrinidae	Granaria	illyrica	4
Mollusca	Stylommatophora	Clausiliidae	Charpentieria	itala	5
Mollusca	Stylommatophora	Clausiliidae	Clausilia	cruciata	5
Mollusca	Stylommatophora	Clausiliidae	Macrogastra	attenuata	5
Mollusca	Stylommatophora	Clausiliidae	Macrogastra	plicatula	5
Mollusca	Stylommatophora	Clausiliidae	Neostyriaca	strobel	5
Mollusca	Stylommatophora	Cochlicopidae	Cochlicopa	lubricella	5
Mollusca	Stylommatophora	Cochlicopidae	Cochlicopa	n.sp.	5
Mollusca	Stylommatophora	Discidae	Discus	rotundatus	5
Mollusca	Stylommatophora	Helicidae	Cepaea	nemoralis	5
Mollusca	Stylommatophora	Helicidae	Helix	pomatia	4
Mollusca	Stylommatophora	Hygromiidae	Candidula	unifasciata	5
Mollusca	Stylommatophora	Hygromiidae	Ciliella	ciliata	5
Mollusca	Stylommatophora	Hygromiidae	Drepanostoma	nautiliforme	3
Mollusca	Stylommatophora	Hygromiidae	Euomphalia	strigella	4
Mollusca	Stylommatophora	Hygromiidae	Helicodonta	angigyra	5
Mollusca	Stylommatophora	Hygromiidae	Helicodonta	obvoluta	5
Mollusca	Stylommatophora	Hygromiidae	Hygromia	cinctella	5
Mollusca	Stylommatophora	Hygromiidae	Monachoides	incarnatus	5
Mollusca	Stylommatophora	Lauriidae	Lauria	sempronii	3
Mollusca	Stylommatophora	Limacidae	Lehmannia	marginata	5
Mollusca	Stylommatophora	Limacidae	Limax	rutilocanus	5
Mollusca	Stylommatophora	Limacidae	Limax	redii	3
Mollusca	Stylommatophora	Milacidae	Tandonia	rustica	5
Mollusca	Stylommatophora	Orculidae	Pagodulina	austeniana	4
Mollusca	Stylommatophora	Orculidae	Sphyradium	doliolum	3
Mollusca	Stylommatophora	Punctidae	Punctum	pygmaeum	5
Mollusca	Stylommatophora	Pupillidae	Pupilla	muscorum	5
Mollusca	Stylommatophora	Pyramidulidae	Pyramidula	pusilla	5
Mollusca	Stylommatophora	Valloniidae	Acanthinula	aculeata	5
Mollusca	Stylommatophora	Valloniidae	Vallonia	costata	5
Mollusca	Stylommatophora	Valloniidae	Vallonia	pulchella	5
Mollusca	Stylommatophora	Vertiginidae	Truncatellina	callicratis	4

Mollusca	Stylommatophora	Vertiginidae	Truncatellina	claustralis	3
Mollusca	Stylommatophora	Vitrinidae	Vitrinobrachium	breve	3
Mollusca	Stylommatophora	Zonitidae	Aegopinella	nitens	5
Mollusca	Stylommatophora	Zonitidae	Aegopinella	pura	5
Mollusca	Stylommatophora	Zonitidae	Oxychilus	cellarius	5
Mollusca	Stylommatophora	Zonitidae	Oxychilus	draparnaudi	5
Mollusca	Stylommatophora	Zonitidae	Oxychilus	mortilleti	5
Mollusca	Stylommatophora	Zonitidae	Retinella	hiulca	5
Mollusca	Stylommatophora	Zonitidae	Vitrea	subrimata	5
Insecta	Coleoptera	Carabidae	Abax	angustatus	5
Insecta	Coleoptera	Carabidae	Abax	ater	5
Insecta	Coleoptera	Carabidae	Abax	continuus	5
Insecta	Coleoptera	Carabidae	Abax	exaratus	5
Insecta	Coleoptera	Carabidae	Acupalpus	meridianus	5
Insecta	Coleoptera	Carabidae	Agonum	micans	5
Insecta	Coleoptera	Carabidae	Agonum	muelleri	5
Insecta	Coleoptera	Carabidae	Agonum	sexpunctatum	5
Insecta	Coleoptera	Carabidae	Agonum	viduum	5
Insecta	Coleoptera	Carabidae	Amara	aenea	5
Insecta	Coleoptera	Carabidae	Amara	aulica	5
Insecta	Coleoptera	Carabidae	Amara	communis	5
Insecta	Coleoptera	Carabidae	Amara	convexior	5
Insecta	Coleoptera	Carabidae	Amara	equestris	5
Insecta	Coleoptera	Carabidae	Amara	familiaris	5
Insecta	Coleoptera	Carabidae	Amara	lucida	5
Insecta	Coleoptera	Carabidae	Amara	lunicollis	5
Insecta	Coleoptera	Carabidae	Amara	nitida	5
Insecta	Coleoptera	Carabidae	Anchomenus	dorsalis	5
Insecta	Coleoptera	Carabidae	Anisodactylus	binotatus	5
Insecta	Coleoptera	Carabidae	Anisodactylus	signatus	5
Insecta	Coleoptera	Carabidae	Antisphodrus	macropus	4
Insecta	Coleoptera	Carabidae	Asaphidion	austriacum	5
Insecta	Coleoptera	Carabidae	Badister	bullatus	5
Insecta	Coleoptera	Carabidae	Badister	sodalis	5
Insecta	Coleoptera	Carabidae	Bembidion	articulatum	5
Insecta	Coleoptera	Carabidae	Bembidion	ascendens	5
Insecta	Coleoptera	Carabidae	Bembidion	decorum	5
Insecta	Coleoptera	Carabidae	Bembidion	deletum	5
Insecta	Coleoptera	Carabidae	Bembidion	geniculatum	5
Insecta	Coleoptera	Carabidae	Bembidion	lampros	5
Insecta	Coleoptera	Carabidae	Bembidion	lunulatum	5
Insecta	Coleoptera	Carabidae	Bembidion	properans	5
Insecta	Coleoptera	Carabidae	Bembidion	pygmaeum	5
Insecta	Coleoptera	Carabidae	Bembidion	quadrimaculatum	5
Insecta	Coleoptera	Carabidae	Bembidion	tibiale	5
Insecta	Coleoptera	Carabidae	Brachinus	explodens	5
Insecta	Coleoptera	Carabidae	Brachinus	ganglbaueri	3
Insecta	Coleoptera	Carabidae	Brachinus	sclopeta	2
Insecta	Coleoptera	Carabidae	Bradycellus	caucasicus	5
Insecta	Coleoptera	Carabidae	Calathus	erratus	5
Insecta	Coleoptera	Carabidae	Calathus	fuscipes	5
Insecta	Coleoptera	Carabidae	Calathus	melanocephalus	5
Insecta	Coleoptera	Carabidae	Calathus	rubripes	4
Insecta	Coleoptera	Carabidae	Callistus	lunatus	5
Insecta	Coleoptera	Carabidae	Carabus	cancellatus	5
Insecta	Coleoptera	Carabidae	Carabus	catenulatus	4
Insecta	Coleoptera	Carabidae	Carabus	convexus	3
Insecta	Coleoptera	Carabidae	Carabus	coriaceus	5
Insecta	Coleoptera	Carabidae	Carabus	glabratus	5
Insecta	Coleoptera	Carabidae	Carabus	granulatus	5
Insecta	Coleoptera	Carabidae	Carabus	intricatus	5
Insecta	Coleoptera	Carabidae	Carabus	italicus	5

Insecta	Coleoptera	Carabidae	Carabus	monticola	4
Insecta	Coleoptera	Carabidae	Carabus	violaceus	5
Insecta	Coleoptera	Carabidae	Chlaenius	nitidulus	5
Insecta	Coleoptera	Carabidae	Chlaenius	vestitus	5
Insecta	Coleoptera	Carabidae	Cicindela	campestris	5
Insecta	Coleoptera	Carabidae	Clivina	collaris	5
Insecta	Coleoptera	Carabidae	Clivina	fossor	5
Insecta	Coleoptera	Carabidae	Cychrus	italicus	5
Insecta	Coleoptera	Carabidae	Cymindis	cingulata	5
Insecta	Coleoptera	Carabidae	Demetrias	atricapillus	5
Insecta	Coleoptera	Carabidae	Diachromus	germanus	5
Insecta	Coleoptera	Carabidae	Dromius	quadrimaculatus	5
Insecta	Coleoptera	Carabidae	Drypta	dentata	3
Insecta	Coleoptera	Carabidae	Elaphropus	parvulus	5
Insecta	Coleoptera	Carabidae	Harpalus	affinis	5
Insecta	Coleoptera	Carabidae	Harpalus	anxius	5
Insecta	Coleoptera	Carabidae	Harpalus	atratus	5
Insecta	Coleoptera	Carabidae	Harpalus	dimidiatus	5
Insecta	Coleoptera	Carabidae	Harpalus	distinguendus	5
Insecta	Coleoptera	Carabidae	Harpalus	honestus	5
Insecta	Coleoptera	Carabidae	Harpalus	latus	5
Insecta	Coleoptera	Carabidae	Harpalus	luteicornis	5
Insecta	Coleoptera	Carabidae	Harpalus	rubripes	5
Insecta	Coleoptera	Carabidae	Harpalus	sulphuripes	5
Insecta	Coleoptera	Carabidae	Harpalus	tardus	5
Insecta	Coleoptera	Carabidae	Limodromus	assimilis	5
Insecta	Coleoptera	Carabidae	Microlestes	minutulus	5
Insecta	Coleoptera	Carabidae	Molops	edurus	4
Insecta	Coleoptera	Carabidae	Nebria	brevicollis	5
Insecta	Coleoptera	Carabidae	Notiophilus	biguttatus	5
Insecta	Coleoptera	Carabidae	Notiophilus	rufipes	3
Insecta	Coleoptera	Carabidae	Ophonus	azureus	5
Insecta	Coleoptera	Carabidae	Ophonus	stictus	5
Insecta	Coleoptera	Carabidae	Paradromius	linearis	5
Insecta	Coleoptera	Carabidae	Paranchus	albipes	5
Insecta	Coleoptera	Carabidae	Paratachys	bistriatus	5
Insecta	Coleoptera	Carabidae	Paratachys	fulvicollis	4
Insecta	Coleoptera	Carabidae	Paratachys	micros	4
Insecta	Coleoptera	Carabidae	Parophonus	maculicornis	5
Insecta	Coleoptera	Carabidae	Perigona	nigriceps	5
Insecta	Coleoptera	Carabidae	Perileptus	areolatus	4
Insecta	Coleoptera	Carabidae	Philorhizus	melanocephalus	5
Insecta	Coleoptera	Carabidae	Poecilus	cupreus	5
Insecta	Coleoptera	Carabidae	Pseudophonus	griseus	5
Insecta	Coleoptera	Carabidae	Pseudophonus	rufipes	5
Insecta	Coleoptera	Carabidae	Pterostichus	apenninus	5
Insecta	Coleoptera	Carabidae	Pterostichus	burmeisteri	5
Insecta	Coleoptera	Carabidae	Pterostichus	gracilis	5
Insecta	Coleoptera	Carabidae	Pterostichus	melanarius	5
Insecta	Coleoptera	Carabidae	Pterostichus	melas	5
Insecta	Coleoptera	Carabidae	Pterostichus	micans	5
Insecta	Coleoptera	Carabidae	Pterostichus	nigrita	5
Insecta	Coleoptera	Carabidae	Pterostichus	oenotrius	5
Insecta	Coleoptera	Carabidae	Pterostichus	strenuus	5
Insecta	Coleoptera	Carabidae	Stenolophus	teutonus	5
Insecta	Coleoptera	Carabidae	Syntomus	truncatellus	5
Insecta	Coleoptera	Carabidae	Synuchus	vivalis	5
Insecta	Coleoptera	Carabidae	Thalassophilus	longicornis	4
Insecta	Coleoptera	Carabidae	Trechus	fairmairei	5
Insecta	Dyctyoptera	Mantidae	Mantis	religiosa	5
Insecta	Ephemeroptera	Baetidae	Baetis	rhodani	5
Insecta	Ephemeroptera	Ephemerellidae	Serratella	ignita	5
Insecta	Ephemeroptera	Ephemeridae	Ephemera	lineata	1

Insecta	Ephemeroptera	Heptageniidae	Ecdyonurus	helveticus	5
Insecta	Hymenoptera	Andrenidae	Andrena	apicata	3
Insecta	Hymenoptera	Andrenidae	Andrena	bicolor	5
Insecta	Hymenoptera	Andrenidae	Andrena	bimaculata	3
Insecta	Hymenoptera	Andrenidae	Andrena	combinata	3
Insecta	Hymenoptera	Andrenidae	Andrena	dorsata	5
Insecta	Hymenoptera	Andrenidae	Andrena	flavipes	5
Insecta	Hymenoptera	Andrenidae	Andrena	fulva	5
Insecta	Hymenoptera	Andrenidae	Andrena	fulvago	5
Insecta	Hymenoptera	Andrenidae	Andrena	fulvata	5
Insecta	Hymenoptera	Andrenidae	Andrena	haemorrhoa	5
Insecta	Hymenoptera	Andrenidae	Andrena	helvola	5
Insecta	Hymenoptera	Andrenidae	Andrena	minutula	5
Insecta	Hymenoptera	Andrenidae	Andrena	minutuloides	5
Insecta	Hymenoptera	Andrenidae	Andrena	nitida	5
Insecta	Hymenoptera	Andrenidae	Andrena	ovatula	5
Insecta	Hymenoptera	Andrenidae	Andrena	proxima	5
Insecta	Hymenoptera	Andrenidae	Andrena	strohmella	5
Insecta	Hymenoptera	Andrenidae	Andrena	subopaca	5
Insecta	Hymenoptera	Andrenidae	Andrena	symphyti	5
Insecta	Hymenoptera	Andrenidae	Andrena	taraxaci	5
Insecta	Hymenoptera	Anthophoridae	Anthophora	plumipes	5
Insecta	Hymenoptera	Anthophoridae	Anthophora	retusa	0
Insecta	Hymenoptera	Anthophoridae	Ceratina	cyanea	5
Insecta	Hymenoptera	Anthophoridae	Xylocopa	iris	2
Insecta	Hymenoptera	Anthophoridae	Xylocopa	valga	3
Insecta	Hymenoptera	Apidae	Apis	mellifera	5
Insecta	Hymenoptera	Apidae	Bombus	hortorum	5
Insecta	Hymenoptera	Apidae	Bombus	lapidarius	5
Insecta	Hymenoptera	Apidae	Bombus	lucorum	5
Insecta	Hymenoptera	Apidae	Bombus	pascuorum	5
Insecta	Hymenoptera	Apidae	Bombus	pratorum	5
Insecta	Hymenoptera	Apidae	Bombus	ruderarius	5
Insecta	Hymenoptera	Apidae	Bombus	soroeensis	5
Insecta	Hymenoptera	Apidae	Psithyrus	sylvestris	5
Insecta	Hymenoptera	Colletidae	Colletes	similis	3
Insecta	Hymenoptera	Colletidae	Hylaeus	annularis	5
Insecta	Hymenoptera	Colletidae	Hylaeus	brevicornis	5
Insecta	Hymenoptera	Colletidae	Hylaeus	communis	5
Insecta	Hymenoptera	Colletidae	Hylaeus	gibbus	5
Insecta	Hymenoptera	Colletidae	Hylaeus	gredleri	5
Insecta	Hymenoptera	Colletidae	Hylaeus	kahri	4
Insecta	Hymenoptera	Colletidae	Hylaeus	nigritus	5
Insecta	Hymenoptera	Halictidae	Halictus	maculatus	5
Insecta	Hymenoptera	Halictidae	Halictus	rubicundus	5
Insecta	Hymenoptera	Halictidae	Halictus	scabiosae	3
Insecta	Hymenoptera	Halictidae	Halictus	sexcinctus	3
Insecta	Hymenoptera	Halictidae	Halictus	simplex	5
Insecta	Hymenoptera	Halictidae	Halictus	subauratus	3
Insecta	Hymenoptera	Halictidae	Halictus	tumulorum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	aeratum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	albipes	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	calceatum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	fulvicorne	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	glabriusculum	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	laticeps	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	lativentre	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	leucopus	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	leucozonium	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	malachurum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	morio	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	nigripes	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	nitidulum	5

Insecta	Hymenoptera	Halictidae	Lasioglossum	pallens	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	parvulum	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	pauxillum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	politum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	pygmaeum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	rufitarse	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	tricinctum	3
Insecta	Hymenoptera	Halictidae	Lasioglossum	villosulum	5
Insecta	Hymenoptera	Halictidae	Lasioglossum	zonulum	5
Insecta	Hymenoptera	Halictidae	Sphecodes	crassus	5
Insecta	Hymenoptera	Halictidae	Sphecodes	ephippius	5
Insecta	Hymenoptera	Halictidae	Sphecodes	ferruginatus	5
Insecta	Hymenoptera	Halictidae	Sphecodes	gibbus	5
Insecta	Hymenoptera	Halictidae	Sphecodes	hyalinatus	5
Insecta	Hymenoptera	Halictidae	Sphecodes	monilicornis	5
Insecta	Hymenoptera	Megachilidae	Anthidium	manicatum	5
Insecta	Hymenoptera	Megachilidae	Heriades	crenulatus	3
Insecta	Hymenoptera	Megachilidae	Heriades	truncorum	5
Insecta	Hymenoptera	Megachilidae	Osmia	cornuta	5
Insecta	Hymenoptera	Megachilidae	Osmia	gallarum	3
Insecta	Hymenoptera	Megachilidae	Osmia	leucomelana	5
Insecta	Hymenoptera	Megachilidae	Osmia	mustelina	5
Insecta	Hymenoptera	Megachilidae	Osmia	submicans	3
Insecta	Lepidoptera	Hesperiidae	Hesperia	comma	5
Insecta	Lepidoptera	Hesperiidae	Heteropterus	morpheus	2
Insecta	Lepidoptera	Hesperiidae	Ochlodes	venatus	5
Insecta	Lepidoptera	Hesperiidae	Pyrgus	alveus	3
Insecta	Lepidoptera	Hesperiidae	Pyrgus	armoricanus	1
Insecta	Lepidoptera	Hesperiidae	Pyrgus	malvoides	5
Insecta	Lepidoptera	Hesperiidae	Spialia	sertorius	5
Insecta	Lepidoptera	Hesperiidae	Thymelicus	lineolus	5
Insecta	Lepidoptera	Lycaenidae	Callophrys	rubi	3
Insecta	Lepidoptera	Lycaenidae	Celastrina	argiolus	5
Insecta	Lepidoptera	Lycaenidae	Lycaena	tityrus	5
Insecta	Lepidoptera	Lycaenidae	Lycaena	virgaureae	3
Insecta	Lepidoptera	Lycaenidae	Polyommatus	bellargus	5
Insecta	Lepidoptera	Lycaenidae	Polyommatus	coridon	3
Insecta	Lepidoptera	Lycaenidae	Polyommatus	dorylas	3
Insecta	Lepidoptera	Lycaenidae	Polyommatus	icarus	5
Insecta	Lepidoptera	Lycaenidae	Scolitantides	orion	2
Insecta	Lepidoptera	Nymphalidae	Aglais	urticae	5
Insecta	Lepidoptera	Nymphalidae	Apatura	iris	3
Insecta	Lepidoptera	Nymphalidae	Argynnis	aglaja	5
Insecta	Lepidoptera	Nymphalidae	Argynnis	niobe	3
Insecta	Lepidoptera	Nymphalidae	Argynnis	paphia	5
Insecta	Lepidoptera	Nymphalidae	Boloria	dia	2
Insecta	Lepidoptera	Nymphalidae	Boloria	euphrosyne	5
Insecta	Lepidoptera	Nymphalidae	Boloria	selene	3
Insecta	Lepidoptera	Nymphalidae	Coenonympha	arcania	4b
Insecta	Lepidoptera	Nymphalidae	Coenonympha	pamphilus	5
Insecta	Lepidoptera	Nymphalidae	Erebia	aethiops	3
Insecta	Lepidoptera	Nymphalidae	Erebia	styx	4a
Insecta	Lepidoptera	Nymphalidae	Hipparchia	semele	2
Insecta	Lepidoptera	Nymphalidae	Hyponephele	lycaon	3
Insecta	Lepidoptera	Nymphalidae	Inachis	io	5
Insecta	Lepidoptera	Nymphalidae	Issoria	lathonia	5
Insecta	Lepidoptera	Nymphalidae	Lasiommata	maera	5
Insecta	Lepidoptera	Nymphalidae	Lasiommata	megera	5
Insecta	Lepidoptera	Nymphalidae	Limenitis	camilla	5
Insecta	Lepidoptera	Nymphalidae	Lopinga	achine	2
Insecta	Lepidoptera	Nymphalidae	Maniola	jurtina	5
Insecta	Lepidoptera	Nymphalidae	Melanargia	galathea	5
Insecta	Lepidoptera	Nymphalidae	Melitaea	athalia	3

Insecta	Lepidoptera	Nymphalidae	Melitaea	aurelia	2
Insecta	Lepidoptera	Nymphalidae	Melitaea	diamina	3
Insecta	Lepidoptera	Nymphalidae	Melitaea	didyma	3
Insecta	Lepidoptera	Nymphalidae	Melitaea	phoebe	2
Insecta	Lepidoptera	Nymphalidae	Minois	dryas	2
Insecta	Lepidoptera	Nymphalidae	Nymphalis	antiopa	3
Insecta	Lepidoptera	Nymphalidae	Nymphalis	polychloros	3
Insecta	Lepidoptera	Nymphalidae	Pararge	aegeria	5
Insecta	Lepidoptera	Nymphalidae	Polygonia	c-album	5
Insecta	Lepidoptera	Nymphalidae	Vanessa	atalanta	6
Insecta	Lepidoptera	Nymphalidae	Vanessa	cardui	6
Insecta	Lepidoptera	Papilionidae	Iphiclides	podalirius	2
Insecta	Lepidoptera	Papilionidae	Papilio	machaon	5
Insecta	Lepidoptera	Pieridae	Colias	crocea	6
Insecta	Lepidoptera	Pieridae	Colias	hyale	5
Insecta	Lepidoptera	Pieridae	Gonepteryx	rhamni	5
Insecta	Lepidoptera	Pieridae	Pieris	brassicae	5
Insecta	Lepidoptera	Pieridae	Pieris	napi	5
Insecta	Lepidoptera	Pieridae	Pieris	rapae	5
Insecta	Odonata	Corduliidae	Oxygastra	curtisii	1
Insecta	Odonata	Lestidae	Sympecma	fusca	5
Insecta	Odonata	Libellulidae	Orthetrum	cancellatum	5
Insecta	Orthoptera	Acrididae	Aiolopus	strepens	3
Insecta	Orthoptera	Acrididae	Chorthippus	brunneus	5
Insecta	Orthoptera	Acrididae	Chorthippus	dorsatus	5
Insecta	Orthoptera	Acrididae	Chorthippus	mollis	3
Insecta	Orthoptera	Acrididae	Chorthippus	parallelus	5
Insecta	Orthoptera	Acrididae	Chorthippus	scalaris	5
Insecta	Orthoptera	Acrididae	Chrysochraon	brachyptera	5
Insecta	Orthoptera	Acrididae	Euchorthippus	declivus	1
Insecta	Orthoptera	Acrididae	Gomphocerippus	rufus	5
Insecta	Orthoptera	Acrididae	Oedipoda	caerulescens	3
Insecta	Orthoptera	Acrididae	Omocestus	haemorrhoidalis	3
Insecta	Orthoptera	Acrididae	Omocestus	rufipes	3
Insecta	Orthoptera	Acrididae	Parapleurus	alliaceus	3
Insecta	Orthoptera	Acrididae	Stenobothrus	lineatus	5
Insecta	Orthoptera	Catantopidae	Calliptamus	siciliae	3
Insecta	Orthoptera	Catantopidae	Miramella	formosanta	3
Insecta	Orthoptera	Catantopidae	Odontopodisma	decipiens	5
Insecta	Orthoptera	Catantopidae	Pezotettix	giornae	5
Insecta	Orthoptera	Catantopidae	Podisma	pedestris	3
Insecta	Orthoptera	Gryllidae	Gryllus	campestris	3
Insecta	Orthoptera	Gryllidae	Nemobius	sylvestris	5
Insecta	Orthoptera	Gryllidae	Oecanthus	pellucens	3
Insecta	Orthoptera	Tetrigidae	Tetrix	bipunctata	3
Insecta	Orthoptera	Tetrigidae	Tetrix	bipunctata	5
Insecta	Orthoptera	Tetrigidae	Tetrix	tenuicornis	5
Insecta	Orthoptera	Tettigoniidae	Antaxius	pedestris	3
Insecta	Orthoptera	Tettigoniidae	Barbitistes	obtusus	3
Insecta	Orthoptera	Tettigoniidae	Conocephalus	discolor	3
Insecta	Orthoptera	Tettigoniidae	Ephippiger	vicheti	3
Insecta	Orthoptera	Tettigoniidae	Eupholidoptera	chabrieri	5
Insecta	Orthoptera	Tettigoniidae	Leptophyes	laticauda	3
Insecta	Orthoptera	Tettigoniidae	Leptophyes	punctatissima	3
Insecta	Orthoptera	Tettigoniidae	Meconema	meridionale	5
Insecta	Orthoptera	Tettigoniidae	Meconema	thalassinum	5
Insecta	Orthoptera	Tettigoniidae	Metrioptera	bicolor	3
Insecta	Orthoptera	Tettigoniidae	Metrioptera	fedtschenkoi	3
Insecta	Orthoptera	Tettigoniidae	Phaneroptera	falcata	3
Insecta	Orthoptera	Tettigoniidae	Phaneroptera	nana	3
Insecta	Orthoptera	Tettigoniidae	Pholidoptera	aptera	5
Insecta	Orthoptera	Tettigoniidae	Pholidoptera	fallax	3
Insecta	Orthoptera	Tettigoniidae	Pholidoptera	griseoaptera	5

Insecta	Orthoptera	Tettigoniidae	Pholidoptera	littoralis	1
Insecta	Orthoptera	Tettigoniidae	Platycleis	albopunctata	3
Insecta	Orthoptera	Tettigoniidae	Platycleis	grisea	5
Insecta	Orthoptera	Tettigoniidae	Polysarcus	denticauda	2
Insecta	Orthoptera	Tettigoniidae	Ruspolia	nitidula	3
Insecta	Orthoptera	Tettigoniidae	Tettigonia	cantans	5
Insecta	Orthoptera	Tettigoniidae	Tettigonia	viridissima	5

AMPHIBIENS-REPTILES

ESPECE	STATUT LR
Bufo bufo	3
Bufo viridis	0
Salamandra salamandra	3
Coluber viridiflavus	3
Coronella austriaca	3
Elaphe longissima	3
Lacerta bilineata	3
Natrix natrix	3
Natrix tessellata	2
Podarcis muralis	3
Vipera aspis	3

MAMMIFERES:

ESPECE	STATUT LR
Muscardinus avellanarius	3
Crocidura suaveolens	3
Lepus europaeus	3
Mustela nivalis	3
Pitymys multiplex	3
Pitymys savii	4
Talpa caeca	4

1804

Monte San Giorgio

Kanton: Tessin

Gemeinden: Arzo, Besazio, Brusino-Arsizio, Ligornetto, Meride, Rancate, Riva San Vitale, Tremona

Bedeutung: Markantes Hügelgebiet im südlichen Tessin. Von ausserordentlichem geologischem Interesse: Triasschichten mit fossilen Sauriern. Naturnahe Landschaft. Insubrische Flora mit seltenen Arten. Charakteristische Tessiner Dörfer in der lombardischen Bauweise des Sottoceneri.

Canton: Tessin

Communes: Arzo, Besazio, Brusino-Arsizio, Ligornetto, Meride, Rancate, Riva San Vitale, Tremona

Importance: Montagne du Tessin meridional présentant un intérêt exceptionnel du point de vue géologique: gisements fossilifères du Trias (Sauriens). Paysage naturel encore intact, flore insubrienne avec des espèces rares.
Villages tessinois caractéristiques du Sotto-Ceneri (style Lombard).

Cantone: Ticino

Comuni: Arzo, Besazio, Brusino-Arsizio, Ligornetto, Meride, Rancate, Riva San Vitale, Tremona

Importanza: Montagna del Ticino meridionale geologicamente molto interessante, con giacimenti triassici contenenti sauri fossili eccezionali. Paesaggio naturale ancora intatto, con flora insubrica ricca di specie rare.
Villaggi ticinesi caratteristici del Sottoceneri (stile Lombardo).


Melide
Bissone
Maroggia
Rovio
Vico Morcote
Brusino Arsizio
Morcote
Melano
Riva S. Vitale
Capolago
Porto Ceresio
Meride
Tremona
Arzo
Besazio
Saltrio
Viggiù
Rancate
Mendrisio
Ligornetto
Stabio
Genestrerio
Coldrerio
Balerna
Novazzano
Bizzarone
Rodero
Peccia
Frammento della carta nazionale 1:50000
Fogli 286 Malcantone, 296 Chiasso

	Scheda di coordinamento: **1.2.** 1 23	**Stato del coordinamento:**	**Risultato intermedio**
1			CdS 5.7.1990
Settore **Componenti naturali del territorio**	Oggetto **Componenti naturali accertate con protezione pianificatoria non ancora coordinata** Vedi elenco allegato alla scheda	Comune Vedi elenco allegato	Piano Vedi elenco allegato
Situazione: problematiche, conflitti	Gli studi di base per l'elaborazione del PD hanno permesso di avere una visione d'assieme del patrimonio naturale del Cantone e di organizzare le sue componenti sulla base della seguente classificazione: · riserve naturali orientate · parchi naturali · zone naturali protette. Detti studi hanno altresì evidenziato la necessità di adottare adeguate misure pianificatorie di protezione, non appena ultimato l'accertamento delle componenti naturali presenti nelle porzioni di territorio considerate. Il disciplinamento della protezione è del resto imposto al Cantone dagli articoli 18a e 18b della Legge federale sulla protezione della natura e del paesaggio del 1.7.1966 (LPN). I contenuti delle componenti naturali delle aree elencate nell'allegato alla presente scheda sono già stati accertati dal profilo scientifico. Le istanze interessate stanno procedendo alla valutazione degli interessi contrapposti al fine di stabilire l'entità della protezione pianificatoria necessaria.		Correlazione con altre schede: vedi piani

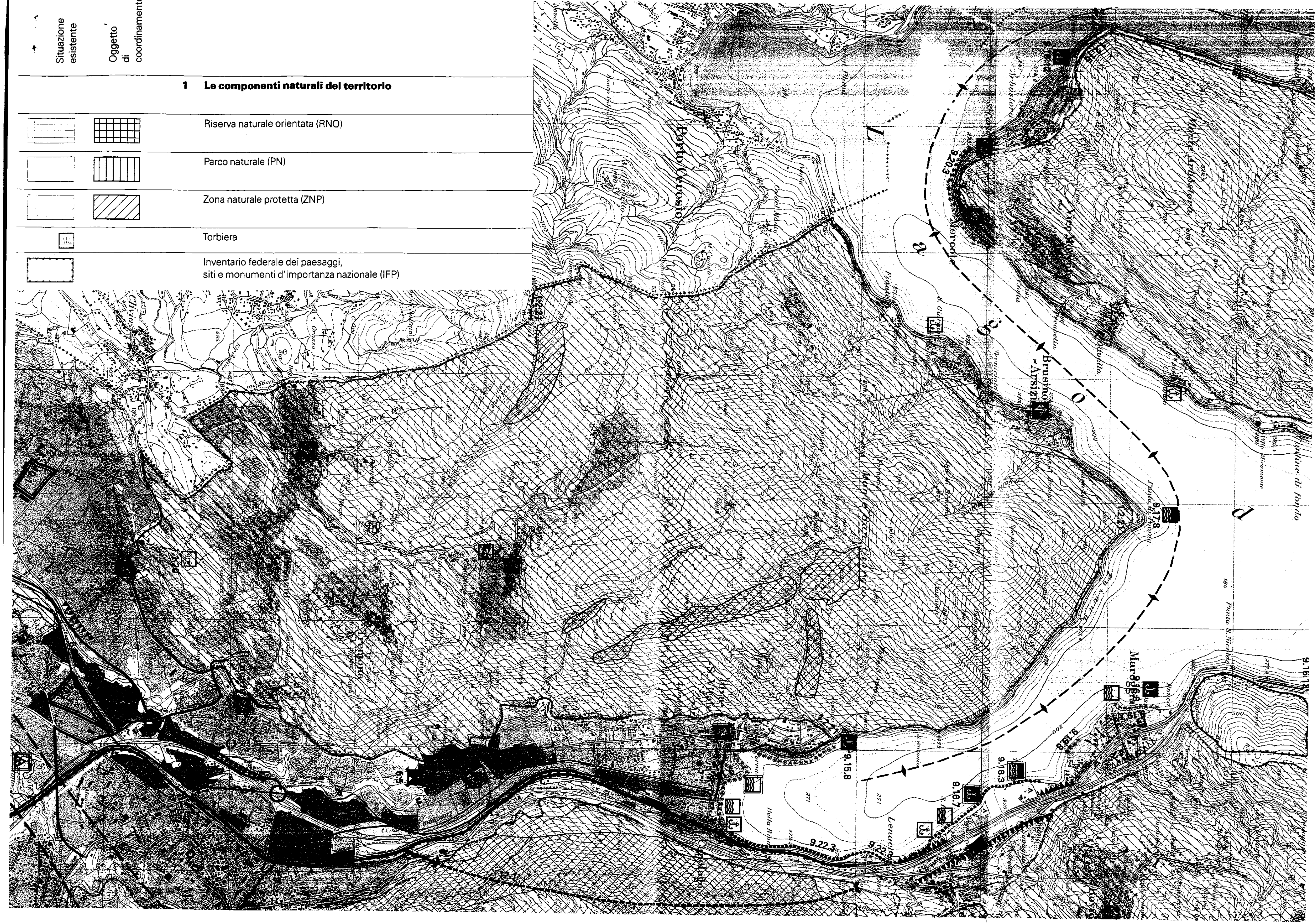
Scheda di coordinamento: **1.2.** 1 23	Allegato

3

Aree con componenti naturali accertate e coordinamento pianificatorio non concluso

Codice		Comune	Osservazioni	Piani PD
	Parchi naturali (PN)			
1.2.1	Arcegno	Losone		11
	Zone naturali protette (ZNP)			
1.2.2	Val Soia	Aquila		4
1.2.3	Novena	Bedretto		2
1.2.4	Vel (Gribbio)	Chironico	IFP 1809	3
1.2.5	Naret	Fusio		2
1.2.6	Greina	Ghirone Aquila		1
1.2.7	Tremorgio-Campolungo	Prato Leventina Fusio	IFP 1809	3
1.2.8	Aurigeno	Aurigeno Gordevio		11
1.2.9	Bosco Gurin - Campo Vallemaggia	Bosco Gurin Campo Vallemaggia		5 8
1.2.10	Val Verzasca	Brione Lavertezzo	IFP 1807	9
1.2.11	Paesaggio fluviale Visletto-Lodano	Cevio – Maggia		9
1.2.12	Arcegno	Losone Ascona	IFP 1806	11
1.2.13	Ponte Brolla	Tegna Losone Locarno Avegno Verscio	IFP 1806	11
1.2.14	Val Vergelletto	Vergelletto Gresso		8
1.2.15	Arbostora	Barbengo, Carona Vico Morcote Morcote	IFP 1811	1
1.2.16	S. Salvatore	Carona Carabbia Pazzallo	IFP 1810	14
1.2.17	Foce Magliasina (sp. destra)	Caslano	IFP1805	14
1.2.18	Manno	Manno Bosco Luganese Arosio Cademario		13
1.2.19	Monti di Medeglia	Medeglia		12
1.2.20	Denti della Vecchia - Brè-Gandria	Valcolla – Gandria	IFP 1812-1813	13
1.2.21	Monte S. Giorgio	Brusino Arsizio Meride Riva S. Vitale	IFP 1804	15
1.2.22	Meandri del Laveggio	Genestrerio Stabio Ligornetto	Coordinamento parziale per la SCP Mendrisio-Gaggiolo	15
1.2.23	Bosco golenale	Lumino		12

Situazione esistente	Oggetto di coordinamento	
		1 Le componenti naturali del territorio
		Riserva naturale orientata (RNO)
		Parco naturale (PN)
		Zona naturale protetta (ZNP)
		Torbiera
		Inventario federale dei paesaggi, siti e monumenti d'importanza nazionale (IFP)



COPIA UFFICIO

PIANO REGOLATORE 1:2000

Appendix F

COMUNE DI ARZO

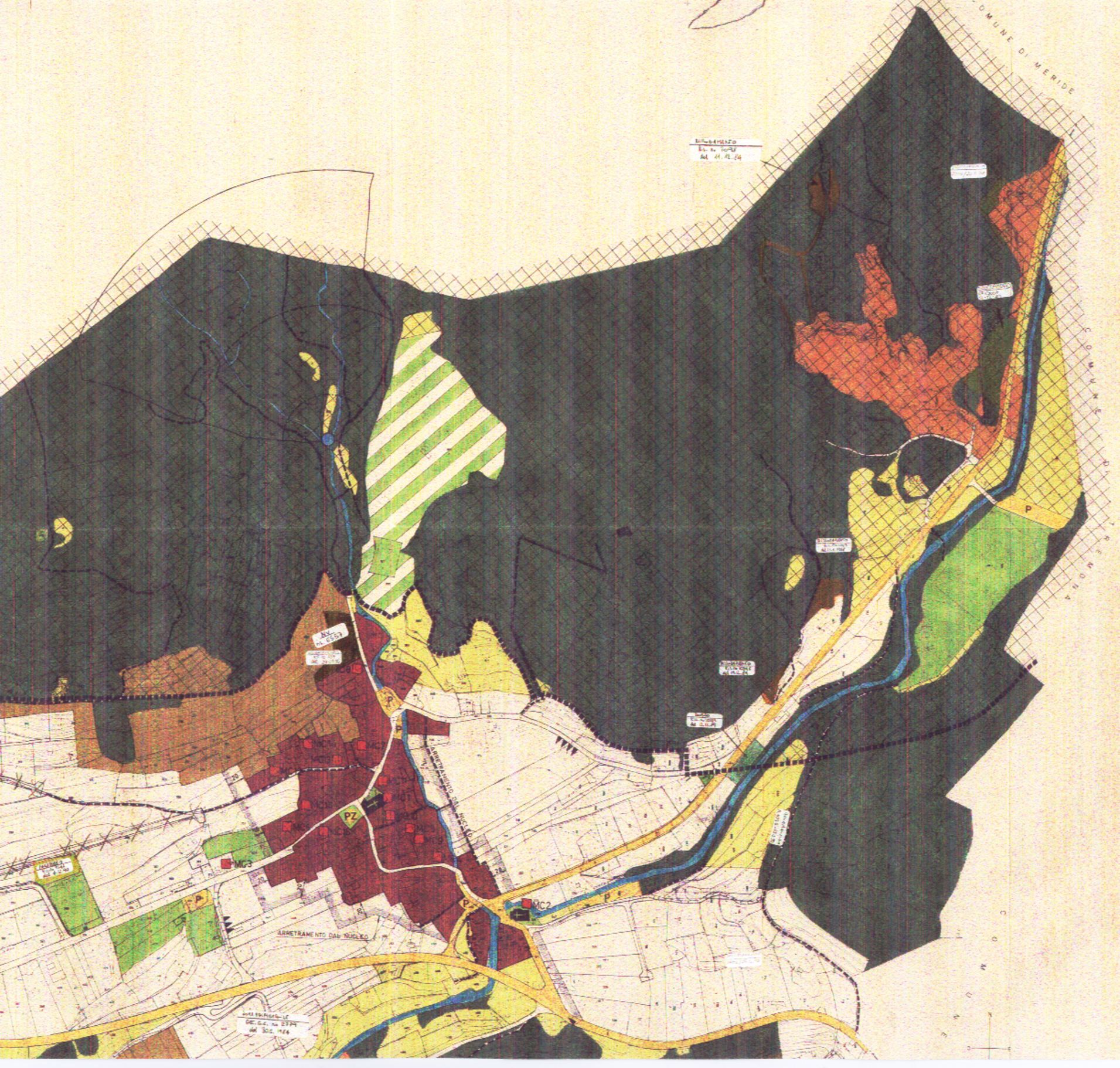
PIANO DEL PAESAGGIO

AGGIORNATO 5.6.91

APPROVATO DAL CONSIGLIO DI STATO
come alla ris. no. 6557 del 9.XI.1982
Sezione pianificazione urbanistica
Ufficio del Circondario del Mendrisiotto

STUDIO DI URBANISTICA TECNICA
ARCH. ENEA MINA VIA F. RODARI BELLINZONA TEL. 25 42 21 (21)

PIANO N° 10.1.2b



ZONA FORESTALE INDICATIVA

TERRITORIO AGRICOLO

ZONA SENZA DESTINAZIONE SPECIFICA

CORSI D'ACQUA

ZONA DI ESTRAZIONE

ATTREZZATURE ED EDIFICI D'INTERESSE PUBBLICO

ZONA DI PROTEZIONE DELLA NATURA

NUCLEO TRADIZIONALE

ZONA EDIFICABILE

STRADE PRINCIPALI

P PZ POSTEGGI – PIAZZA

PASSAGGI PEDONALI INDICATIVI

MC MONUMENTI CULTURALI

SORGENTI (PERIMETRO PROTEZIONE)
M 50
M 150
M 300

ARRETRAMENTO DAL NUCLEO

PUNTI DI VISTA

COMUNE DI MERIDE

PIANO REGOLATORE

PIANO GENERALE PAESAGGIO

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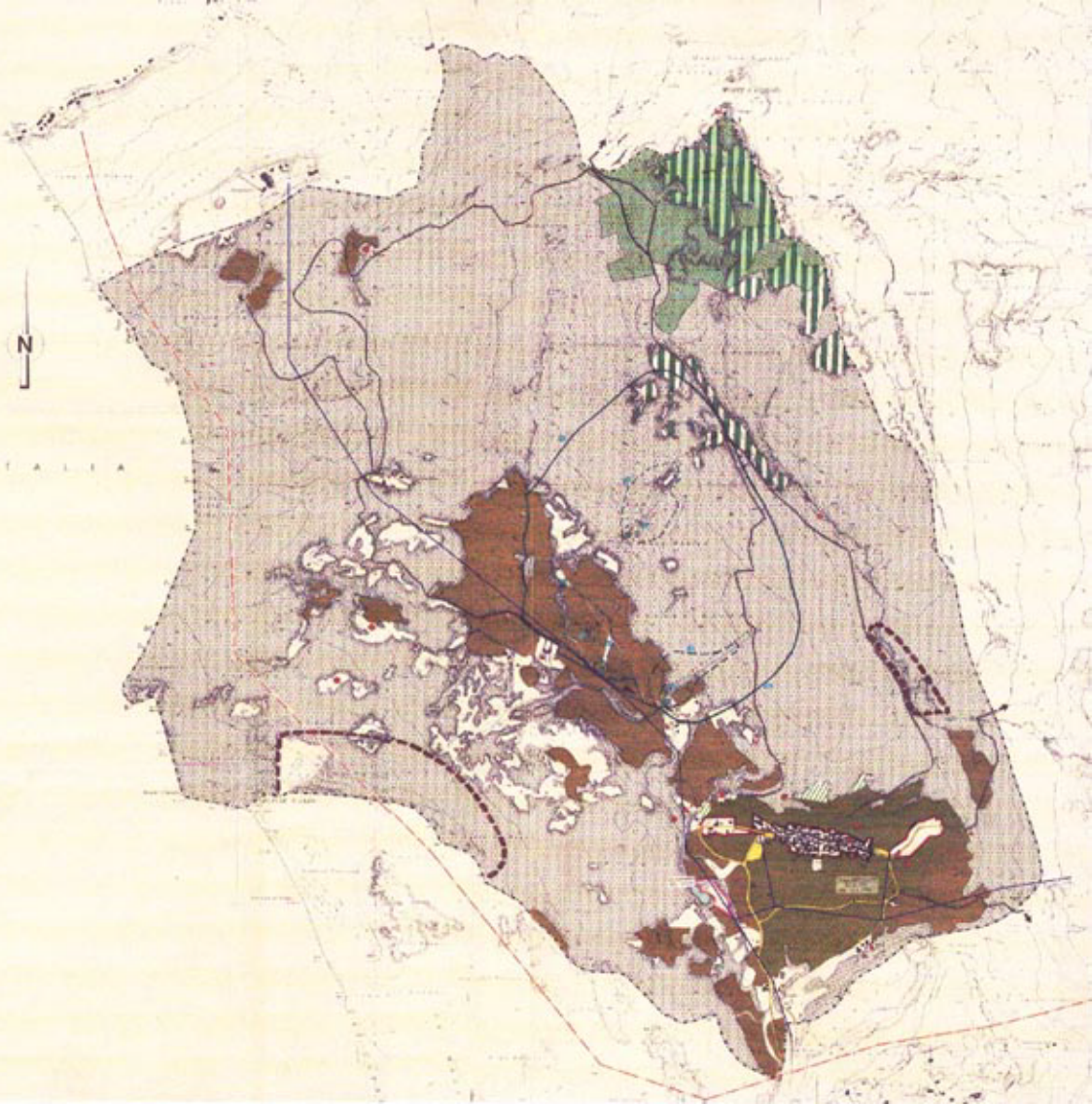

Appendix O

Experts' evaluations and opinions

- Dr. *Stefano Bernasconi*, Senior Scientific Assistant at the Federal Institute of Technology (ETH), Zurich (CH)
- Prof. *Daniel Bernoulli*, Lecturer in Geology and Stratigraphy at the Federal Institute of Technology (ETH), Zurich (CH)
- Prof. *F.T. Fürsich*, President of the European Palaeontological Association and Lecturer in Invertebrate Palaeontology at the Institute of Palaeontology of the University of Würzburg (D)
- Dr. *Heinz Furrer*, Curator at the Palaeontological Institute and Museum of the University of Zurich (CH)
- Prof. *Maurizio Gaetani*, Professor of Geology at the Department of Earth Sciences, University of Milan (I)
- Dr. *Christian Meyer*, privatdocent, President of the Swiss Palaeontology Society and Director of the Museum of Natural History, Basle (CH)
- Prof. *Hans Rieber*, Director (retired in October 2001) of the Palaeontological Institute and Museum of the University of Zurich (CH)
- Dr. *Olivier Rieppel*, Director and Curator of the Field Museum, Chicago (USA)
- Prof. *Andrea Tintori*, Professor of Palaeontology at the Department of Earth Sciences, University of Milan (I)
- Dr. *Rupert Wild*, privatdocent, Chief Curator of the National Museum of Natural History, Stuttgart (D)

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Dr. Markus Felber
via Molino Nuovo
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Zürich, August 10. 2001

Dear Dr. Felber.

I am writing this letter in support of the candidature of the Monte San Giorgio for the UNESCO World Heritage List. The Monte San Giorgio contains one of the world-wide richest fossil deposits of middle Triassic age, the so called Grenzbitumenzone and different specific levels in the Kalkschieferzone formation which are also rich in fossil reptiles and fishes. This formations are important for their richness in the more well known saurid fossils, but their scientific importance lays also in the high biodiversity of fishes and other vertebrates and invertebrates and plants found in these deposits. The presence of ash layers intercalated in the fossil-rich layers also has given a great opportunity to refine the absolute ages of the Middle Triassic and define a more firm calibration of the fossil-based timescale.

In addition to the fossil content, the Grenzbitumenzone is characterized by extremely high organic matter contents and displays very unique features from the organic-chemical point of view. For example it contains extremely high concentrations of vanadium porphyrins, a chlorophyll-derived compounds, which has been characterized for the first time in bituminous rocks from Monte San Giorgio and other localities by Albert Treibs, which proposed their derivation from chlorophyll and Heme and demonstrated in this way the biological origin of petroleum. Later studies of the organic chemistry of these rocks has led to important advances in the understanding of the chemistry and structure of these organic compounds.

The Monte San Giorgio has also a interesting flora and fauna due to the particular climate and soils and is therefore a very important zone to be protected.

Best regards

S Bernasconi

Stefano Bernasconi

Daniel Bernoulli
Professor of Geology emeritus
Swiss Institute of Technology (ETH), Zürich

Monte San Giorgio

Monte San Giorgio does not only display a beautiful, well exposed stratigraphic succession ranging from the Lower Permian to the Upper Cretaceous, it also preserves one of the most famous and best documented Triassic fossil vertebrate locations in the world, and one of the most important sites documenting the tectonic movements accompanying the birth of a former ocean whose remnants are now preserved in the Alps: the quarries of Arzo.

The birth of an ocean is preceded by extensional movements in the continental crust and lithosphere ("rifting") which affects also the pre-rift sediments overlying the continental crust. These extensional movements thin the continental crust until, at a certain moment, the continental lithosphere cannot be extended any further and, after final break-up of the continent, new oceanic lithosphere is created along a mid-ocean spreading ridge. In the evolving continental margins flanking the nascent ocean basin, the extensional tectonic movements may occur in a submarine environment and affect syn-rift sedimentation in a particular way. These interactions between submarine tectonics and sedimentation are magnifically illustrated in the Arzo quarries. I do not know any other location in the entire Alps where the phenomena associated with syn-sedimentary tectonics are exposed in an equally spectacular way and are documented in comparable detail.

In the Arzo quarries, the grey, shallow-water pre-rift carbonate sediments of the Upper Triassic are cut by a network of extensional faults which were active at different times during the early Jurassic (200 to 184 million years). Repeated collapse of the rock framework led to the evolution of complex breccias with the infill and injection of unconsolidated carbonate sediments during the different tectonic events which were accompanied by submarine earthquakes. The product of tectonic fragmentation of the sedimentary rocks and injection of unconsolidated sediments is a vary-coloured breccia, the so-called Macchia Vecchia, with different types of older pre- and syn-rift rock fragments set in a matrix of typically red limestones. Beautiful outcrops of the post-rift deep-water sediments are also present immediately south and west of the village of Arzo. These outcrops display some of the most beautiful examples of mass-wasting in deep-sea sediments (Molinello di Arzo)

The breccias of Arzo have been quarried for centuries and been used in churches and palaces all over western Europe, particularly Italy (including the floors of Saint Peter in Rome). Quarrying is still active with the same technical means as in the beginning of the last century and preserves a very important example of cultural heritage of southern Switzerland and northern Italy. Being part of a living industrial archaeology, it be should preserved for coming generations.

The scientific importance of the Arzo quarries and their sourroundings is also shown by the fact that they have been visited by numerous geological excursions, in particular in connection with international congresses (26th International Geological Congress, Paris 1980; International Association of Sedimentologists, Davos 2001; and presumably the 32th International Geological Congress, Florence 2004).

Basel/Zürich, 15th October 2001 Daniel Bernoulli

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Stellungnahme zur Bedeutung des Monte San Giorgio (Tessin)

Der Monte San Giorgio enthält eine Abfolge von Gesteinen der Alpinen Trias, zu denen auch die schwärzlichen, bituminösen Dolomite und Tonschiefer der sogenannten Grenzbitumenzone gehören. Diese Schwarzschiefer sind eine der bedeutendsten Fossillagerstätten Europas, die sich durch ihren Reichtum an marinen Wirbeltieren, insbesondere Fische und Reptilien auszeichnen. Daneben finden sich zahlreiche Vertreter einiger Invertebratengruppen, insbesondere Muscheln und Ammonoideen. Die Erhaltung artikulierter Skelette von marinen Reptilien und Fischen erlaubt wesentliche Einblicke in die Evolution dieser Gruppen. Da eine derartige Erhaltung weltweit nur in wenigen Lokalitäten existiert und für den hier repräsentierten Zeitabschnitt (Mitteltrias) sonst nirgendwo, kommt den Funden am Monte San Giorgio in mehrerer Hinsicht eine hervorragende Bedeutung zu. So kennen wir viele der Reptilien und Fische nur von diesem Fundort; sie vermitteln uns damit einen Überblick über die Formenvielfalt im damaligen Trias-Meer. Die Fauna erlaubt überdies mehr als dies gewöhnlich in fossilen Ablagerungen der Fall ist die Rekonstruktion des Ökosystems und Aussagen über die Lebensweise der einzelnen Formen.
Die Funde am Monte San Giorgio stehen deshalb von ihrer Bedeutung her auf einer Stufe mit anderen berühmten Fossillagerstätten wie Solnhofen und Holzmaden, die allerdings andere Zeitabschnitte repräsentieren. Aus derartigen Fossillagerstätten schöpft die Paläontologie ein Vielfaches an Information im Vergleich zu „normalen" Fossilvorkommen. Sie dokumentieren mehr als jene die wirkliche Biodiversität vergangener Epochen und tragen entscheidend dazu bei, die Geschichte des Lebens auf unserem Planeten zu rekonstruieren.
Aus diesen Gründen sind Fossilfundstellen wie die am Monte San Giorgio absolut schutzwürdig, zumal ihr wissenschaftliches Potential noch lange nicht ausgeschöpft ist.

Aufgrund der herausragenden Bedeutung der Fossillagerstätte am Monte San Giorgio für taxonomische, systematische, phylogenetische und ökologische Fragestellungen, befürworte ich ihre Aufnahme in die UNESCO World Heritage List vorbehaltlos.

Prof. Dr. F.T. Fürsich
Präsident, European Palaeontological Association

UNIVERSITÀ DEGLI STUDI
DI MILANO
Dipartimento
di
Scienze della Terra

CANDIDATURA MSG---WHL UNESCO

PROF. ANDREA TINTORI

1) Since 20 years part of my and my students research activities has been done in the area of MSG, on both Italian and Swiss sides. Heavy excavation campaigns have been done yearly in the Kalkschieferzone (upper member of the Meride Limestone) in the sites of Ca' del Frate (Italy) and Meride-Val Mara (Switzerland) with about 4.000 fish specimens recovered, a few reptiles and insects and small crustaceans by the thousand. Our excavations have been done in a very detailled way, separatinf levels of few cm in thickness in order to obtain distinct fossil assemblages for both stratigraphic and paleobiological purposes. Other than the anathomical descriptions, related to an accurate tassonomic revision of the fish fauna, many paleobiological aspects have been clarified, such has ontogenetic variations of many species, sexual dimorphism and very high intrageneric variability in the peltopleurids, high seasonal mortality events possibly related to sudden environmental changes, identification of 'natural' assemblages for the fishes (so far more than 25 species for the whole unit). Regarding reptiles, one of the most important discoveries is the find of nothosaurid embryos, three of them clustered together: this find has been considered a strong, and the only one so far, indication of viviparity in advanced nothosaurs. Crustaceans are very common, even if only two species seem to be present. Conchostracans have a high importance in paleoenvironmental restorations, while the misidiacean *Schimperella* is known in only two other sites outside MSG. Insects, one of the major results from the Meride-Val Mara excavations are now known by a few specimens, since the first find in 1998 after more than 150 years researches in the area!
Several pubblications on international reviews have been done, though much material is still under study owing to the ammount of collected specimens and to the time consuming preparation of the fossils (see attachment).

--- The Middle Triassic sequence of the Monte San Giorgio is almost unique in the world showing a continuous deposition through about 15 My in similar environments with several fossiliferous levels yielding marine and (rare) terrestrial vertebrates, other than plant remains, ammonites, bivalvs, crustaceans, insects. Most specimens are very well preserved and can be nicely prepared for both scientific studies and exhibits. As the Middle Triassic is a crucial time for the evolution of fishes and reptiles, the importance of the fossiliferous sequence of the MSG is clear at once as we can follow step by step the evolutionary events. Most of the taxa found on the MSG are unique to the site. Furthermore, we must consider that this paleontological area is the only one in the world where Museums and Universities managed scientific excavations for more than 150 years and in the last 80 years we had at least one site under excavation.

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Zur Kandidatur des Monte San Giorgio für die UNESCO World Heritage List

Das Gebiet des Monte San Giorgio ist schon seit Beginn des 19. Jahrhunderts bekannt für seine Oelschiefer-Vorkommen in den Karbonatgesteinen der Mitteltrias. Die darin enthaltenen Reste von fossilen Wirbeltieren wie Fischen und Sauriern, aber auch von wirbellosen Tieren wie Muscheln und Ammonoideen, fanden bald grosses Interesse bei den damaligen Naturgelehrten. Nach ersten Studien italienischer Wissenschafter aus Mailand waren seit 1924 besonders die Paläontologen der Universität Zürich am Monte San Giorgio aktiv. Unter der Leitung von Bernhard Peyer wurde die wissenschaftliche Erforschung durch gründliche Prospektion in der ersten Hälfte des 20. Jahrhunderts vorangetrieben und seither mit systematischen Grabungen erfolgreich weitergeführt.

Dank sorgfältiger Präparation in den Zürcher Werkstätten steht das umfangreiche Fossilmaterial in den Sammlungen der Universität Zürich und des Naturhistorischen Museums Lugano der Forschung zur Verfügung. Die besten Stücke sind zudem in den Museen von Zürich, Lugano und Meride ausgestellt und dem allgemeinen Publikum zugänglich.

Zahlreiche fachspezifische sowie populärwissenschaftliche Publikationen sind bisher über den Monte San Giorgio und seine Fossilien erschienen. Anfänglich waren es vor allem Neubeschreibungen verschiedenster Saurier und Fische. Zur Zeit sind 20 verschiedene Saurier- und 50 verschiedene Fischarten bekannt. Viele davon wurden erstmals vom Monte San Giorgio beschrieben, bei anderen konnte die Kenntnis durch Funde vollständiger Skelette entscheidend erweitert werden. Das Studium der wirbellosen Tiere wie Ammonoideen und Bivalven hat entscheidend zur Klärung stratigraphischer Fragen beigetragen. Neben den weiterhin wichtigen paläontologischen Forschungen haben in neuerer Zeit Untersuchungen zur damaligen Umwelt (Paläoökologie und Paläogeographie) und zur Entstehung (Taphonomie) dieser für die Mitteltrias weltweit einmaligen Fundstelle an Bedeutung gewonnen. Dazu gehören vor allem taphonomische, aber auch sedimentologische, mikrofazielle und geochemische Studien.

Die Fossil-Lagerstätte des Monte San Giorgio ist im Vergleich mit anderen mitteltriassischen Fossilfundstellen (z.B. germanischer Muschelkalk in Deutschland, Frankreich und den Niederlanden, ostalpine Mitteltrias in der Schweiz und Oesterreich, Mitteltrias in Spanien, in der Türkei, in Nordamerika und China) von herausragender Bedeutung. Das gilt insbesondere für die Qualität der Fossil-Erhaltung mit vielen zusammenhängenden Skeletten und verschiedenen Alterstadien bei vielen Fischen und Reptilien, aber auch in Bezug auf den Stand der wissenschaftlichen Untersuchungen. Weltweit einmalig ist zudem das Vorkommen von fünf übereinanderliegenden, d.h. verschiedenaltrigen wirbeltierreichen Fundschichten (von unten nach oben: Grenzbitumenzone, Cava-inferiore-, Cava-superiore- und Cassina-Schichten des Unteren Meride-Kalks sowie Kalkschieferzone), die in der Mitteltrias vor etwa 245 bis 230 Millionen Jahren, also in einem Zeitabschnitt von etwa 15 Millionen Jahren entstanden sind. Damit

steht der Forschung einmaliges Fossilmaterial zur Evolution wichtiger Fisch- und Reptilgruppen zur Verfügung.

Der Monte San Giorgio steht als Wirbeltier-Fundstelle der marinen Mitteltrias in vorderster Reihe mit anderen weltweit einmaligen Fossil-Lagerstätten wie z.B. den einiges jüngeren Fundstellen von Holzmaden (Lias), Solnhofen (Malm) oder Messel (Tertiär) in Deutschland.

Eine Aufnahme des Monte San Giorgio in die UNESCO World Heritage List kann zudem durch die kulturhistorische Bedeutung des Oelschiefer-Bergbaus bei Serpiano und Meride, durch die landschaftlichen Besonderheiten am Luganersee im Südtessin sowie durch die spezielle heutige Pflanzen- und Tierwelt begründet werden.

Zürich, 30. August 2001

Dr. Heinz Furrer

UNIVERSITÀ DEGLI STUDI
DI MILANO
Dipartimento
di
Scienze della Terra

TO WHOM IS CONCERNED

The Southern Alps, In Italy and in Ticino (Switzerland) preserve the best Triassic record on our planet as far as the vertebrate fossils in marine environment are concerned.

The Monte San Giorgio area is the richest and most diversified in this kind of remains for the Middle Triassic. Moreover, not only vertebrates, but also invertebrates very useful for biostratigraphy as ammonoids, daonellids and conodonts have been recovered. Recently, also fossils of insects have been described for the first time.

The vertebrate palaeontology requires a very long preparation in laboratory. As consequence the amount of fossils recovered and prepared is also connected to how long lasted the palaeontological studies. Being active since near a century, this allow to have a very large documentation. This record is the best for a very important span of time, critical to unravel the history of the life recovery after the most severe crisis of the Phanerozoic, at the end of the Permian.

This are few items to indicate how is important the Monte San Giorgio area for the World Heritage. Therefore, I strongly support the proposal to include the Monte San Giorgio in the World Heritage list of the UNESCO.

Sincerely,

Maurizio GAETANI
Past President of the IUGS Triassic Subcommission
Member of the IGCP Board (UNESCO, IUGS)

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Naturhistorisches Museum Basel
Natural History Museum Basel
Muséum d'Histoire Naturelle Bâle

PD Dr. Christian A. Meyer
Direktor

Basel, july 26th 2001

UNESCO World Heritage List Monte San Giorgio

To whom it may concern

The Fossil-Lagerstätten of the Monte San Giorgio in the southern Swiss Alps is one of the most important paleontological sites in the world. It is renowned for its superbly preserved Middle Triassic reptiles and plays an important role in the undertsanding of evolutionary processes in marine biotas. The Monte San Giorgio yields a wealth of information concerning the evolution of early ichthyosaurs and other reptiles such as nothosaurs and others. The excellent preservation of articulated specimens at different localities around the mountain and the long research tradition have brought the Monte San Giorgio to international reputation. Worldwide there are only very few "black-shale" localities that can be compared with the site in the Ticino.
Furthermore the terrestrial fossils, such as Ticinosuchus, have played a key role in the evolution of early archosaurs as well as in the search of the enigmatic trackmaker Chirotherium.
Recent excavations have shown that a large potential of important fossils (e.g. insects) exists and may contribute to a much better understanding of mid Triassic terrestrial biotas on a world-wide scale.
The geological sections around the site are of high educational value for students and scholars from all over the world and make it to one of the most desired fieldtrips in Switzerland.

I strongly support a candidature of the Monte San Giorgio as part of the UNESCO's World Heritage List and I think this exceptional site must be protected with all possible means.

Sincerely yours
PD Dr. Christian A. Meyer
Director Natural History Musem Basel
President, Swiss Palaeontological Society
Delegate, Senat Swiss Academy of Sciences

Ch. Meyer

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Zürich, 5. Oktober 2001

Markus Felber, dr. sc. nat. ETH
Consulenze geologiche e ambientali
via Molino Nuovo
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UNESCO World Heritage List Kandidatur des Monte San Giorgio (Tessin Schweiz)

Sehr geehrter Herr Felber, lieber Markus,

leider komme ich erst jetzt dazu, auf Dein Schreiben vom 10. Juli diesen Jahres zu antworten.

Für mich steht ausser Zweifel, dass der Monte San Giorgio (Tessin Schweiz) ein ausgezeichneter und sehr wichtiger Kandidat für die UNESCO World Heritage List (WHL) ist.

Begründung:
Seine Berühmtheit und Einmaligkeit verdankt der Monte San Giorgio in erster Linie dem sehr reichen
Vorkommen von marinen Fischen und Sauriern in der dortigen Mitteltrias. Es gibt weltweit keine andere Lokalität, an der Fische und Saurier dieses Zeitabschnitt der Erdgeschichte so häufig auftreten und so vollständig erhalten sind.
Bei den flächenhaften wissenschaftlichen Grabungen, mit denen der Zürcher Paläontologe Bernhard Peyer schon 1924 am Monte San Giorgio begonnen hatte, konnte im Verlauf der Zeit sehr umfangreiches und wissenschaftlich überaus wertvolles Material von Fischen und Sauriern geborgen werden.
Die Grabungen, die zunächst unter Leitung von Bernhard Peyer standen, wurden von dessen Nachfolger, Emil Kuhn-Schnyder, von 1950 an energisch und systematisch weitergeführt. Nach einer Unterbrechung von 1974 bis 1993 wurden 1994 flächenhafte Grabungen in der Mitteltrias im Gebiet des Monte San Giorgio von H. Furrer (Paläontologischen Institut und Museum der Universität Zürich) wieder aufgenommen.

Besonders reich an Wirbeltierresten ist die sogenannten Grenzbitumenzone. Es ist dies ein ca. 16 m mächtiger Schichtkomplex, der aus einer Wechsellagerung von bituminösen Dolomitbänken und zahlreichen Lagen sehr stark bituminöser Tonschiefer sowie einigen Lagen toniger Tuffite, ehemaliger vulkanischer Aschen, besteht.
Die wichtigsten Fundstücke, Saurier und Fische, wurden in den Laboratorien der Universität Zürich präpariert und so der wissenschaftlichen Untersuchung zugänglich gemacht. Die Beschreibung der einmaligen Wirbeltier-Funde ist mit den Namen Bernhard Peyer, Emil Kuhn-Schnyder, Rainer Zangerl, Bernard Krebs, Olivier Rieppel, Toni Bürgin u. a. verbunden. Sowohl unter den Sauriern als auch unter den Fischen finden sich jeweils mehrere Taxa, die bisher nur vom Monte San Giorgio bekannt sind. Die Einmaligkeit der Wirbeltierfauna der Mitteltrias , besonders jener der Grenzbitumenzone beruht einerseits auf der grossen Häufigkeit der Fossilien und andererseits auf der grossen Artenvielfalt der Fische und Saurier. Die zahlreichen Fisch- und Saurier-Arten aus der Mitteltrias des Monte San Giorgio erweitern nicht nur den Formenschatz dieser Wirbeltiergruppen aus der Trias gewaltig, sondern sie sind auch für die Erforschung der Stammesgeschichte von grosser Bedeutung.

Neben den Wirbeltieren wurden in der Grenzbitumenzone eine grosse Zahl von Ammonoideen und Muscheln gefunden, mit denen sich die Grenzbitumenzone biostratigraphisch fein gliedern liess. In der Zwischenzeit hat sich herausgestellt, dass die Ammonoideen und Muscheln von grosser Bedeutung für die stratigraphische Gliederung der Mitteltrias in den gesamten Südalpen und darüber hinaus für die chronostratigraphische Glieder der marinen Mitteltrias sind. Damit kommt der Grenzbitumenzone nicht nur als weltweit einmalige Wirbeltier-Lagerstätte, sondern auch als weltweit wichtige Fundstelle besonderer Ammonoideen und Muscheln sehr beachtliche wissenschaftliche Bedeutung zu.

Die einzelnen feingeschichten, bitunmiösen Schichtfolgen, die im Gebiet des Monte San Giorgio reich an Wirbeltierresten sind, bilden modellhafte Beispiele für den Typ der sogenannten Stagnat-Lagerstätte. Die Stagnat-Lagerstätten sind eine Gruppe der Konservat-Lagerstätten, die unter anderem durch die vollständige Überlieferung gegliedertr Skelette charakterisiert sind.

Neben diesen paläontologischen Gesichtpunkten, die eine Aufnahme des Monte San Giorgio in die WHL vollauf rechtfertigen, muss noch auf den besondern geologischen Aufbau des Monte San Giorgio-Gebiets hingewiesen. Der Monte San Giorgio gewährt einen ausgezeichneten Einblick in die Ausbildung der Trias der Tessiner Kalkalpen und im Gebiet von Arzo ist die jüngste Trias und der ältere Jura in Form einer heterogenen Breccie, dem sogenannten Marmor d'Arzo ausgebildet. Durch Abbau dieses schönen Gesteins, wurde im Verlauf der Zeit für das Studium und die Betrachtung dieses Gesteinsvorkommen ideale Verhältnisse geschaffen. In Arzo wurde übrigens auch das Phänomen der heterogenen, synsedimentären Breccienbildung, das sehr weit verbreitet ist, erstmals klar erkannt und beschrieben.

Der Unterzeichnende will hier nicht auf die aussergewöhnliche heutige Flora, die die "Kalkinsel" Monte San Giorgio in dieser südlichen Position der Schweiz aufweist, eintreten. Für den Naturfreund ist auch sie ein besonderer Leckerbissen.

Der Unterzeichnende ist davon überzeugt, dass das Gebiet des Monte San Giorgio ein ausgezeichneter Kandidat für die WHL ist und möchte die Aufnahme des Monte San Giorgio in die WHL aus der Sicht der Paläontologie uneingeschränkt befürworten.

Hans Rieber

Prof. Dr. Hans Rieber

The Field Museum exploring the earth and its people

Dr. Markus Felber
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August 6, 2001

Dear Dr. Felber,

It is with great pleasure and enthusiasm that I comment on the scientific importance of the Monte San Giorgio as a Middle Triassic Lagerstätte yielding an excellent record of fossil vertebrates.

Indeed, the Monte San Giorgio is one of the few such Largerstätten known worldwide for all geological ages, comparable in its importance to other world famous localities such as Holzmaden and Solnhofen in Germany, the Green River Formation in Wyoming, or the new sites in Liaoning Province, northeastern China.

Through the activities of Bernhard Peyer and Emil Kuhn-Schnyder, an unparalleled number of fossil vertebrates were collected at Monte San Giorgio. There is, indeed, such a lot of material that not all of it has already been subject of a thorough scientific investigation. Such taxa as the ichthyosaurs referred to the genus *Mixosaurus*, and especially some of the numerous fishes, have not yet been studied at all. Yet the material from Monte San Giorgio holds the potential to investigate kinds of question that are not normally possible to address using the pre-Tertiary fossil record of vertebrates. These include the analysis of individual variation, ontogenetic variation, sexual dimorphism and taxonomic variation across a fossil community represented by large numbers of individuals such as the pachypleurosaurs. The in depth investigation of this group, as well as of fishes such as *Saurichthys*, has allowed to address evolutionary problems such as anagenesis, even speciation, at a time when models of sympatric speciation become increasingly popular (e.g., Via, S. 2001. Sympatric speciation in animals: the ugly duckling grows up. TREE, 16 [7]: 381). Indeed, I believe that the thorough investigation of the fossil record from Monte San Giorgio, parallel to similar efforts directed towards other, neighboring intraplatform basis such as Perledo etc., provides a unique opportunity to study patterns and processes of evolution in fossil vertebrates. This ideal setting is almost one of a paleontological "laboratory of evolution."

Fossils have been collected at Monte San Giorgio for a considerable time, and even longer at neighboring outcrops of the same basin near Besano in Italy. This may result in the belief that what was living in this basin 250 Million years ago is sufficiently well represented in the collections held by the Paleontological Institute and Museum of the University of Zürich, and by the Museo Civico di Storia Naturale di Milano. But consider the fact that while the investigation of fossil vertebrates from the "scisti bituminosi

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triassici di Besano" began with the work of Stoppani (1857) and Bassani (1886), i.e., almost 150 years ago, Dr. Stefania Nosotti from the Milano Museum and I are engaged in the description of an entirely new taxon from those deposits, a taxon that has never before been collected in the Grenzbitumen-horizon at Besano or at the Monte San Giorgio, and that proves to be of major importance for our understanding of higher level reptile phylogeny. Knowledge of the fossil record from any site is never complete, and there is no way to predict what will be found as future fieldwork at Monte San Giorgio will be conducted.

Finally, let me draw your attention to the fact that large numbers of Middle Triassic marine reptiles are currently being collected in Guizhou Province, Southern China. I am involved in a collaborative effort with researchers from the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing to describe those fossils, and to assess their phylogenetic and paleobiogeographic significance. This project is currently funded by the Chinese Academy of Sciences and the National Geographic Society, and we will seek support from the U.S. National Science Foundation this fall. Our work so far indicates close relationship of several taxa from southern China with fossils from Monte San Giorgio. In that context, the fauna from Monte San Giorgio acquires a significance that goes well beyond the southern Alpine realm. Indeed, through the analysis of the phylogenetic and paleobiogeographic affinities of the faunal elements known from Monte San Giorgio, fossils from the Grenzbitumen-horizon become involved in global analyses of paleogeographic reconstructions of the Tethys and beyond. Furthermore, there is some evidence that the diversification of Middle Triassic marine reptiles can be linked to the exotic terrane model (Rieppel, O. 1999. Phylogeny and paleobiogeography of Triassic Sauroperygia: problems solved and unresolved. Paleoclimatology, Paleogeography, Plaeoecology, 153: 1-15), which adds even more significance to the Monte San Giorgio as a Middle Triassic Lagerstätte for marine reptiles.

I hope that these comments make it clear that in my view, a very strong case can be made for the addition of Monte San Giorgio to the World Heritage List of the UNESCO.

Sincerely,

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Other fossiliferous sites have been exploited even for longer time, but fossils collecting is there a by-product of commercial quarring, thus with loss of many important informations. Thus the MSG holds also a precious historical meaning in the Paleontology History.

--- The importance of the Monte San Giorgio fossils vertebrates is even enanced if we consider that very few other sites are known all over the world for Middle triassic vertebrates. In Europe only scarce remains are know from the German Muschelkalk and the English Otter Formation. In both cases only very badly preserved and fragmentary specimens have been recorded. From Spain, we know the Montral-Alcover fauna, which gives a good ammont of specimens: however, their preservation is scanty, most of the fossils being made of impressions without any bone remains preventing a detailled study.
Other faunas are known from the Southern emisphere: the Karoo in South Africa and Angola, Ischigualasto Fm. in Argentina, Gosford Fm. in Australia, but everywhere fossils are scarce and/or not well studied in recent time.: nothing really comparable to the richness of Monte San Giorgio. Recently, it seems that a new Chinese site has been discovered, even if news about it are still very scarce and thus it is not possible make a safe comparison.

Concluding, I think that the Monte san Giorgio area is worth to be evalueted by UNESCO to be included in the World Heitage List, as it shows the best sequence of well preserved fossil vertebrates from the Middle Triassic all over the world.

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Milano, 1.9.01

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SVIZZERA

Stellungnahme zur beantragten Aufnahme des Monte San Giorgio (Tessin, Schweiz) in die UNESCO World Heritage List aus wirbeltierpaläontologischer Sicht

Der Mte. San Giorgio am Luganer See im Kanton Tessin, Schweiz, wird an seiner Basis aus permischen Porphyriten und darüber folgenden Gesteinen der Trias, hauptsächlich der Mitteltrias, aufgebaut. Diese sind mariner Entstehung. Sie enthalten in der sogenannten Grenzbitumenzone der Anis-/Ladin-Stufe und in den darüber folgenden Meride-Kalken der Ladin-Stufe der Mitteltrias außerordentlich reiche Fundstellen fossiler Wirbeltiere, die auf der Erde einzigartig sind. Nach ihrer Entdeckung im ausgehenden 19. Jahrhundert durch italienische Paläontologen widmeten sich Prof. Dr. Bernhard Peyer vom zoologischen Institut, später Prof. Dr. E. Kuhn-Schnyder vom Paläontologischen Institut der Universität Zürich und in den letzten Jahren Prof. Dr. H. Rieber von ebendiesem Institut der Erforschung der Fauna der Mitteltrias des Mte. San Giorgio. Hierzu wurden langjährige systematische Fossilgrabungen bis in jüngste Zeit durchgeführt. Sie erbrachten ein umfangreiches, einzigartiges Material an fossilen Wirbeltieren. Dessen wissenschaftliche Auswertung ist sowohl eine der Hauptaufgaben des Paläontologischen Instituts der Universität Zürich, als auch eine Aufgabe internationaler paläontologischer Forschung, dokumentiert durch eine umfangreiche Publikationsliste. Die meist vollständigen, im natürlichen Skelettverband vorliegenden Fische und Reptilien, die Diversität der Wirbeltierfauna, die Seltenheit oder Einzigartigkeit verschiedener mariner, aber auch terrestrischer eingeschwemmter Wirbeltiere sowie der enorme Individuen-Reichtum an Skeletten nur weniger, oft monospezifischer Arten in bestimmten Schichten haben den

Mte. San Giorgio in den Geowissenschaften, insbesondere in der Paläontologie zu Weltgeltung verholfen. Der Mte. San Giorgio gilt schlechthin als "der Berg der Fossilien".

Die Wirbeltierfauna setzt sich aus Fischen und Reptilien zusammen. Die Fischfauna der Fundstellen des Mte. San Giorgio besteht aus schätzungsweise über 60 Arten aus den Gruppen der Knorpelfische (z.B. Haie und Verwandte), der Actinopterygier (u.a. Knochenfische) und Crossopterygier (Quastenflosser). Einige sind ausschließlich auf die Grenzbitumenzone oder die Meride-Kalke beschränkt und sonst weltweit an keiner weiteren Fundstelle mitteltriassischer Wirbeltiere vorhanden. Besonderheiten sind die nahezu vollständig überlieferten Skelette von Haien, erkennbar an den im natürlichen Skelettverband erhaltenen Flossenstacheln und Zahnbatterien. Das Knorpelskelett ist fossil nicht überliefert. Bei dem Actinopterygier Saurichthys wurde festgestellt, daß er lebendgebärend war und mehrere Junge zur Welt bringen konnte. Zahlreiche Knochenfische harren noch der wissenschaftlichen Bearbeitung.

Die fossilen Reptilien des Mte. San Giorgio sind nahezu alle beschrieben. Sie sind allesamt marin, ausgenommen der räuberische Archosaurier Ticinosuchus, der als Leiche vom Land her in den Ablagerungsraum des Mte. San Giorgio eingeschwemmt wurde.Neben einigen Skelettresten ist der Hauptfund das weltweit bislang einzige, von der Schnauzenspitze über die Wirbelsäule und die Gliedmaßen bis zur Schwanzspitze vollständig im natürlichen Verband erhaltene Skelett eines Rauisuchiers oder Scheinkrokodils weltweit. Da diese in die Verwandtschaft der Dinosaurier-Vorfahren gehören, gilt ihnen großes wissenschaftliches Interesse, auch im Hinblick auf die Entstehung der Raubdinosaurier. Alle anderen Reptilien, wie die mit Mixosauriern und Shastasauriern vertretenen lebendgebärenden Ichthyosaurier - was erstmals in der Trias von Funden des Mte. San Giorgio nachgewiesen werden konnte - die Nothosaurier, die Placodontier oder Pflasterzahnsaurier und die Thalattosaurier sind marin. Von Trias-Ichthyosauriern des Mte. San Giorgio wurden in letzter Zeit zahlreiche neue Arten beschrieben. Die vollständig und im natürlichen Verband erhaltenen Skelette des für den Mte. San Giorgio endemischen Nothosauriers Ceresiosaurus sind weltweit einzigartig und damit für die Rekonstruktion und die Vorstellung des Aussehens der Nothosaurier von grundlegender Bedeutung, wie eine in diesem Jahr erscheinende Dissertation belegt. Eine weitere Gruppe der Nothosaurier sind die mit mehreren Arten vertretenen, kleinwüchsigen Pachypleurosaurier. Vom Mte. San Giorgio sind hunderte von

Skeletten bekannt geworden, z.T. in Massenansammlungen auf Schichtflächen vorkommend. Die seltenen, meist disartikuliert vorliegenden Skelette von Placodontiern des Mte. San Giorgio sind paläontologisch von großem Interesse, weil sie an der Wurzel dieser Gruppe von Reptilien stehen, die neuerdings wieder mit den Nothosauriern in Verbindung gebracht werden. Interessante Beziehungen ergeben sich zu den Einzelfunden von Placodontiern aus Mitteleuropa und dem Mittelmeergebiet. Schließlich seien die Thalattosaurier mit den vollständig erhaltenen Skeletten von Askeptosaurus oder die mit Askeptosaurus verwandten, nur vom Mte. San Giorgio bekannten Gattungen Helveticosaurus, Hescheleria und Clarazia erwähnt. Ihre systematische Zugehörigkeit ist noch nicht zufriedenstellend geklärt, was die Unterschutzstellung und Bedeutung des Mte. San Giorgio als Fossillagerstätte zur Gewinnung weiteren Fossilmaterials in der Zukunft unterstreicht.

Um die Diversität der Reptilfauna des Mte. San Giorgio aufzuzeigen, sei noch die Gruppe der amphibisch und teils terrestrisch, teils marin lebenden Prolacertilier mit Macrocnemus und Tanystropheus angeführt. Der Giraffenhalssaurier Tanystropheus kommt auch in Mitteleuropa und im Mediterrangebiet, vielleicht sogar in Nordamerika vor, jedoch immer nur in Einzelresten oder Einzelknochen. Für Tanystropheus ist der Mte. San Giorgio als Fossillagerstätte deshalb von großer Bedeutung, weil von ihm zahlreiche Skelette von Jung- und Alttieren stammen, von ca. 90 cm bis über 6 m Gesamtlänge, so daß die ontogenetische Variabilität, die Veränderungen im Bau des Skeletts und dessen Proportionen im Laufe der Altersentwicklung verfolgt werden konnten. So lebten die Jungtiere von Tanystropheus wahrscheinlich hauptsächlich auf dem Land, ernährten sich insectivor, während die Alttiere im Meer ihre aus Tintenfischen und Fischen bestehende Beute erjagten. Mit diesem Wechsel des Lebensraums ging eine Änderung der Bezahnung von dreispitzigen Zähnen im Jugendstadium zu einspitzigen Zähnen im erwachsenen Zustand einher. Dieses Beispiel mag die Bedeutung der Fossilien des Mte. San Giorgio für die Wissenschaft aufzeigen. Wesentliche Fortschritte in der Paläontologie sind durch die Gewinnung neuen Fossilmaterials - durch systematische Grabungen an reichen Fossilfundstätten, wie am Mte. San Giorgio, zu erlangen - und durch Verbesserung der Präparationsmethoden, um altes und neues Fossilmaterial bestmöglich für die wissenschaftliche Untersuchung aufzubereiten. Dies betonte mein geschätzter Lehrer, Prof. Dr. Emil Kuhn-Schnyder immer wieder bei den Fossilgrabungen am Mte. San Giorgio. Dieser "Berg der Fossilien" wurde durch seine Fossilfunde die bedeutendste mitteltrias-

sische Wirbeltierfundstätte der Erde. Sie in die Liste des UNESCO Weltkulturerbes aufzunehmen, würde nicht nur höchst bedeutendes Forschungsmaterial schützen und für zukünftige paläontologische Forschungen zur Verfügung stellen können, sondern auch der Arbeit und den Verdiensten der Zürcher Paläontologen Prof. Dr. Bernhard Peyer und Prof. Dr. Emil Kuhn-Schnyder eine würdige und dauerhafte Anerkennung verleihen.

Candidature of MONTE SAN GIORGIO for inclusion on the WORLD HERITAGE LIST

Additional information for the attention of **IUCN**

Introduction

After examining the dossier regarding the candidature of Monte San Giorgio for inclusion on the World Heritage List, and carrying out a site evaluation visit from 15 to 17 July 2002, the IUCN made a written request on 12 December 2002 for additional information on the dossier in order to complete its own final candidature evaluation report, to be presented to the World Heritage Committee.

The management of the IUCN Protected Areas Programme made two specific requests:

- a comparative study on the scientific significance of Monte San Giorgio in relation to other fossil-bearing sites around the world, particularly from the Triassic period;
- certain information regarding the management of the candidate site and, in particular, the Draft Site Management Plan.

For the first request, the reader is referred to the ***COMPARATIVE ANALYSIS***, drawn up by a special group of experts and enclosed with this document.
The additional information requested on the future management and integrity of Monte San Giorgio is reported hereunder.

1. Protection, management, and presentation of palaeontological components

We would again like to stress that all matters relating to the palaeontological heritage of Monte San Giorgio are already subject to management and periodic statutory monitoring by state authorities, if only because all fossil remains are the exclusive property of the state.
Specifically, it is the task of Canton Ticino – acting through the cantonal museum of natural history (CMNH) of the department responsible for the territory – to supervise palaeontological excavations, to identify the fossil remains discovered, to provide for their conservation, and to decide how they should be employed for the purpose of display.

In 1994, the CMNH re-opened scientific excavations in the Swiss area of Monte San Giorgio. Previously, excavations had been conducted by the University of Zurich since 1924. Work was suspended in 1975, except for a brief interlude in 1983, on the occasion of a conference.
Excavations were restarted after about two decades of inactivity thanks to the contribution of two institutes:

- the Paläontologisches Institut and Museum of the University of Zurich (PIMUZ, Dr. Heinz Furrer), which in 1994 began a series of trial excavations at Val Mara (Kalkschieferzone, in the Uppermost Meride Limestone), and then in 1995 opened the current dig at Acqua del Ghiffo (Lower Meride Limestone). Studies focus principally on marine reptiles (Ceresiosaurus, Neusticosaurus) and reconstruction of the environment.
- the department of earth sciences at the University of Milan (UNIMI, Prof. A. Tintori), which in 1996 inaugurated the current dig at "Site D" in Val Mara (Kalkschieferzone). Research is concerned mainly with fossil fishes and reconstruction of the palaeoecology.

At present, the above two institutes do not have any long-term agreements. Relationships are defined year-by-year through study mandates formulated from projects proposed by the institutes themselves. In this context, the CMNH finances excavation-related expenses (generally two excavation campaigns each year for a total of three to four weeks) and the preparation of part of the material (through the institutes or external preparers).
After completion of analysis and related publications, the fossils pass to the CMNH collections, under the canton's law of property.

In the future, Monte San Giorgio will remain a pivotal site and a major element in the scientific activity promoted by the CMNH. In consequence, CMNH's intention is to carry out research activities at Monte San Giorgio to acquire better knowledge of the geopalaeontological aspects of the site, and to build up, patiently and in the long term, a fossil collection worthy of an institute responsible for the conservation of one of the most important palaeontological heritages anywhere in the world.
CMNH will continue to support collaboration with the two institutes, such support being conditional upon the institutes' willingness to participate and the availability of finance. Finally, depending on developments regarding the proposed expansion of the CMNH structure, it is not to be excluded that CMNH may in future seek new synergies (for example, to replace any such relationships that might be terminated) with other scientific institutes, or indeed be capable of undertaking directly excavation campaigns on Monte San Giorgio.

The Monte San Giorgio management plan will include the information on the planning of research campaigns, the conservation of fossil remains, and their presentation, and will stress the guiding role that will continue to be played in future by the cantonal museum of natural history (CMNH) at Lugano.

2. The new fossil museum

After the recent meeting between a delegation from the Meride local authority and the committee for the Meride fossil museum, the Ticino cantonal department with responsibility for the territory stressed the importance of a fossil museum as a space for sharing knowledge of the extraordinary palaeontological value of Monte San Giorgio.

Over the next few months, a mixed working party from the department of the territory and the Meride local authority will develop the 2002 project for the new fossil museum (already forwarded to IUCN for information on 30 August 2002), specifically examining logistical, functional, organizational, and financial aspects.
It is already felt that the new museum should not merely offer a context for acquiring knowledge of the palaeontological and naturalistic heritage. It should also be a complete visitor centre for local and international users of the mountain.

The subject of staff to be assigned to the museum at Meride (manager/events co-ordinator, caretaker/museum technician, territory guides) will be dealt with in the framework of the working party.

3. Territorial management, planning, and co-ordination

As many as 36 bodies, including 14 Swiss and Italian local authorities from the Monte San Giorgio area, supported the *Monte San Giorgio - Orsa – Pravello* protocol of understanding, initialled at Varese on 21 September 2002, which replaces and expands the Besano protocol, dated 10 May 2001.
The same bodies have taken advantage of the European Union INTERREG III A initiative to activate nine projects for cross-border collaboration, eight of which have been approved. The corresponding actions are operational and under way. A document (CD ROM) containing details of all the INTERREG projects was forwarded to IUCN on 30 August 2002.

These cross-border collaboration projects are all linked, in one way or another, to the protection, management, and promotion of the geopalaeontological heritage of Monte San Giorgio.
The aim of work carried out under the aegis of INTERREG is to make available a model for cross-border territory management. This overview, accompanied by detailed sectoral analyses, will provide sufficient knowledge to enable the inauguration of a sustainable management programme that will above all take into account the characteristics that make the site unique worldwide while ensuring that the environment remains habitable.
The inclusion of the human component in the candidature is instrumental to the management objective. The proposed model links legal constraints to the development of a culture and living pattern that are compatible with protection needs. Ensuring bottom-up protection, involving all levels of society, means that cultural, social, and economic repercussions must be taken into account.
The appropriate promotion of Monte San Giorgio involves identifying a protection zone and a buffer zone. This is essential, and is regarded as a mainstay of future site management. In this context, the legal protection already enjoyed by palaeontological remains will be extended, after the co-ordination activity carried out in the framework of the INTERREG III A project, thanks to the emerging overview of the territory.
In the protection zone, fossil beds, as well as fauna, flora, and mycological resources, will be completely protected and managed essentially for the purposes of scientific research, the dissemination of scientific knowledge, and compatible recreational activities (hillwalking, geology tourism, and so on).
Planning regulations and, in particular, visitor codes of conduct will be specified in a management and co-ordination document. These will also be clearly indicated on the territory with special notices. Access to the protection zone will be marked at border crossings.
The aim of the buffer zone is to guarantee preservation of the landscape and cultural features developed during the long interaction of humanity and the environment. In this respect, the focus of attention will be to weigh the interests of economic requirements and the road system against protection of the features described above and the necessary conservation of the high quality of life currently enjoyed in the region.
To consolidate the protection strategy, the INTERREG III A project will evaluate the appropriateness of restricting, to a ring of local authorities outside the candidature area, the possibility intervening directly on

the territory of Monte San Giorgio (leisure and mobility). In consequence, regulations regarding the buffer zone will also be drafted to encourage suitable use of the nature resources of Monte San Giorgio.

Work carried out so far for the candidature and the for the INTERREG III A project, as well as other initiatives of a local nature (for example, the project for the new fossil museum at Meride, in addition to territory-oriented activities by regional associations) has laid the foundations for the comprehensive, cross-border management of the entire Monte San Giorgio area. Although some of the proposals contained in this initiative are at the project stage, the intended lines of development are clear.
The cross-border territory management model will encourage the implementation of the following actions:

- codifying decisions made in the context of the INTERREG III A initiative, and subsequent in-depth studies, into higher-order territorial co-ordination tools;
- adding implementation forms to local authority long-term land-use plans to execute, at local level, cross-border co-operation actions for the sustainable development of the area;
- setting up a management body with clear competencies acknowledged at all institutional and national levels (there are already several examples in Ticino, the most apposite being the bodies with responsibility for the Bolle di Magadino, the Gole della Breggia park, and the Valle Bavona park).

One of the most practical and easily implemented proposals is the creation of a foundation, constituted under public law, with the participation of the local actors, both private and public, present on the territory (local authorities, mountain communities, museums) and competent supra-local authority bodies (confederation and canton, on the Swiss side; regional and provincial authorities in Italy). The foundation structure would report to a strategic organ, performing the functions of a board, flanked by a technical and administrative management with the task of implementing decisions. The internal structure would reflect, for example in working parties, the various sectors involved (nature, farming, leisure, tourism, and so on), with special focus on geopalaeontological matters. In the context of INTERREG III A co-ordination, the collaboration project involving three museums in the region (Meride, Besano, and Induno Olona) set up in the month of December 2002 a permanent scientific forum to manage territory-related, didactically significant, museum-relevant geopalaeontological matters, also ensuring co-ordination of initiatives under way with other projects. The forum will be incorporated into the proposed management structure, making an important scientific, technical, and above all operational, contribution.

In conclusion, we may state that although no body has yet been officially set up, the various co-operative efforts described above already constitute a skeleton management of the area in a spirit of active collaboration. The groundwork has been carried out for an even more efficient, systematic, and integrated management of the geopalaeontological heritage of the area as a whole in the future. Thanks to cantonal and federal co-ordination of the public and private sectors, the nine Swiss local authorities supporting the candidature have been able to develop, from the beginning and with the five local authorities in Italy, a unified, cross-border vision of the management of Monte San Giorgio. Co-ordination of the repeatedly expressed political decisions is underpinned by academic institutions and public bodies, like the local museums and the universities of Zurich and Milan, which guarantee the necessary scientific foundation.

4. Management and protection of the Italian area

The provincial and local authorities in Italy have recently signed a declaration of intent – a copy of which is annexed to this document – **for the future candidature of the Italian area of Monte San Giorgio** for inclusion on the World Heritage List.
Extension on the Italian side further strengthens the preconditions for sustainable management of the entire site. Close cross-border collaboration permits the formulation of a consistent regionwide policy that encompasses the entire geological formation, which does not come to an end at national borders.

COMPARATIVE ANALYSIS

by

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1. INTRODUCTION

The marine Middle Triassic deposits at Monte San Giorgio, and the *Grenzbitumenzone* and fossiliferous layers of the *Calcare di Meride* (*Meride Limestone*) above them, fully deserve to be considered one of the most important fossil vertebrate lagerstätten anywhere in the world. Monte San Giorgio and its fossils have been collected and studied by the palaeontological institute and museum of the university of Zurich since 1924. The site has yielded an unparalleled diversity of fishes and marine reptiles, as well as a few terrestrial forms. The fossils from Monte San Giorgio are known for their exquisite preservation, which reveals a degree of anatomical detail that is exceedingly uncommon for Triassic vertebrates, especially reptiles. The rich taxonomic diversity, and the abundance of specimens, make the fossil fauna from Monte San Giorgio one of the extremely rare windows through which we can observe entire biota in a time capsule.

Another peculiarity of the site is the stratigraphic sequence of five fossiliferous levels, which yield increasing numbers of vertebrate assemblages across the Middle Triassic. The most important level is the earliest, the Grenzbitumenzone (Late Anisian/Earliest Ladinian). It is followed by three vertebrate beds in the *Calcare di Meride Inferiore (Lower Meride Limestone,* Early Ladinian), and the youngest level, in the *Kalkschieferzone* at the top of the *Calcare di Meride* (*Uppermost Meride Limestone,* Late Ladinian). The section covers an evolutionary history of 10-15 million years.

1. The Middle Triassic of Monte San Giorgio documents a time window from 245-240 to 230 million years ago. Vertebrate, invertebrate, and plant fossils from five different fossil beds cover the Late Anisian to Late Ladinian, a time window of 10-15 million years.

2. The five fossil beds yield richly diverse faunas and floras, evolving over time and in response to environmental changes. There are marine and terrestrial reptiles (about 35 species), fishes (about 100 species), invertebrates (>100 species), such as echinoderms, arthropods (including crustaceans, insects, and one scorpion), ammonoids, gastropods, bivalves, and microfossils (foraminifers, ostracods, conodonts, spores, and pollen), in addition to marine and terrestrial plants (> four).

3. Monte San Giorgio is the most important fossil lagerstätte for middle Triassic marine faunas known today. It is the classic site of this type, and the one that has been most thoroughly investigated. Recent field studies by Swiss and Italian research teams, at several localities on Monte San Giorgio and on material from collections in Zurich, Tübingen, and Milan, have shown promising potential for taxonomy, evolutionary biology, and palaeoecology.

4. Other comparable sites contributing to the history of this time period are known only in Spain (Alcover-Montral), the USA (Nevada), and Southern China. All provide a briefer time window on another evolutionary level. Other localities with marine Middle Triassic faunas do not present Monte San Giorgio's rich diversity, quality of preservation, or number of fossils. The terrestrial lagerstätten in Argentina and elsewhere in South America are complementary sites documenting a time-equivalent, or slightly younger, continental environment.

5. The first discoveries and scientific studies of Monte San Giorgio date from 1850, and were made on the Italian side. These were followed by numerous papers and monographs on the fauna written by Swiss palaeontologists. As a classic site for techniques in the systematic excavation of, and research into, marine reptiles and fish, Monte San Giorgio is well known and mentioned in many review papers and text books. The site is also the type locality of many fossil taxa. There are various outstanding ontogenetic series of species, from embryos to juveniles and adult individuals.
Today, the focus of interest is on morphological and evolutionary studies of actinopterygian fishes, and on palaeoecological analyses.

6. Ongoing small-scale excavations by research teams from Zurich and Milan show that systematic field work can lead to the discovery of new species of vertebrates, invertebrates, and plants. However, the detailed study of undescribed material in the huge collections at Zurich and Milan also offers great potential, as was recently demonstrated by a study on Colobodontid fishes, which identified seven new species (Mutter, R. 2002). The richness of the material offers major potential for the biometric study of vertebrates.

7. Monte San Giorgio is the type locality for many vertebrate and invertebrate fossils. As a result, there is much international interest in the site, partly in the form of field trips by students or participants at international congresses. Specialists also come from all over the world to see the site itself and/or to study material in the museums and collections at Meride, Lugano, Zurich, Milan, Besano, and Induno-Olona.

8. Monte San Giorgio has great scientific and tourist potential for its landscape, vegetation, and fauna, which are typical of a Southern Alpine mountain environment. Its flowers and insects present many particularities. Pathways to the top of the mountain offer an exceptional view over the beautiful scenery of Southern Switzerland and Northern Italy, from the Alpine chain to the north and over the subalpine mountains and lakes to the Po plain in the south. Other attractions are the historic mining sites, where oil shales and ore minerals were extracted.

9. Fossil specimen preservation is very good. Reptiles, fish, and arthropods are usually preserved in articulated skeletons. Soft part preservation is also good: embryos and stomach contents have been described.

10. The exceptional vertical sequence of five fossil beds at one site, with a time window of more than 10 million years, and careful bed-by-bed studies, have enabled evolutionary studies to be carried out on several taxa, including marine reptiles (sauropterygians, ichthyosaurs, Tanystropheus), actinopterygian fishes, ammonoids, and bivalves (Daonella). Palaeoecological studies on functional morphology, feeding strategies, and sexual dimorphism have been published for a number of reptile and fish taxa. Ongoing taphonomic studies are leading to a better knowledge of the changing palaeoenvironment.

Table 1: *Summary description of the scientific significance of fossil fauna in the Middle Triassic formations at Monte San Giorgio*

2. The importance of Monte San Giorgio in relation to other fossil sites worldwide

Monte San Giorgio is part of the western Southern Alps. It belongs to the Western Tethyan faunal province in Triassic time. To find other important Middle Triassic fossil sites that are comparable to Monte San Giorgio, we have to look first at the central and eastern part of the Southern Alps (Lombardy and the Dolomites) and at the Austroalpine units of Switzerland and Austria. Middle Triassic faunas from the Eastern Tethyan faunal province are poorly represented in, for example, the Antalya region of Turkey. Interesting but rare marine vertebrate faunas are recorded from the boreal Triassic (mainly Early Triassic) in, for example, Spitzbergen. Other sites belong to the epicontinental Germanic facies of Central Europe. Fossil sites with marine reptiles, but few fishes, are known from Nevada and Japan, and belong to a Pacific faunal province. The rich remains of vertebrate fauna from Guizhou province in Southern China are more significant. Other Triassic fossil sites from South America, South Africa, and Australia are lagerstätten in a continental environment, which are quite different in age and faunal composition.

2.1. Lombardy and the Dolomites (Italy)

The Middle Triassic sediments of the central and eastern part of the Southern Alps in Lombardy and the Dolomites are characterized by a complex palaeogeography of shallow carbonate platforms and deep basins. Marine invertebrate faunas are well known and very important for the biostratigraphy of the area. However, vertebrate fossils are rare and usually very fragmentary. Only the classic Perledo location near Lecco, about 40 kilometres east of Monte San Giorgio (*Perledo-Varenna Limestone*, Ladinian) is noted for its well preserved fishes and marine reptiles, which are stored in a number of long-established collections. However, only a few specimens have been published, most dating from the 19th and early 20th centuries. Specimens were found mainly during quarrying for black ornamental stone before the First World War. Although the fauna is on the whole similar to that of Monte San Giorgio, there seems to be no evidence of enriched levels. Fossils have been found scattered throughout the unit, which is several hundred metres thick. As quarrying has now ceased, and the area is heavily built-up, there is little chance of finding new material in any abundance from the Perledo-Varenna Formation.

2.1.1. Prà della Vacca (Braies-Bolzano Dolomites, Italy)

One of the most recent developments regarding Middle Triassic vertebrates comes from the classic Anisean section of Prà della Vacca, in the Braies Dolomites, where articulated remains of fishes and reptiles have been found in distinctly unusual conditions. It is not an isolated, more or less random, find but a genuine, and potentially very rich, level. Although lacking scientific rigour, the intensive collecting carried out so far in a roughly one-metre-deep level, which is extremely rich in terrestrial plant remains, has brought to light some fishes and a reptile. In a certain sense, they are a by-product of the main line of research. Although conservation of the vertebrates is not optimal because of the emplacement of the plant-rich level, which is twisted and fragmented, the fossils are proving to be of exceptional significance. The deposit environment is clearly marine, as is indicated by the presence of brachiopods (both inside and outside the plant level), ammonites, crinoids, conodonts, and so on. However, the presence of a considerable accumulation of terrestrial plants precludes an unambiguous interpretation of the life environment of the fishes found. The terrestrial vegetation could have been carried into the sea during catastrophic phenomena, such as flooding, that involved the plants. This is especially true for the genus *Dipteronotus*, the first to be discovered, which is typical of environments that are paralic, or closely related to freshwater. Other ichthyan genera (*Bobasatrania, Saurichthys, Peltopleurus*, and a coelacanthid) are regarded as more strictly marine. For this reason, we are probably correct in considering the ichthyofauna as being associated with a coastal environment. The new reptile does not present problems as it is obviously terrestrial and very probably arboreal. Its discovery in a plant-rich level is entirely reasonable. Apart from the significance of this small reptile, which helps us to better

understand a crucial stage in the evolution of the forebears of today's lizards and snakes, the exceptional nature of the new site lies in its variety of fishes, in proportion to the very small number of remains found. Only eight fossils account for six genera, three of which may be regarded as very rare because they are known through a single find, or a very small number of finds at sites that have produced thousands of fossils (see *Bobasatrania*, the coelacanthids, and *Dipteronotus* at Besano-Monte San Giorgio, in this volume). The situation is difficult to interpret, but nevertheless complementary to the research under way at Monte San Giorgio. It permits us to confirm that the genera found at the main Middle Triassic sites were also present in the entire Western Tethys basin, although normally their remains would not have been conserved.

2.2. Austroalpine units in Switzerland and Austria

A few fossil marine reptiles and fish are known from the Middle Triassic of the Drau region (*Fellbach Limestone*, Ladinian) and the Northern Calcareous Alps (*Arlberg Limestone*, Ladinian) in Austria. A well preserved fauna of actinopterygian fishes from the Austroalpine Prosanto Formation, in Eastern Switzerland (Ladinian), has been investigated over the last 15 years. Diversity is not as rich as at Monte San Giorgio, but preservation is of the same quality, or even higher. Some taxa are identical; others are new. Reptiles are not as frequent and diverse as at Monte San Giorgio. Beneath a few articulated skeletons of pachypleurosaurids, only a few isolated bones of larger sauropterygians have been found so far.

2.3. *Muschelkalk* from Central Europe (Germany, France, the Netherlands)

Many vertebrate and invertebrate fossils have been found and described in the past 300 years from the classic Germanic Triassic in Germany, Eastern France and the Netherlands (Winterswijk). Vertebrate fossils have been collected from the *Uppermost Buntsandstein*, the *Muschelkalk* and the *Lowermost Keuper*. Articulated skeletons from conservation or obrution deposits are rare, but large quantities of isolated bones, teeth, and scales from reptiles and fish are known from concentration deposits, like bonebeds. The Middle Triassic sediments were deposited in a large, shallow epicontinental basin connected by seaways to the Tethys ocean. Apart from a few natural outcrops, most classic localities were small quarries or temporary outcrops along roads, highways, and railways that are no longer accessible today.

Many Middle Triassic fish and reptile species were first described from isolated or fragmentary skeletal remains in the German Muschelkalk. The articulated material from systematic excavations in the Middle Triassic of Monte San Giorgio later enabled the revision of morphological and systematic studies of identical or similar species. A typical example is the mysterious reptile *Tanystropheus*, a taxon erected in 1852 by H.v. Huene on the basis of some fragmentary vertebrae from the

Muschelkalk of Bayreuth. During his excavation at Monte San Giorgio in 1929, B. Peyer found the first complete skeleton of a long-necked reptile. He recognized that this animal had very long cervical vertebrae, identical to the fragmentary bones of *Tanystropheus* and *Tribelosodon longobardicus* from the Grenzbitumenzone of Besano, published by F. Bassani (1886) and interpreted by F. v. Nopcsa (1923) as wing bones from the oldest flying reptile. In 1931, Peyer published his monograph on *Tanystropheus longobardicus*, proposing a new interpretation as a prolacertid reptile.

The Central European Muschelkalk is therefore the time-equivalent facies of the Middle Triassic at Monte San Giorgio. It contains many classic vertebrate fossil localities with marine and terrestrial reptiles, and fishes. Fossils are usually isolated bones, teeth or scales, and only rarely fragmentary articulated skeletons. These fossils are often well preserved, sometimes even three-dimensionally.

2.4. Mont-ral-Alcover (Spain)

The deposit at Mont-ral-Alcover (Catalonia, North-Eastern Spain) has yielded faunas diversified into vertebrates and invertebrates. According to some authors, the presence of the bivalves *Daonella lommeli* var. *hispanica* and *Entolium discites*, and of the ammonoids *Protrachiceras pseudarchelaus* and *Hungarites pradoi*, is indicative that this unit is from the late Ladinian. However, examination of the ichthyofauna suggests that it may belong to an earlier stage. There are several fossiliferous sites. For the most part, they are old laminated dolomia quarries, like the classic La Lluera location near the village of Alcover. The sites at El Pinatell, near Mont Blanc, and Dos Marías at Alcover, were discovered only recently. Fossils are usually recovered during quarry work. Only very rarely are digs performed specifically to locate fossils.

The fossiliferous levels have yielded echinoderms, arthropods, molluscs, brachiopods, and coelenterates, indicating a free marine environment, but the various sites belonging to this unit are known above all for their vertebrate faunas.

Reptiles include the nothosaurs *Lariosaurus balsami* (also found in the Ladinian Perledo-Varenna Formation, Northern Italy) and *Nothosaurus cymatosauroides*, known only through two fossils from this group. The small diapsid, *Cosesaurus aviceps*, of which a single example is known, is also exclusive to the Alcover unit.

Fishes are the organisms most frequently encountered. Ichthyofauna includes both coelacanthids and actinopterygia for a total of several hundred fossils on display in public collections. The collections prominently feature the group of the so-called "subholosteans" (Perleidiformes and Peltopleuriformes), present in both large numbers and a remarkable range of genera and species, as has already been amply reported for the Middle Triassic faunas of Monte San Giorgio. Although the most primitive subholosteans are numerically prevalent, the remarkable diversification of the neopterygia should also be noted as it provides evidence of their first radiation, which took place in the Middle Triassic. Neopterygia are well represented in the fauna of Mont-ral but, because of lacunae in the anatomical characteristics available, it is often not possible to identify the fossil remains to species level. The

identification of numerous morphological groups, corresponding to at least 11 genera, is nevertheless significant. It confirms the crucial moment in the evolution of the group, clearly highlighted by studies of the faunas at Monte San Giorgio. The ichthyofauna includes a large number of fossils belonging to the Saurichthyidae, an order of chondrosteans typical of the Triassic. Some of the species in the fauna at Mont-ral-Alcover are known from the Perledo-Varenna Formation and from the most ancient levels at Monte San Giorgio, which correspond to the Besano Formation. Finally, we should note the apparent absence of Palaeoniscidae fossils, primitive chondrosteans that are relatively widespread in other Middle Triassic locations, and of cartilaginous, or bony, fishes.

The first fossil finds at Mont-ral date from 1963. Since then, several studies have been published, particularly in the decade from 1970 to 1980. The ichthyofauna is remarkably diversified and has undergone a number of revisions in the past 10 years, because of problems relating to fossil conservation in particular.

The Alcover unit levels comprise thinly stratified laminate dolomia. Dolomitization has led to the disappearance of all organic remains so the organisms are conserved exclusively as imprints, often poorly defined. These conservation conditions have assumed major relevance in the systematic definition of the various taxa since they may influence the interpretation of key anatomical features for fossil identification. For this reason, comparison with the excellently conserved faunas from the various levels at Monte San Giorgio is especially important, from both the taxonomic and the palaeobiogeographical points of view. The fauna of the Alcover unit, which has many elements in common with the faunas of Monte San Giorgio, at least for the lower levels, also presents significant similarities with the Ladinian faunas of the *Prosanto Formation* (Grisons, Switzerland) and the Perledo-Varenna Varenna. However, the absence of precise stratigraphic data for the origin of individual fossils and, especially, the type of conservation, which does not admit detailed reconstruction, mean that Mont-ral-Alcover is a site whose significance is almost exclusively palaeobiogeographical. It could be argued that, given the type of fossil conservation, Mont-ral-Alcover's fossil fauna "depends" on the fauna at Monte San Giorgio for both its systematic and its paleobiological interpretation.

Apart from a partial revision of the ichthyofauna, there has been no sign in recent years of any initiative to protect or promote these sites and their fossil fauna.

List of vertebrate species found at the Mont-ral-Alcover site:

FISHES

Coelacanthidae

'Alcoveria'

Palaeopterygii

Saurichthys (at least two species, one almost certainly *S. costasquamosus*)

Subholosteans

Luganoia, Peltopleurus, Peripeltopleurus, Peltoperleidus, Ctenognathichthys, Habroichthys

Neopterygii

Eoeugnathus, Eosemionotus, "Heterolepidotus pectoralis", "Allolepidotus ruppellii", "Ophiopsis lepturus"

Ind. gen. (at least five genera)

Other fish genera reported in the literature are:

Ptycholepis, Boreosomus, Cleithrolepis, Perleidus, Platysiagum, and Caturus, which are certainly to be traced back to the forms listed above. It should be remembered that for most of the fossils, it is practically impossible to identify to species level because of the absence of bony elements.

REPTILES

Lariosaurus balsami, Nothosaurus cymatosauroides, Cosesaurus aviceps

2.5. Nevada (United States of America)

Triassic basinal carbonates from Nevada are well known for their significant invertebrate faunas and for their marine reptiles. Very large ichthyosaurs from the Ladinian and Carnian are preserved with partly articulated skeletons, and present close taxonomical relationships with the large ichthyosaurs from Monte San Giorgio. Knowledge of the ichthyofauna is poor and usually based on a few disarticulated fossils.

2.6. Guizhou province (China)

More recently, an abundance of fossil reptiles has been recorded from Guizhou province in Southern China. The fossiliferous outcrops are known as the *Wayao Formation* (or as the *Wayao Member* of the *Falang Formation*). The layers are held to be from the early Carnian age (Early Upper Triassic). However, the only ammonoid found in these layers ranges from late Ladinian to Early Carnian in its stratigraphic distribution, although this unit should be coeval only with the uppermost fossiliferous levels at Monte San Giorgio, the Kalkschieferzone. Fieldwork sponsored by the National Geographic Society is currently under way to better determine the age of the reptiles. All the fossil sites in Guizhou province are on the South China Block, a terrane that at that time had not yet accreted to the main Asiatic Plate. Although the fossil finds are not as numerous as at Monte San Giorgio, the taxonomic

diversity of Triassic marine reptiles approaches that of the Swiss locality. The groups represented are ichthyosaurs, thalattosaurs, pachypleurosaurs, nothosaurs, and tanystropheids.
The same situation obtains for fish fauna. Although it has not yet been studied and published, personal communications from Chinese researchers indicate that fish fauna is very varied and comparable with Monte San Giorgio. The quality of preservation of the Chinese material is excellent, which allows for detailed comparison of the fossils from Southern China with those from Monte San Giorgio. Comparison in detail is of paramount importance in improving precision in phylogenetic analysis, the reconstruction of the evolutionary history of these taxa. Knowledge of evolutionary history can then be used as a basis for paleobiogeographical interpretation. Whereas Monte San Giorgio belongs to the Western Tethyan faunal province, during the Triassic, the South China Block occupied an intermediate position between the Eastern Tethyan and the Western Pacific faunal provinces.

It is this palaeogeographic position that makes the Middle Triassic marine reptiles from Guizhou province so interesting, and comparison with the fauna from Monte San Giorgio, and the much rarer finds of Middle and Upper Triassic marine reptiles from the Eastern Pacific faunal province, so significant. While there is some indication that certain fossil marine reptiles from Guizhou province share trans-Pacific relationships, their sister taxa are to be found overwhelmingly in the Middle Triassic taxa from Monte San Giorgio. Conversely, some taxa from Monte San Giorgio have sister-group relationships with taxa from the Eastern Pacific province, a pattern that is hard to explain from the current reconstruction of Triassic continental plates.

2.6. Ischigualasto-Talampaya (Argentina)

The fossil-bearing area known as Ischigualasto, from the name of the formation that has yielded the most famous remains, is located in the department of Valle Fértil in the province of San Juan, Argentina. Research and systematic study of these fossils began relatively recently, in 1958, but the discovery of the first fossils dates back to the early 1940s. Since 1971, the area has been incorporated into the provincial park of Ischigualasto, which has the principal purpose of protecting the area's palaeontological heritage. On 29 November 2000, ISCHIGUALASTO - TALAMPAYA was included as the sixth palaeontological site on UNESCO's World Heritage List.

The palaeontological significance of the location is self-evident from its inclusion on the World Heritage List. The three main fossiliferous units, from the most ancient to the most recent, are briefly mentioned and their fossil content described. It is, however, pointed out that stratigraphic detail is distinctly lower than in other coeval marine units, making comparison from this point of view very difficult. For example, it is not possible to determine what part of the Middle Triassic is covered by the *Chañares Formation* and no further biostratigraphic subdivisions appear to have been made within that formation. In contrast, detailed stratigraphic subdivisions are possible for the fossiliferous units at Monte San Giorgio.

- **Chañares Formation** (Middle Triassic): has yielded only reptiles, 80% being therapsids (advanced synapsids and the forebears of mammals) and 20% archosaurs (including the ancestors of dinosaurs and present-day crocodiles). This unit, coeval with the Grenzbitumenzone and Meride Limestone, is the only one that may be directly correlated with Monte San Giorgio. The deposit environment is prevalently fluvial and lacustrine, in a stage of transition from the semi-desert conditions of the Lower Triassic to the lusher environment that would culminate in the deposit of the *Ischigualasto Formation.*

- **Ischigualasto Formation** (Carnian-Late Triassic): is the best known unit because it contains the most primitive dinosaurs and also presents the greatest biodiversity. The deposit environment is a well watered valley, whose rivers favoured vegetation and, during the periodic flooding characteristic of a monsoon climate, deposited fine sediment over the carcasses of organisms that had probably died in those floods (many of the fossils are anatomically connected, so the carcass cannot have been exposed to the atmosphere for long). The most ancient and primitive dinosaurs discovered are the carnivores, *Eoraptor* and *Herrerasaurus*, and the herbivore *Pisanosaurus*. Many archosaurs and therapsids (at least 15 genera) are associated with certain large amphibians. There are many plant fossils, which permit a more complete reconstruction of the environment. The unit is, however, more recent than the fossiliferous levels of Monte San Giorgio, where the Carnian age is represented by *Marne del Pizzella (Pizzella Marls)*, which have yet to yield macrofossils.

- **Los Colorados Formation** (Norian?-Late Triassic): as the climate became a little drier, biodiversity also diminished. Fossil association, however, reveals the incipient domination of the dinosaurs over the therapsids, which had begun to decline after having been the forebears of the first mammals. There are no corresponding fossiliferous levels at Monte San Giorgio, where the Norian is represented by *Dolomia Principale*, which is excluded from the area proposed for inclusion on the UNESCO World Heritage List because of the absence of fossil remains. Marine units heteropic with Dolomia Principale featuring abundant remains of marine and terrestrial vetrebrates (*Calcare di Zorzino/Zorzino Limestone - Argillite di Riva di Solto*) crop out a few dozen kilometres from Monte San Giorgio and could present a situation similar to that of the Chañares units and the Grenzbitumenzone-Calcare di Meride series.

The area of Ischigualasto has preserved abundant Middle to Late Triassic terrestrial palaeofauna. The Ischigualasto Formation is the richest of the above three for the quantity, variety, and conservation quality of the fossils found there. The environment at the moment of deposition in this formation was similar to a modern-day African savannah, including a zone of plants (Pteridofitas/seed-ferns) which provided grassy areas interspersed with coniferous woods.

The importance of the fauna of Ischigualasto is not restricted to the wide diversity of forms preserved. It also contributes to explaining one of the most interesting chapters in vertebrate evolutional history: Ischigualasto has preserved fossil remains which document the origin of mammals, as well as dinosaurs.

In this perspective, Ischigualasto is an ideal complement to Monte San Giorgio for the Middle Triassic. It testifies to the evolution of terrestrial faunas, whereas Monte San Giorgio is prevalently marine. Ischigualasto is located in Gondwana, the southern supercontinent, and Monte San Giorgio is part of Tethys, the great oceanic gulf that separated the two major continental blocks. At Ischigualasto, it is possible to follow the history of the dinosaurs, and the evolution of the last ancestors of the mammals in a sub-desert climate. At Monte San Giorgio, we witness the radiation of marine reptiles and actinopterygii fishes in a subtropical lagoon. It should also be noted that the time interval covered by Ischigualasto is much greater than that at Monte San Giorgio where, however, we may observe a much more detailed sequence of fossil associations, albeit one limited to "only" 10-15 million years.

The prospect that both these sites might be included on the World Heritage List is, in our opinion, a very exciting one. It would link two coeval sites with absolutely complementary characteristics in terms of evolutionary period, palaeographic period, the environments in which they are located today, and historical importance.

2.7. Brookvale-Gosford-St. Peter (Australia)

The *Hawkesbury Sandstones* crop out near Sydney and comprise thick-bedded, greyish-white freestones, used commonly in the Sydney area for building purposes. Locally, there are argillitic lenses that yielded, around the turn of the 19th and 20th centuries, fossils of continental faunas, of which the most numerous are freshwater fishes. From its ichthyofauna, this unit is generally considered to belong to the Middle Triassic, although it is not possible to be more specific. It has to be remembered that the ichthyofauna under consideration (Monte San Giorgio and the German Muschelkalk) are marine, whereas the Australian examples are freshwater. In addition, there is the problem of distance with no intermediate fauna.

In fact, the evolutionary stage of this fauna may confidently be regarded as Middle Triassic. Although various environments are present, there is a recognizable, characteristic imprint related to the presence of numerous, well differentiated subholosteans. Unlike better known coeval marine faunas (Monte San Giorgio), neopterygii are rare, whereas basal palaeopterygii are proportionately more abundant. This would seem to imply an evolutionary delay in freshwater with respect to seawater, or simply an earlier age than that of the lower faunas at Monte San Giorgio.
The conservation of a large number of fossils, albeit only as imprints, is to be regarded as satisfactory, given the sharpness and detail of the remains. This made possible a revised description of much of the fauna 30 years or so ago, particularly for the Redfieldiform group, which may be considered the

freshwater equivalent of the Perleidforms + Peltopleuridiforms, partly because of the plastic quality of the imprints, which enables good diversification.
The Hawkesbury Sandstones provide an important snapshot of conditions in the freshwater environment. Nevertheless, the site does not permit us to trace the evolution of the ichthyofauna because of the circumstances of sedimentation, which precluded any possibility of conservation outside a very limited time window. It is also sad to note that there are no reports of new finds, or of new research projects on these faunas. As is very clear from activity so far on Monte San Giorgio, targeted excavations can produce significant results, even in areas that have long been the focus of scientific attention. A project in this area is therefore desirable to expand the collections, adding the many data that may be garnered from targeted excavation and not, as in the past, as a by-product of quarrying.

3. COMPARATIVE ANALYSIS WITH OTHER IMPORTANT FOSSIL LAGERSTÄTTEN OF DIFFERENT AGES

The five superimposed vertebrate fossil beds in the Middle Triassic of Monte San Giorgio can be considered as typical marine, stratiform, conservation lagerstätten (or "fossil bonanzas"). They document, in a single restricted area, the evolutionary history not only of very different taxonomic groups such as marine reptiles, actinopterygian fishes, ammonoids, and bivalves, but also of a shallow marine environment in the Western Tethyan ocean over a period of about 10-15 million years. The area of Monte San Giorgio in Swiss and Italian territory has also been a very important focus of palaeontological studies since the middle of the 19th century. It is one of the so-called classic fossil sites.

Quality of preservation and diversity of organisms, especially aquatic vertebrates, are as outstanding as the much older, Devonian, Miguasha Park in Canada, also included on the World Heritage List, or the younger marine localities around Holzmaden (Lower Jurassic, Southern Germany) and Solnhofen (Upper Jurassic, South-Eastern Germany). Comparable vertebrate-rich Tertiary fossil sites are the Eocene lagoonal deposits at Monte Bolca (North-Eastern Italy) and the lacustrine fossil beds of the Eocene Green River Formation (USA) and Messel (Germany). The classic fossil site of Messel, with its wonderfully preserved aquatic and terrestrial vertebrates (especially mammals), its invertebrates, and its plants, is one of the outstanding freshwater fossil sites and included on the World Heritage List. Monte San Giorgio's Middle Triassic marine fossil lagerstätten comprise a unique example of a marine environment from 230 to 245 million years ago, and would complement the continental Triassic fossil sites of the East Devon coast in Great Britain (*Otter Sandstone*) and Ischigualasto-Talampaya in Argentina.

4. CONCLUSIONS

The Triassic is an important period, which witnessed major radiations of both reptiles and actinopterygian fishes. In this global perspective of evolutionary and paleobiogeographical research, the excellently preserved, taxonomically diverse Middle Triassic marine vertebrate fauna from Monte San Giorgio play a pivotal role in our understanding of how bony fishes and reptiles evolved during the critical period when the supercontinent of Pangea started to break up.

The candidature of the palaeontological site of Monte San Giorgio is thus amply justified for the following reasons, already extensively documented in the ***Nomination of Monte San Giorgio for Inclusion on the World Heritage List*** (see Dossier dated 15 January 2002) and briefly summarized here:

- **Paleontological diversity** (updated to February 2003)

  - 35 species of reptiles,
  - almost 100 species of fishes,
  - certain exceptionally well conserved insect species,
  - about 100 species of cephalopods, lamellibranchs, gasteropods, echinoderms, crustaceans, etc.
  - numerous plant species.

- **Rare and even unique specimens**: many vertebrate and invertebrate fossils have been found exclusively at Monte San Giorgio.

- **An abundance of fossil fauna**: the fossiliferous rocks of Monte San Giorgio present five distinct, superimposed levels with at least eight fish assemblage zones, documenting the evolution of a biocoenosis in a similar environment over 10-15 million years.

- **The geology** of Monte San Giorgio, and the immediate surrounding area, is a key to the interpretation of the history of the southern Alps, from the Carboniferous to the present day, over a period of 350 million years.

- **Exceptionally well preserved specimens:** the fossils are mainly complete and perfectly preserved, in even their minor details.

- **The protection of the site in the past** has permitted the almost complete conservation of the palaeontological heritage in the museums of Zurich, Milan, Lugano, Induno Olona, Meride, and Besano.

- **Scientific studies**: the paleontology of Monte San Giorgio is described in at least 360 scientific studies.

- **Close relationship of humanity and territory**: there is a very close relationship between humanity and the geology of Monte San Giorgio, which was once exploited by mining and quarrying for ornamental stone. Today, it is a focus for scientific research, the protection and management of the mountain, and the promotion and divulgation for educational purposes of its exceptional palaeontological heritage.

SITE CHARACTERISTICS WELL'S (1996) RECOMMENDATIONS	**MONTE SAN GIORGIO (TI-CH)** **Late Anisian-Ladinian**	ISCHIGUALASTO (ARGENTINA) Middle-Late Triassic	MONT-RAL-ALCOVER (CATALONIA, SPAIN) Ladinian
Well preserved fossil accumulation - high species/group diversity - environmental changes through time	**Completely or partially articulated fossils of about 80 fish species, >30 reptile species, and molluscs, crustaceans, plants in several different assemblages. Marine environment with continental representatives.**	Mainly reptile remains, both articulated and isolated - about 50 reptile species; five amphibians; a few fish remains; terrestrial plants; and fresh water crustaceans in three major assemblages.	Fossils remains are imprints, which are hard to interpreti. No stratigraphic or environmental differentiation. There are 15 fish and three reptiles taxa.
The evolutionary 'events' shown in the site encompass the iconography of a tree of life (not a ladder of progress)	**The fossil assemblages encompass the middle Triassic radiation of subholostean fishes, as well as the origin of the neopterygians. Evolutionary trends are well documented for sauropterygians, especially the pachypleurosaurid reptiles**	The fossil assemblages encompass the middle/late Triassic radiation of terrestri reptiles, showing the oldest dinosaurs and some of the youngest mammal precursors.	The fossil assemblages encompass the middle Triassic radiation of subholostean fishes, as well as the origin of the neopterygians. However, the poor state of preservation, and low number, of specimens collected mean that this fauna cannot be considered important for evolutionary studies.
Fossil lagerstätten tell this story most graphically	**The Monte San Giorgio faunas have been studied for 150 years. All the specimens are curated a small number of public collections and are always available to researchers for new studies. Fieldwork and the curation and display of collected specimens is becoming increasingly important in local public museums that have links with major centres of research, like universities**	Although only recently discovered (1958), these faunas are well studied, preserved, and displayed, mainly in local and national museums in Argentina.	Scientific excavations have never been carried out and only a few specimens ar on display. Studies are restricted by the poor preservation of the fossils.
The site tells the history of communities and/or stages in the evolution of major groups	**Marine reptiles and fishes show a strong radiation during most of the Middle Triassic. This event sequence is recorded in the rocks of Monte San Giorgio for more than eight million years. The site also offers an opportunity to follow the evolutionary trend of several groups because the palaeoenvironments changed little much during deposition of all the MSG fossiliferous levels**	Various tetrapod evolutionary trends (the origin and first rise of dinosaurs, the last evolutionary stages of therapsids into mammals) during the Middle-Late Triassic are well recorded for the terrestrial environment	So far, this assemblage has given only a snapshot of Middle Triassic marine fauna. It is a single event, in contrast to the long history recorded in the Mont San Giorgio fossiliferous sequence
The site is representative in time and space of both community structure and selected phylogenetic lineages	**Monte San Giorgio covers at least eight million years in a sequence of marine fossiliferous beds that record vertebrate (fishes and reptiles) and invertebrate (arthropods, molluscs, echinoderms, and conodonts) communities. The site also documents the evolution of actinopterygian fishes, and sauropterygian and ichthyopterygian reptiles. In addition, a few terrestrial tetrapods are present in the fossil assemblage, together with plant remains and insects.**	The Ischigualasto fossiliferous sequence covers most of the Middle and Late Triassic. The three major fossil-bearing levels involve terrestrial tetrapod communities, characterized mainly by archosaurs and therapsids .	The site provides a brief glance of the marine community of fishes and reptiles during the Ladinian. The site is important mainly for palaeobiogeography.
The site show high diversity in both vertebrates and invertebrates	**Marine fishes (about 100 spp.) and aquatic reptiles (35 spp) are the most common vertebrates. Some invertebrates are very common: cephalopods include 50 ammonites, as well as coloidea; there are 10 Daonella spp.; a few other bivalves and gastropods; and rare echinoderms and crustaceans. All are associated with oxygen-rich surface waters or the benthic environment around the depositional basin. Insects are rare, whereas freshwater crustaceans are extremely common locally.**	This site is important for terrestrial vertebrates. Very few freshwater crustaceans and, locally, numerous plant remains are the only non-vertebrate fossils at Ischigualasto.	In addition to fishes and reptiles, a few echinoderms, arthropods, molluscs, brachiopods, and jelly-fishes have also been found. As for vertebrates, the state of preservation is rather poor.

Curation, study and display of the material from the site	**We can identify two levels of curation and display. One is local, in the two museums at Meride and Lugano, and the other national, at the PIMUZ in Zurich. Studies have recently been carried out by PIMUZ and university of Milan staff. On the italian side, there are also two local museums, at Besano and Induno Olona, and studies are being carried out by researchers from the Insubria university at Varese, the university of Milan, and the Civico Museo Storia Naturale in Milan. It should be borne in mind that the site is very close to densely populated areas, especially in Italy, and is in one of the best known tourist areas in Northen Italy-Southern Switzerland.**	Collections are concentrated, curated, and studied in a few Argentinian centers (San Juan, La Rioja,Tucuman, Buenos Aires) with the assistance of North American palaeontologists.	A small local museum in Alcover displays a few specimens. There are no plans for further studies and/or field research.

MUSCHELKALK SEA (GERMANY) Middle Triassic	BRAIES-PRA DELLA VACCA (DOLOMITES - N. ITALY) Anisian	GUIZHOU PROVINCE (S. CHINA) Late Ladinian-Early Carnian	BROOKVALE-GOSFORD-ST. PETER (AUSTRALIA) Hawkesbury Fm-Middle Triassic
Several scattered classic vertebrate fossil localities with marine and terrestrial reptiles and fishes. Fossils are usually isolated bones, teeth, or scales, and rarely fragmentary articulated skeletons, often well preserved, sometimes even three-dimensionally. Significant environmental changes are present in the whole basinal sequence (composite section), but not in one locality	A single event with fish assemblage very close to that from Monte San Giorgio. Very few specimens have been collected so far but the biodiversity confirms the presence of the same fauna all over Western Tethys. The single terrestrial reptile is related to early Lepidosauriomorpha. The vertebrate-yielding bed is very rich in terrestrial plant remains, which are very well preserved	Well preserved reptiles whose assemblage is very similar to that of Monte San Giorgio. Fishes have been also discovered, but none have so far been published. However, the ichthyofauna again appears to be closely related to finds at Mont San Giorgio	Nicely preserved fossils from freshwater-terrestrial environments. Several close superimposed lenses of similar alluvional-estuarine environments.
Analyses of composite faunas highlight evolutionary trends in different groups of marine reptiles and fish.	The marine series covers only part of the Anisian. Vertebrates appear to be present in a single bed, although isolated teeth are present in many conodont samples.	The apparently brief period covered by the fossil-bearing level offers only a glance at a period with very strong faunal variation, as may be inferred from the Monte San Giorgio fossiliferous sequence.	The fossil assemblage gives only a snapshot of this continental environment
Each of the scattered Muschelkalk localities tells only one or two chapters of the whole story. Many classic localities are no longer accessible. Typical fossils are on display in many museums.	Single shot, palaeobiogeografic, and palaeoenvironmental interest.	Too few data so far. However, as the site encompasses only a short time period it is unlikely to offer the most complete account of this chapter in the history of life.	One of the few freshwater fish fauna from the Middle Triassic. The site shows good biodiversity, compared to other small sites in South America, which seems comparable to that found in coeval marine beds (Monte San Giorgio).
Muschelkalk faunas are well studied and document well defined palaeocommunities, dominated by benthic invertebrates. Fish and reptiles are represented by several evolutionary stages.	important for terrestrial community of plants and reptiles, deposited in a marine environment	There are no indications of different stratigraphic levels with vertebrates. Data point to a single level lasting a single ammonite zone.	Middle Triassic freshwater fish communities from Australia appear to be more 'primitive' than those from marine environments, as they have very few neopterygians, and proportionally many more basal palaeopterygians.
Muschelkalk palaeocommunities are representative for a large epicontinental basin. Well based phylogenetic lineages are known in invertebrates. Vertebrate lineages are postulated from fragmentary material and are still highly controversial.	Important for terrestrial community, otherwise rare in this region. No phylogeneti interest	The site provides a snapshot of the marine community of fishes and reptiles at the end of the Ladinian. So far, its importance is mainly related to palaeobiogeography, although the presumed good preservation of fossil remains will also permit work in the future on systematics and phylogeny.	Very little is known about the fossil assemblage as a whole, but it is an importan site. It offers a glance into an environment that is otherwise unknown.
Muschelkalk faunas are famous for their great diversity of benthic invertebrates and endemic nectic cephalopod fauna. Marine vertebrates are fairly diverse, but freshwater and terrestrial vertebrates are also known from allochthonous elements or deposits.	Vertebrates are rare, brachiopods are very common, and ammonites and bivalves are fai common.	There is rich diversity for vertebrates but nothing is yet known about invertebrates.	There is good diversity in the fish fauna, whereas invertebrates seem to be poorly differentiated.

Classic Muschelkalk faunas are well curated and on display in many local, regional, or centralized collections in Germany, France, and the Netherlands. Ongoing scientific studies are being carried out by specialists, including palaeoecologists. There are many important private collections, which are only partly open to researchers.	Excavation was not carried on by a research institute. However, the material will be curated at Bolzano Museo di Storia Naturale, and studied by researchers from the universities of Milan and Ferrara.	As the site was discovered very recently, information is still very scarce. The material is curated at Beijing (I.V.P.P.- Academia Sinica) and fieldwork is under way with the assistance of N.G.S. and N. American palaeontologists.	The collections, assembled mainly at the end of the 19th and in the first half of the last century, are stored in the Natural History Museum in London. The material is not believed to be on display. Some of the fishes were revised about 30 years ago.

PROTOCOLLO CONCERNENTE L'ESTENSIONE AL TERRITORIO ITALIANO, DELL'AREA CANDIDATA ALL'INSERIMENTO NELLA 'WORLD HERITAGE LIST' DELL'UNESCO

I Sottoscritti Sindaci dei Comuni di Besano, Porto Ceresio, Viggiù, Saltrio, Clivio, il Presidente della Comunità Montana della Valceresio ed il Presidente della Provincia di Varese per i rispettivi territori di loro competenza;
anche in qualità di sottoscrittori del Protocollo di intesa per un programma congiunto di sviluppo integrato del Monte S. Giorgio - Orsa -Pravello

vista

la candidatura della Confederazione Elvetica e del Cantone del Ticino, presentata all'UNESCO per ottenere l'inclusione dell'area del Monte San Giorgio nella "World Heritage List" dell'UNESCO per ragioni di carattere scientifico,

visti

i risultati dei sopralluoghi eseguiti dalla Commissione scientifica dell'UNESCO che confermano le premesse contenute nell'istanza di candidatura

vista

la carta geologica della regione

visto

che la perimetrazione dell'area candidata é stata condizionata dalla presenza del Confine di Stato a che pertanto non tiene conto di rilevanti ed obiettivi fattori topografici, geologici e paleontologici, limitandone il significato e condizionando lo sviluppo di studi e ricerche

visti

i ritrovamenti paleontologici avvenuti in territorio italiano, con la collaborazione del Museo di Storia Naturale di Milano e conservati nel Museo Civico dei Fossili di Besano

visti

i ritrovamenti paleontologici avvenuti in territorio italiano, con la collaborazione del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano e conservati nel Civico Museo Insubrico di Induno Olona

dichiarano

il rispettivo intendimento di collaborare al fine di estendere al territorio italiano (Comuni di Besano, Porto Ceresio, Viggiù, Saltrio e Clivio) il riconoscimento di "area patrimonio dell'umanità"

A tale fine viene intendono istituire i necessari contatti per accertare:

a) le possibilità effettive di raggiungere l'obiettivo
b) le modalità e le pratiche a ciò necessarie
c) che l'iniziativa non interferisca con la procedura in corso concernente il solo territorio elvetico
d) se può essere - in via di principio - garantito l'appoggio delle competenti autorità sia elvetiche che italiane

ritengono

di presentare entro il 31 marzo 2003 una breve relazione iniziale sugli accertamenti richiesti al punto precedente;
a seguito di tale relazione, i sottoscritti. si riservano di dare inizio alla istruzione del dossier e del le pratiche necessarie

intendono deliberare

di estendere il campo di azione del Protocollo di Intesa "all'ampliamento in territorio italiano dell'area svizzera già candidata all'iscrizione nella "World Heritage List" dell'UNESCO.

Monte San Giorgio, 5 febbraio 2003.

Comune di Besano, ...

Comune di Clivio, ...

Comune di Porto Ceresio, ...

Comune di Saltrio, Delega .....

Comune di Viggiù, ...

Comunità Montana della Valceresio, delega .....

Provincia di Varese, ...

Azienda di promozione turistica di Varese .....

PROTOCOL REGARDING THE EXTENSION TO ITALIAN TERRITORY OF THE AREA PROPOSED FOR INCLUSION ON THE UNESCO WORLD HERITAGE LIST

The undersigned mayors of the local authorities of Besano, Ceresio, Viggiù Saltrio, and Clivio, the president of the mountain community of Valceresio and the president of the provincial authority of Varese, for the territories falling within their respective jurisdictions;
and as subscribers of the protocol of understanding for a joint integrated development programme of Monte San Giorgio - Orsa - Pravello

whereas
the candidature of the Swiss Confederation and Canton Ticino has been presented to UNESCO to secure the inclusion of the Monte San Giorgio area on the UNESCO World Heritage List for reasons of a scientific nature,

whereas
the results of the site inspections carried out by the UNESCO scientific committee confirm the premises contained in the candidature application

whereas
the geological map of the region has been taken into consideration by the signatories

whereas
the site definition of the candidate area was influenced by the presence of an international border and does not take into account relevant, objective, topographical, geological, and palaeontological factors, thus restricting the significance of the area and prejudicing the development of study and research

whereas
palaeontological finds have been made on Italian territory, with the collaboration of the museum of natural history in Milan, and are conserved at the civic fossil museum at Besano

whereas
palaeontological finds have been made on Italian territory, with the collaboration of the department of earth sciences at the university of Milan, and are conserved in the Insubric civic museum at Induno Olona

hereby declare
their respective intention to collaborate for the purpose of extending recognition as a "world heritage area" to Italian territory (local authorities of Besano, Porto Ceresio, Viggiù, Saltrio, and Clivio).

To that end, the undersigned declare their intention to establish the contacts necessary to ascertain:

a) the actual probability of achieving this objective
b) the procedures and formalities necessary to that end
c) that the initiative shall not interfere with the procedure under way exclusively concerning Swiss territory
d) whether – in principle – the support of the appropriate Swiss and Italian authorities can be guaranteed

hereby affirm
that, before 31 March 2003, the undersigned will present a brief initial report on the points to be ascertained listed above;
following presentation of that report, the undersigned reserve the right to commence preparation of the dossier and formalities required

intend to resolve
to extend the scope of the protocol of understanding "to the extension into Italian territory of the Swiss area already proposed for inclusion on the World Heritage List" of UNESCO.

Monte San Giorgio, 5 February 2003.

Bresano local authority, *Signature (illegible)*

Clivio local authority, *Signature (illegible)*

Porto Ceresio local authority,	*Signature (illegible)*
Saltrio local authority, *Proxy*	*Signature (illegible)*
Viggiù local authority,	*Signature (illegible)*
Valceresio mountain community, *Proxy*	*Signature (illegible)*
Varese provincial authority, *illegible*	*Signature (illegible)*
Varese tourism office	*Signature (illegible)*

Comparative analysis

by

Markus FELBER [1] , Andrea TINTORI [2], Cristina LOMBARDO [2], Heinz FURRER [3] & Olivier RIEPPEL[4]

1) **Commissione Museo dei Fossili, CH-6866 Meride**
2) **Dipartimento di Scienze della Terra, Università degli Studi, I-22100 Milano**
3) **Paläontologisches Institut Universität Zurich, CH-8006 Zurich**
4) **The Field Museum, USA-60605 Chicago**

1. Introduction

The marine Middle Triassic deposits at Monte San Giorgio, and the *Grenzbitumenzone* and fossiliferous layers of the *Calcare di Meride* (*Meride Limestone*) above them, fully deserve to be considered one of the most important fossil vertebrate la gerstätten anywhere in the world. Monte San Giorgio and its fossils have been collected and studied by the palaeontological institute and museum of the university of Zurich since 1924. The site has yielded an unparalleled diversity of fishes and marine reptiles, as well as a few terrestrial forms. The fossils from Monte San Giorgio are known for their exquisite preservation, which reveals a degree of anatomical detail that is exceedingly uncommon for Triassic vertebrates, especially reptiles. The rich taxonomic diversity, and the abundance of specimens, make the fossil fauna from Monte San Giorgio one of the extremely rare windows through which we can observe entire biota in a time capsule.

Another peculiarity of the site is the stratigraphic sequence of five fossiliferous levels, which yield increasing numbers of vertebrate assemblages across the Middle Triassic. The most important level is the earliest, the Grenzbitumenzone (Late Anisian/ Earliest Ladinian). It is followed by three vertebrate beds in the *Calcare di Meride Inferiore (Lower Meride Limestone,* Early Ladinian), and the youngest level, in the

Kalkschieferzone at the top of the *Calcare di Meride* (*Uppermost Meride Limestone,* Late Ladinian). The section covers an evolutionary history of 10-15 million years.

1. The Middle Triassic of Monte San Giorgio documents a time window from 245-240 to 230 million years ago. Vertebrate, invertebrate, and plant fossils from five different fossil beds cover the Late Anisian to Late Ladinian, a time window of 10-15 million years.

2. The five fossil beds yield richly diverse faunas and floras, evolving over time and in response to environmental changes. There are marine and terrestrial reptiles (about 35 species), fishes (about 100 species), invertebrates (>100 species), such as echinoderms, arthropods (including crustaceans, insects, and one scorpion), ammonoids, gastropods, bivalves, and microfossils (foraminifers, ostracods, conodonts, spores, and pollen), in addition to marine and terrestrial plants (> four).

3. Monte San Giorgio is the most important fossil lagerstätte for middle Triassic marine faunas known today. It is the classic site of this type, and the one that has been most thoroughly investigated. Recent field studies by Swiss and Italian research teams, at several localities on Monte San Giorgio and on material from collections in Zurich, Tübingen, and Milan, have shown promising potential for taxonomy, evolutionary biology, and palaeoecology.

4. Other comparable sites contributing to the history of this time period are known only in Spain (Alcover-Montral), the USA (Nevada), and Southern China. All provide a briefer time window on another evolutionary level. Other localities with marine Middle Triassic faunas do not present Monte San Giorgio's rich diversity, quality of preservation, or number of fossils. The terrestrial lagerstätten in Argentina and elsewhere in South America are complementary sites documenting a time-equivalent, or slightly younger, continental environment.

5. The first discoveries and scientific studies of Monte San Giorgio date from 1850, and were made on the Italian side. These were followed by numerous papers and monographs on the fauna written by Swiss palaeontologists. As a classic site for techniques in the systematic excavation of, and research into, marine reptiles and fish, Monte San Giorgio is well known and mentioned in many review papers and text books. The site is also the type locality of many fossil taxa. There are various outstanding ontogenetic series of species, from embryos to juveniles and adult individuals.
Today, the focus of interest is on morphological and evolutionary studies of actinopterygian fishes, and on palaeoecological analyses.

6. Ongoing small-scale excavations by research teams from Zurich and Milan show that systematic field work can lead to the discovery of new species of vertebrates, invertebrates, and plants. However, the detailed study of undescribed material in the huge collections at Zurich and Milan also offers great potential, as was recently demonstrated by a study on Colobodontid fishes, which identified seven new

species (Mutter, R. 2002). The richness of the material offers major potential for the biometric study of vertebrates.

7. Monte San Giorgio is the type locality for many vertebrate and invertebrate fossils. As a result, there is much international interest in the site, partly in the form of field trips by students or participants at international congresses. Specialists also come from all over the world to see the site itself and/or to study material in the museums and collections at Meride, Lugano, Zurich, Milan, Besano, and Induno-Olona.

8. Monte San Giorgio has great scientific and tourist potential for its landscape, vegetation, and fauna, which are typical of a Southern Alpine mountain environment. Its flowers and insects present many particularities. Pathways to the top of the mountain offer an exceptional view over the beautiful scenery of Southern Switzerland and Northern Italy, from the Alpine chain to the north and over the subalpine mountains and lakes to the Po plain in the south. Other attractions are the historic mining sites, where oil shales and ore minerals were extracted.

9. Fossil specimen preservation is very good. Reptiles, fish, and arthropods are usually preserved in articulated skeletons. Soft part preservation is also good: embryos and stomach contents have been described.

10. The exceptional vertical sequence of five fossil beds at one site, with a time window of more than 10 million years, and careful bed-by-bed studies, have enabled evolutionary studies to be carried out on several taxa, including marine reptiles (sauropterygians, ichthyosaurs, Tanystropheus), actinopterygian fishes, ammonoids, and bivalves (Daonella). Palaeoecological studies on functional morphology, feeding strategies, and sexual dimorphism have been published for a number of reptile and fish taxa. Ongoing taphonomic studies are leading to a better knowledge of the changing palaeoenvironment.

Table 1: Summary description of the scientific significance of fossil fauna in the Middle Triassic formations at Monte San Giorgio

2. The importance of Monte San Giorgio in relation to other fossil sites worldwide

Monte San Giorgio is part of the western Southern Alps. It belongs to the Western Tethyan faunal province in Triassic time. To find other important Middle Triassic fossil sites that are comparable to Monte San Giorgio, we have to look first at the central and eastern part of the Southern Alps (Lombardy and the Dolomites) and at the Austroalpine units of Switzerland and Austria. Middle Triassic faunas from the Eastern Tethyan faunal province are poorly represented in, for example, the Antalya region of Turkey. Interesting but rare marine vertebrate faunas are recorded from the boreal Triassic (mainly Early Triassic) in, for example, Spitzbergen. Other sites belong to the epicontinental Germanic facies of Central Europe. Fossil sites with marine reptiles, but few fishes, are known from Nevada and Japan, and belong to a Pacific faunal province. The rich remains of vertebrate fauna from Guizhou province in Southern China are more significant. Other Triassic fossil sites from South America, South Africa, and Australia are lagerstätten in a continental environment, which are quite different in age and faunal composition.

2.1. Lombardy and the Dolomites (Italy)

The Middle Triassic sediments of the central and eastern part of the Southern Alps in Lombardy and the Dolomites are characterized by a complex palaeogeography of shallow carbonate platforms and deep basins. Marine invertebrate faunas are well known and very important for the biostratigraphy of the area. However, vertebrate fossils are rare and usually very fragmentary. Only the classic Perledo location near Lecco, about 40 kilometres east of Monte San Giorgio (*Perledo-Varenna Limestone*, Ladinian) is noted for its well preserved fishes and marine reptiles, which are stored in a number of long-established collections. However, only a few specimens have been published, most dating from the 19th and early 20th centuries. Specimens were found mainly during quarrying for black ornamental stone before the First World War. Although the fauna is on the whole similar to that of Monte San Giorgio, there seems

to be no evidence of enriched levels. Fossils have been found scattered throughout the unit, which is several hundred metres thick. As quarrying has now ceased, and the area is heavily built-up, there is little chance of finding new material in any abundance from the Perledo-Varenna Formation.

2.1.1. Prà della Vacca (Braies-Bolzano Dolomites, Italy)

One of the most recent developments regarding Middle Triassic vertebrates comes from the classic Anisean section of Prà della Vacca, in the Braies Dolomites, where articulated remains of fishes and reptiles have been found in distinctly unusual conditions. It is not an isolated, more or less random, find but a genuine, and potentially very rich, level. Although lacking scientific rigour, the intensive collecting carried out so far in a roughly one-metre-deep level, which is extremely rich in terrestrial plant remains, has brought to light some fishes and a reptile. In a certain sense, they are a by-product of the main line of research. Although conservation of the vertebrates is not optimal because of the emplacement of the plant-rich level, which is twisted and fragmented, the fossils are proving to be of exceptional significance. The deposit environment is clearly marine, as is indicated by the presence of brachiopods (both inside and outside the plant level), ammonites, crinoids, conodonts, and so on. However, the presence of a considerable accumulation of terrestrial plants precludes an unambiguous interpretation of the life environment of the fishes found. The terrestrial vegetation could have been carried into the sea during catastrophic phenomena, such as flooding, that involved the plants. This is especially true for the genus *Dipteronotus*, the first to be discovered, which is typical of environments that are paralic, or closely related to freshwater. Other ichthyan genera (*Bobasatrania, Saurichthys, Peltopleurus*, and a coelacanthid) are regarded as more strictly marine. For this reason, we are probably correct in considering the ichthyofauna as being associated with a coastal environment. The new reptile does not present problems as it is obviously terrestrial and very probably arboreal. Its discovery in a plant-rich level is entirely reasonable. Apart from the significance of this small reptile, which helps us to better understand a crucial stage in the evolution of the forebears of today's lizards and snakes, the exceptional nature of the new site lies in its variety of fishes, in pro-

portion to the very small number of remains found. Only eight fossils account for six genera, three of which may be regarded as very rare because they are known through a single find, or a very small number of finds at sites that have produced thousands of fossils (see *Bobasatrania*, the coelacanthids, and *Dipteronotus* at Besano-Monte San Giorgio, in this volume). The situation is difficult to interpret, but nevertheless complementary to the research under way at Monte San Giorgio. It permits us to confirm that the genera found at the main Middle Triassic sites were also present in the entire Western Tethys basin, although normally their remains would not have been conserved.

2.2. Austroalpine units in Switzerland and Austria

A few fossil marine reptiles and fish are known from the Middle Triassic of the Drau region (*Fellbach Limestone*, Ladinian) and the Northern Calcareous Alps (*Arlberg Limestone*, Ladinian) in Austria. A well preserved fauna of actinopterygian fishes from the Austroalpine Prosanto Formation, in Eastern Switzerland (Ladinian), has been investigated over the last 15 years. Diversity is not as rich as at Monte San Giorgio, but preservation is of the same quality, or even higher. Some taxa are identical; others are new. Reptiles are not as frequent and diverse as at Monte San Giorgio. Beneath a few articulated skeletons of pachypleurosaurids, only a few isolated bones of larger sauropterygians have been found so far.

2.3. *Muschelkalk* from Central Europe (Germany, France, the Netherlands)

Many vertebrate and invertebrate fossils have been found and described in the past 300 years from the classic Germanic Triassic in Germany, Eastern France and the Netherlands (Winterswijk). Vertebrate fossils have been collected from the *Uppermost Buntsandstein*, the *Muschelkalk* and the *Lowermost Keuper*. Articulated skeletons from conservation or obrution deposits are rare, but large quantities of isolated bones, teeth, and scales from reptiles and fish are known from concentration deposits, like bonebeds. The Middle Triassic sediments were deposited in a large, shallow

epicontinental basin connected by seaways to the Tethys ocean. Apart from a few natural outcrops, most classic localities were small quarries or temporary outcrops along roads, highways, and railways that are no longer accessible today.

Many Middle Triassic fish and reptile species were first described from isolated or fragmentary skeletal remains in the German Muschelkalk. The articulated material from systematic excavations in the Middle Triassic of Monte San Giorgio later enabled the revision of morphological and systematic studies of identical or similar species. A typical example is the mysterious reptile *Tanystropheus*, a taxon erected in 1852 by H.v. Huene on the basis of some fragmentary vertebrae from the Muschelkalk of Bayreuth. During his excavation at Monte San Giorgio in 1929, B. Peyer found the first complete skeleton of a long-necked reptile. He recognized that this animal had very long cervical vertebrae, identical to the fragmentary bones of *Tanystropheus* and *Tribelosodon longobardicus* from the Grenzbitumenzone of Besano, published by F. Bassani (1886) and interpreted by F. v. Nopcsa (1923) as wing bones from the oldest flying reptile. In 1931, Peyer published his monograph on *Tanystropheus longobardicus*, proposing a new interpretation as a prolacertid reptile.

The Central European Muschelkalk is therefore the time-equivalent facies of the Middle Triassic at Monte San Giorgio. It contains many classic vertebrate fossil localities with marine and terrestrial reptiles, and fishes. Fossils are usually isolated bones, teeth or scales, and only rarely fragmentary articulated skeletons. These fossils are often well preserved, sometimes even three-dimensionally.

2.4. Mont-ral-Alcover (Spain)

The deposit at Mont-ral-Alcover (Catalonia, North-Eastern Spain) has yielded faunas diversified into vertebrates and invertebrates. According to some authors, the presence of the bivalves *Daonella lommeli* var. *hispanica* and *Entolium discites*, and of the ammonoids *Protrachiceras pseudarchelaus* and *Hungarites pradoi*, is indicative that this unit is from the late Ladinian. However, examination of the ichthyofauna suggests that it may belong to an earlier stage. There are several fossiliferous sites.

For the most part, they are old laminated dolomia quarries, like the classic La Lluera location near the village of Alcover. The sites at El Pinatell, near Mont Blanc, and Dos Marías at Alcover, were discovered only recently. Fossils are usually recovered during quarry work. Only very rarely are digs performed specifically to locate fossils.

The fossiliferous levels have yielded echinoderms, arthropods, molluscs, brachiopods, and coelenterates, indicating a free marine environment, but the various sites belonging to this unit are known above all for their vertebrate faunas.

Reptiles include the nothosaurs *Lariosaurus balsami* (also found in the Ladinian Perledo-Varenna Formation, Northern Italy) and *Nothosaurus cymatosauroides*, known only through two fossils from this group. The small diapsid, *Cosesaurus aviceps*, of which a single example is known, is also exclusive to the Alcover unit.

Fishes are the organisms most frequently encountered. Ichthyofauna includes both coelacanthids and actinopterygia for a total of several hundred fossils on display in public collections. The collections prominently feature the group of the so-called "subholosteans" (Perleidiformes and Peltopleuriformes), present in both large numbers and a remarkable range of genera and species, as has already been amply reported for the Middle Triassic faunas of Monte San Giorgio. Although the most primitive subholosteans are numerically prevalent, the remarkable diversification of the neopterygia should also be noted as it provides evidence of their first radiation, which took place in the Middle Triassic. Neopterygia are well represented in the fauna of Mont-ral but, because of lacunae in the anatomical characteristics available, it is often not possible to identify the fossil remains to species level. The identification of numerous morphological groups, corresponding to at least 11 genera, is nevertheless significant. It confirms the crucial moment in the evolution of the group, clearly highlighted by studies of the faunas at Monte San Giorgio. The ichthyofauna includes a large number of fossils belonging to the Saurichthyidae, an order of chondrosteans typical of the Triassic.

Some of the species in the fauna at Mont-ral-Alcover are known from the Perledo-Varenna Formation and from the most ancient levels at Monte San Giorgio, which

correspond to the Besano Formation. Finally, we should note the apparent absence of Palaeoniscidae fossils, primitive chondrosteans that are relatively widespread in other Middle Triassic locations, and of cartilaginous, or bony, fishes.

The first fossil finds at Mont-ral date from 1963. Since then, several studies have been published, particularly in the decade from 1970 to 1980. The ichthyofauna is remarkably diversified and has undergone a number of revisions in the past 10 years, because of problems relating to fossil conservation in particular.

The Alcover unit levels comprise thinly stratified laminate dolomia. Dolomitization has led to the disappearance of all organic remains so the organisms are conserved exclusively as imprints, often poorly defined. These conservation conditions have assumed major relevance in the systematic definition of the various taxa since they may influence the interpretation of key anatomical features for fossil identification. For this reason, comparison with the excellently conserved faunas from the various levels at Monte San Giorgio is especially important, from both the taxonomic and the palaeobiogeographical points of view. The fauna of the Alcover unit, which has many elements in common with the faunas of Monte San Giorgio, at least for the lower levels, also presents significant similarities with the Ladinian faunas of the *Prosanto Formation* (Grisons, Switzerland) and the Perledo-Varenna Varenna.

However, the absence of precise stratigraphic data for the origin of individual fossils and, especially, the type of conservation, which does not admit detailed reconstruction, mean that Mont-ral-Alcover is a site whose significance is almost exclusively palaeobiogeographical. It could be argued that, given the type of fossil conservation, Mont-ral-Alcover's fossil fauna "depends" on the fauna at Monte San Giorgio for both its systematic and its paleobiological interpretation.

Apart from a partial revision of the ichthyofauna, there has been no sign in recent years of any initiative to protect or promote these sites and their fossil fauna.

List of vertebrate species found at the Mont-ral-Alcover site:

FISHES

Coelacanthidae

'Alcoveria'

Palaeopterygii

Saurichthys (at least two species, one almost certainly *S. costasquamosus*)

Subholosteans

Luganoia, Peltopleurus, Peripeltopleurus, Peltoperleidus, Ctenognathichthys, Habroichthys

Neopterygii

Eoeugnathus, Eosemionotus, "Heterolepidotus pectoralis", "Allolepidotus ruppellii", "Ophiopsis lepturus"

Ind. gen. (at least five genera)

Other fish genera reported in the literature are:
Ptycholepis, Boreosomus, Cleithrolepis, Perleidus, Platysiagum, and *Caturus*, which are certainly to be traced back to the forms listed above. It should be remembered that for most of the fossils, it is practically impossible to identify to species level because of the absence of bony elements.

REPTILES

Lariosaurus balsami, *Nothosaurus cymatosauroides*, *Cosesaurus aviceps*

2.5. Nevada (United States of America)

Triassic basinal carbonates from Nevada are well known for their significant invertebrate faunas and for their marine reptiles. Very large ichthyosaurs from the Ladinian and Carnian are preserved with partly articulated skeletons, and present close tax-

onomical relationships with the large ichthyosaurs from Monte San Giorgio. Knowledge of the ichthyofauna is poor and usually based on a few disarticulated fossils.

2.6. Guizhou province (China)

More recently, an abundance of fossil reptiles has been recorded from Guizhou province in Southern China. The fossiliferous outcrops are known as the *Wayao Formation* (or as the *Wayao Member* of the *Falang Formation*). The layers are held to be from the early Carnian age (Early Upper Triassic). However, the only ammonoid found in these layers ranges from late Ladinian to Early Carnian in its stratigraphic distribution, although this unit should be coeval only with the uppermost fossiliferous levels at Monte San Giorgio, the Kalkschieferzone. Fieldwork sponsored by the National Geographic Society is currently under way to better determine the age of the reptiles. All the fossil sites in Guizhou province are on the South China Block, a terrane that at that time had not yet accreted to the main Asiatic Plate. Although the fossil finds are not as numerous as at Monte San Giorgio, the taxonomic diversity of Triassic marine reptiles approaches that of the Swiss locality. The groups represented are ichthyosaurs, thalattosaurs, pachypleurosaurs, nothosaurs, and tanystropheids.

The same situation obtains for fish fauna. Although it has not yet been studied and published, personal communications from Chinese researchers indicate that fish fauna is very varied and comparable with Monte San Giorgio. The quality of preservation of the Chinese material is excellent, which allows for detailed comparison of the fossils from Southern China with those from Monte San Giorgio. Comparison in detail is of paramount importance in improving precision in phylogenetic analysis, the reconstruction of the evolutionary history of these taxa. Knowledge of evolutionary history can then be used as a basis for paleobiogeographical interpretation. Whereas Monte San Giorgio belongs to the Western Tethyan faunal province, during the Triassic, the South China Block occupied an intermediate position between the Eastern Tethyan and the Western Pacific faunal provinces.

It is this palaeogeographic position that makes the Middle Triassic marine reptiles from Guizhou province so interesting, and comparison with the fauna from Monte San Giorgio, and the much rarer finds of Middle and Upper Triassic marine reptiles from the Eastern Pacific faunal province, so significant. While there is some indication that certain fossil marine reptiles from Guizhou province share trans-Pacific relationships, their sister taxa are to be found overwhelmingly in the Middle Triassic taxa from Monte San Giorgio. Conversely, some taxa from Monte San Giorgio have sister-group relationships with taxa from the Eastern Pacific province, a pattern that is hard to explain from the current reconstruction of Triassic continental plates.

2.6. Ischigualasto-Talampaya (Argentina)

The fossil-bearing area known as Ischigualasto, from the name of the formation that has yielded the most famous remains, is located in the department of Valle Fértil in the province of San Juan, Argentina. Research and systematic study of these fossils began relatively recently, in 1958, but the discovery of the first fossils dates back to the early 1940s. Since 1971, the area has been incorporated into the provincial park of Ischigualasto, which has the principal purpose of protecting the area's palaeontological heritage. On 29 November 2000, Ischigualasto - Talampaya was included as the sixth palaeontological site on UNESCO's World Heritage List.

The palaeontological significance of the location is self-evident from its inclusion on the World Heritage List. The three main fossiliferous units, from the most ancient to the most recent, are briefly mentioned and their fossil content described. It is, however, pointed out that stratigraphic detail is distinctly lower than in other coeval marine units, making comparison from this point of view very difficult. For example, it is not possible to determine what part of the Middle Triassic is covered by the *Chañares Formation* and no further biostratigraphic subdivisions appear to have been made within that formation. In contrast, detailed stratigraphic subdivisions are possible for the fossiliferous units at Monte San Giorgio.

- **Chañares Formation** (Middle Triassic): has yielded only reptiles, 80% being therapsids (advanced synapsids and the forebears of mammals) and 20% archosaurs (including the ancestors of dinosaurs and present-day crocodiles). This unit, coeval with the Grenzbitumenzone and Meride Limestone, is the only one that may be directly correlated with Monte San Giorgio. The deposit environment is prevalently fluvial and lacustrine, in a stage of transition from the semi-desert conditions of the Lower Triassic to the lusher environment that would culminate in the deposit of the *Ischigualasto Formation.*

- **Ischigualasto Formation** (Carnian-Late Triassic): is the best known unit because it contains the most primitive dinosaurs and also presents the greatest biodiversity. The deposit environment is a well watered valley, whose rivers favoured vegetation and, during the periodic flooding characteristic of a monsoon climate, deposited fine sediment over the carcasses of organisms that had probably died in those floods (many of the fossils are anatomically connected, so the carcass cannot have been exposed to the atmosphere for long). The most ancient and primitive dinosaurs discovered are the carnivores, *Eoraptor* and *Herrerasaurus*, and the herbivore *Pisanosaurus*. Many archosaurs and therapsids (at least 15 genera) are associated with certain large amphibians. There are many plant fossils, which permit a more complete reconstruction of the environment. The unit is, however, more recent than the fossiliferous levels of Monte San Giorgio, where the Carnian age is represented by *Marne del Pizzella (Pizzella Marls)*, which have yet to yield macrofossils.

- **Los Colorados Formation** (Norian?-Late Triassic): as the climate became a little drier, biodiversity also diminished. Fossil association, however, reveals the incipient domination of the dinosaurs over the therapsids, which had begun to decline after having been the forebears of the first mammals. There are no corresponding fossiliferous levels at Monte San Giorgio, where the Norian is represented by *Dolomia Principale*, which is excluded from the area proposed for inclusion on the UNESCO World Heritage List because of the absence of fossil remains. Marine units heteropic with Dolomia Principale fea-

turing abundant remains of marine and terrestrial vetrebrates (*Calcare di Zorzino/Zorzino Limestone - Argillite di Riva di Solto*) crop out a few dozen kilometres from Monte San Giorgio and could present a situation similar to that of the Chañares units and the Grenzbitumenzone-Calcare di Meride series.

The area of Ischigualasto has preserved abundant Middle to Late Triassic terrestrial palaeofauna.

The Ischigualasto Formation is the richest of the above three for the quantity, variety, and conservation quality of the fossils found there. The environment at the moment of deposition in this formation was similar to a modern-day African savannah, including a zone of plants (Pteridofitas/seed-ferns) which provided grassy areas interspersed with coniferous woods.

The importance of the fauna of Ischigualasto is not restricted to the wide diversity of forms preserved. It also contributes to explaining one of the most interesting chapters in vertebrate evolutional history: Ischigualasto has preserved fossil remains which document the origin of mammals, as well as dinosaurs.

In this perspective, Ischigualasto is an ideal complement to Monte San Giorgio for the Middle Triassic. It testifies to the evolution of terrestrial faunas, whereas Monte San Giorgio is prevalently marine. Ischigualasto is located in Gondwana, the southern supercontinent, and Monte San Giorgio is part of Tethys, the great oceanic gulf that separated the two major continental blocks. At Ischigualasto, it is possible to follow the history of the dinosaurs, and the evolution of the last ancestors of the mammals in a sub-desert climate. At Monte San Giorgio, we witness the radiation of marine reptiles and actinopterygii fishes in a subtropical lagoon. It should also be noted that the time interval covered by Ischigualasto is much greater than that at Monte San Giorgio where, however, we may observe a much more detailed sequence of fossil associations, albeit one limited to "only" 10-15 million years.

The prospect that both these sites might be included on the World Heritage List is, in our opinion, a very exciting one. It would link two coeval sites with absolutely complementary characteristics in terms of evolutionary period, palaeographic period, the environments in which they are located today, and historical importance.

2.7. Brookvale-Gosford-St. Peter (Australia)

The *Hawkesbury Sandstones* crop out near Sydney and comprise thick-bedded, greyish-white freestones, used commonly in the Sydney area for building purposes. Locally, there are argillitic lenses that yielded, around the turn of the 19th and 20th centuries, fossils of continental faunas, of which the most numerous are freshwater fishes. From its ichthyofauna, this unit is generally considered to belong to the Middle Triassic, although it is not possible to be more specific. It has to be remembered that the ichthyofauna under consideration (Monte San Giorgio and the German Muschelkalk) are marine, whereas the Australian examples are freshwater. In addition, there is the problem of distance with no intermediate fauna.

In fact, the evolutionary stage of this fauna may confidently be regarded as Middle Triassic. Although various environments are present, there is a recognizable, characteristic imprint related to the presence of numerous, well differentiated subholosteans. Unlike better known coeval marine faunas (Monte San Giorgio), neopterygii are rare, whereas basal palaeopterygii are proportionately more abundant. This would seem to imply an evolutionary delay in freshwater with respect to seawater, or simply an earlier age than that of the lower faunas at Monte San Giorgio.

The conservation of a large number of fossils, albeit only as imprints, is to be regarded as satisfactory, given the sharpness and detail of the remains. This made possible a revised description of much of the fauna 30 years or so ago, particularly for the Redfieldiform group, which may be considered the freshwater equivalent of the Perleidforms + Peltopleuridiforms, partly because of the plastic quality of the imprints, which enables good diversification.

The Hawkesbury Sandstones provide an important snapshot of conditions in the freshwater environment. Nevertheless, the site does not permit us to trace the evolution of the ichthyofauna because of the circumstances of sedimentation, which precluded any possibility of conservation outside a very limited time window. It is also sad to note that there are no reports of new finds, or of new research projects on these faunas. As is very clear from activity so far on Monte San Giorgio, targeted excavations can produce significant results, even in areas that have long been the focus of scientific attention. A project in this area is therefore desirable to expand the collections, adding the many data that may be garnered from targeted excavation and not, as in the past, as a by-product of quarrying.

3. Comparative analysis with other important fossil Lagerstätten of different ages

The five superimposed vertebrate fossil beds in the Middle Triassic of Monte San Giorgio can be considered as typical marine, stratiform, conservation lagerstätten (or "fossil bonanzas"). They document, in a single restricted area, the evolutionary history not only of very different taxonomic groups such as marine reptiles, actinopterygian fishes, ammonoids, and bivalves, but also of a shallow marine environment in the Western Tethyan ocean over a period of about 10-15 million years. The area of Monte San Giorgio in Swiss and Italian territory has also been a very important focus of palaeontological studies since the middle of the 19th century. It is one of the so-called classic fossil sites.

Quality of preservation and diversity of organisms, especially aquatic vertebrates, are as outstanding as the much older, Devonian, Miguasha Park in Canada, also included on the World Heritage List, or the younger marine localities around Holzmaden (Lower Jurassic, Southern Germany) and Solnhofen (Upper Jurassic, South-Eastern Germany). Comparable vertebrate-rich Tertiary fossil sites are the Eocene lagoonal deposits at Monte Bolca (North-Eastern Italy) and the lacustrine fossil beds of the Eocene Green River Formation (USA) and Messel (Germany). The classic

fossil site of Messel, with its wonderfully preserved aquatic and terrestrial vertebrates (especially mammals), its invertebrates, and its plants, is one of the outstanding freshwater fossil sites and included on the World Heritage List. Monte San Giorgio's Middle Triassic marine fossil lagerstätten comprise a unique example of a marine environment from 230 to 245 million years ago, and would complement the continental Triassic fossil sites of the East Devon coast in Great Britain (*Otter Sandstone*) and Ischigualasto-Talampaya in Argentina.

4. Conclusions

The Triassic is an important period, which witnessed major radiations of both reptiles and actinopterygian fishes. In this global perspective of evolutionary and paleobiogeographical research, the excellently preserved, taxonomically diverse Middle Triassic marine vertebrate fauna from Monte San Giorgio play a pivotal role in our understanding of how bony fishes and reptiles evolved during the critical period when the supercontinent of Pangea started to break up.

The candidature of the palaeontological site of Monte San Giorgio is thus amply justified for the following reasons, already extensively documented in the ***Nomination of Monte San Giorgio for Inclusion on the World Heritage List*** (see Dossier dated 15 January 2002) and briefly summarized here:

- **Paleontological diversity** (updated to February 2003)

  - 35 species of reptiles,
  - almost 100 species of fishes,
  - certain exceptionally well conserved insect species,
  - about 100 species of cephalopods, lamellibranchs, gasteropods, echinoderms, crustaceans, etc.
  - numerous plant species.

- **Rare and even unique specimens**: many vertebrate and invertebrate fossils have been found exclusively at Monte San Giorgio.

- **An abundance of fossil fauna**: the fossiliferous rocks of Monte San Giorgio present five distinct, superimposed levels with at least eight fish assemblage zones, documenting the evolution of a biocoenosis in a similar environment over 10-15 million years.

- **The geology** of Monte San Giorgio, and the immediate surrounding area, is a key to the interpretation of the history of the southern Alps, from the Carboniferous to the present day, over a period of 350 million years.

- **Exceptionally well preserved specimens:** the fossils are mainly complete and perfectly preserved, in even their minor details.

- **The protection of the site in the past** has permitted the almost complete conservation of the palaeontological heritage in the museums of Zurich, Milan, Lugano, Induno Olona, Meride, and Besano.

- **Scientific studies**: the paleontology of Monte San Giorgio is described in at least 360 scientific studies.

- **Close relationship of humanity and territory**: there is a very close relationship between humanity and the geology of Monte San Giorgio, which was once exploited by mining and quarrying for ornamental stone. Today, it is a focus for scientific research, the protection and management of the mountain, and the promotion and divulgation for educational purposes of its exceptional palaeontological heritage.

Annexe

SITE CHARACTERISTICS WELL'S (1996) RECOMMENDATIONS	MONTE SAN GIORGIO (TI-CH) Late Anisian-Ladinian	ISCHIGUALASTO (ARGENTINA) Middle-Late Triassic	MONT-RAL-ALCOVER (CATALONIA, SPAIN) Ladinian	MUSCHELKALK SEA (GERMANY) Middle Triassic	BRAIES-PRA DELLA VACCA (DOLOMITES - N. ITALY) Anisian	GUIZHOU PROVINCE (S. CHINA) Late Ladinian-Early Carnian	BROOKVALE-GOSFORD-ST. PETER (AUSTRALIA) Hawkesbury Fm-Middle Triassic
Well preserved fossil accumulation - high species/group diversity - environmental changes through time	Completely or partially articulated fossils of about 80 fish species, >30 reptile species, and molluscs, crustaceans, plants in several different assemblages. Marine environment with continental representatives.	Mainly reptile remains, both articulated and isolated - about 50 reptile species; five amphibians; a few fish remains; terrestrial plants; and fresh water crustaceans in three major assemblages.	Fossils remains are imprints, which are hard to interpreti. No stratigraphic or environmental differentiation. There are 15 fish and three reptiles taxa.	Several scattered classic vertebrate fossil localities with marine and terrestrial reptiles and fishes. Fossils are usually isolated bones, teeth, or scales, and rarely fragmentary articulated skeletons, often well preserved, sometimes even three-dimensionally. Significant environmental changes are present in the whole basinal sequence (composite section), but not in one locality.	A single event with fish assemblage very close to that from Monte San Giorgio. Very few specimens have been collected so far but the biodiversity confirms the presence of the same fauna all over Western Tethys. The single terrestrial reptile is related to early Lepidosauriomorpha. The vertebrate-yielding bed is very rich in terrestrial plant remains, which are very well preserved.	Well preserved reptiles whose assemblage is very similar to that of Monte San Giorgio. Fishes have been also discovered, but none have so far been published. However, the ichthyofauna again appears to be closely related to finds at Mont San Giorgio.	Nicely preserved fossils from freshwater-terrestrial environments. Several closely superimposed lenses of similar alluvional-estuarine environments.
The evolutionary 'events' shown in the site encompass the iconography of a tree of life (not a ladder of progress)	The fossil assemblages encompass the middle Triassic radiation of subholostean fishes, as well as the origin of the neopterygians. Evolutionary trends are well documented for sauropterygians, especially the pachypleurosaurid reptiles.	The fossil assemblages encompass the middle/late Triassic radiation of terrestrial reptiles, showing the oldest dinosaurs and some of the youngest mammal precursors.	The fossil assemblages encompass the middle Triassic radiation of subholostean fishes, as well as the origin of the neopterygians. However, the poor state of preservation, and low number, of specimens collected mean that this fauna cannot be considered important for evolutionary studies.	Analyses of composite faunas highlight evolutionary trends in different groups of marine reptiles and fish.	The marine series covers only part of the Anisian. Vertebrates appear to be present in a single bed, although isolated teeth are present in many conodont samples.	The apparently brief period covered by the fossil-bearing level offers only a glance at a period with very strong faunal variation, as may be inferred from the Monte San Giorgio fossiliferous sequence.	The fossil assemblage gives only a snapshot of this continental environment.
Fossil lagerstätten tell this story most graphically	The Monte San Giorgio faunas have been studied for 150 years. All the specimens are curated a small number of public collections and are always available to researchers for new studies. Fieldwork and the curation and display of collected specimens is becoming increasingly important in local public C5museums that have links with major centres of research, like universities.	Although only recently discovered (1958), these fossils represent exceptional assemblages, distributed, mainly in local and national museums in Argentina.	Scientific excavations have never been carried out and only a few specimens are on display. Studies are restricted by the poor preservation of the fossils.	Each of the scattered Muschelkalk localities tells only one or two chapters of the whole story. Many classic localities are no longer accessible. Typical fossils are on display in many museums.	Single shot, palaeobiogeografic, and palaeoenvironmental interest.	Too few data so far. However, as the site encompasses only a short time period, it is unlikely to offer the most complete account of this chapter in the history of life.	One of the few freshwater fish fauna from the Middle Triassic. The site shows good biodiversity, compared to other small sites in South America, which seems comparable to that found in coeval marine beds (Monte San Giorgio).
The site tells the history of communities and/or stages in the evolution of major groups	Marine reptiles and fishes show a strong radiation during most of the Middle Triassic. This event sequence is recorded in the rocks of Monte San Giorgio for more than eight million years. the site also offers an opportunity to follow the evolutionary trend of several groups because the palaeoenvironments changed little much during deposition of all the Monte San Giorgio fossiliferous levels.	Various tetrapod evolutionary trends like origin and first rise of dinosaurs; the last evolutionary stages of therapsids into mammals during the Middle-Late Triassic are well recorded for the terrestrial environment.	So far, this assemblage has given only a snapshot of Middle Triassic marine fauna. It is a single event, in contrast to the long history recorded in the Monte San Giorgio fossiliferous sequence.	Muschelkalk faunas are well studied and document well defined palaeocommunities, dominated by benthic invertebrates. Fish and reptiles are represented by several evolutionary stages.	Important for terrestrial community of plants and reptiles, deposited in a marine environment.	There are no indications of different stratigraphic levels with vertebrates. Data point to a single level lasting a single ammonite zone.	Middle Triassic freshwater fish communities from Australia appear to be more 'primitive' than those from marine environments, as they have very few neopterygians, and proportionally many more basal palaeopterygians.
The site is representative in time and space of both community structure and selected phylogenetic lineages	Monte San Giorgio covers at least eight million years in a sequence of marine fossiliferous beds that record vertebrate (fishes and reptiles) and invertebrate (arthropods, molluscs, echinoderms, and conodonts) communities. The site also documents the evolution of actinopterygian fishes, and sauropterygian and ichthyopterygian reptiles. In addition, a few terrestrial tetrapods are present in the fossil assemblage, together with plant remains and insects.	The Ischigualasto fossiliferous sequence covers most of the Middle and Late Triassic. The three major fossil-bearing levels involve terrestrial tetrapod communities, characterized mainly by archosaurs and therapsids .	The site provides a brief glance of the marine community of fishes and reptiles during the Ladinian. The site is important mainly for palaeobiogeography.	Muschelkalk palaeocommunities are representative for a large epicontinental basin. Well based phylogenetic lineages are known in invertebrates. Vertebrate lineages are postulated from fragmentary material and are still highly controversial.	Important for terrestrial community, otherwise rare in this region. No phylogenetic interest.	The site provides a snapshot of the marine community of fishes and reptiles at the end of the Ladinian. So far, its importance is mainly related to palaeobiogeography, although the presumed good preservation of fossil remains will also permit work in the future on systematics and phylogeny.	Very little is known about the fossil assemblage as a whole, but it is an important site. It offers a glance into an environment that is otherwise unknown.
The site show high diversity in both vertebrates and invertebrates	Marine fishes (about 100 spp.) and aquatic reptiles (35 spp) are the most common vertebrates. Some invertebrates are very common: cephalopods include 50 ammonites, as well as coloidea; there are 10 Daonella spp.; a few other bivalves and gastropods; and rare echinoderms and crustaceans. All are associated with oxygen-rich surface waters or the benthic environment around the depositional basin. Insects are rare, whereas freshwater crustaceans are extremely common locally.	This site is important for terrestrial vertebrates. Very few freshwater crustaceans and, locally, numerous plant remains are the only non-vertebrate fossils at Ischigualasto.	In addition to fishes and reptiles, a few echinoderms, arthropods, molluscs, brachiopods, and jelly-fishes have also been found. As for vertebrates, the state of preservation is rather poor.	Muschelkalk faunas are famous for their great diversity of benthic invertebrates and endemic nectic cephalopod fauna. Marine vertebrates are fairly diverse, but freshwater and terrestrial vertebrates are also known from allochthonous elements or deposits.	Vertebrates are rare, brachiopods are very common, and ammonites and bivalves are fairly common.	There is rich diversity for vertebrates but nothing is yet known about invertebrates.	There is good diversity in the fish fauna, whereas invertebrates seem to be poorly differentiated.
Curation, study and display of the material from the site	We can identify two levels of curation and display. One is local, in the two museums at Meride and Lugano, and the other national, at the PIMUZ in Zurich. Studies have recently been carried out by PIMUZ and university of Milan staff. On the Italian side, there are also two local museums, at Besano and Induno Olona, and studies are being carried out by researchers from the Insubria university at Varese, the university of Milan, and the Civico Museo Storia Naturale in Milan. It should be borne in mind that the site is very close to densely populated areas, especially in Italy, and is in one of the best known tourist areas in Northen Italy-Southern Switzerland.	Collections are concentrated, curated, and studied in a few Argentinian centers (San Juan, La Rioja,Tucuman, Buenos Aires) with the assistance of North American palaeontologists.	A small local museum in Alcover displays a few specimens. There are no plans for further studies and/or field research.	Classic Muschelkalk faunas are well curated and on display in many local, regional, or centralized collections in Germany, France, and the Netherlands. Ongoing scientific studies are being carried out by specialists, including palaeoecologists. There are many important private collections, which are only partly open to researchers.	Excavation was not carried on by a research institute. However, the material will be curated at Bolzano Museo di Storia Naturale, and studied by researchers from the universities of Milan and Ferrara.	As the site was discovered very recently, information is still very scarce. The material is curated at Beijing (I.V.P.P.- Academia Sinica) and fieldwork is under way with the assistance of N.G.S. and N. American palaeontologists.	The collections, assembled mainly at the end of the 19th and in the first half of the last century, are stored in the Natural History Museum in London. The material is not believed to be on display. Some of the fishes were revised about 30 years ago.

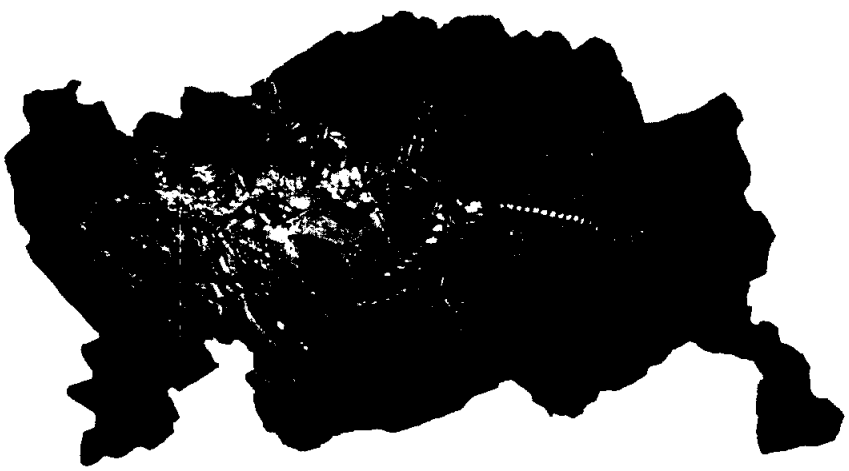
CANDIDATURE OF

MONTE SAN GIORGIO

FOR

INCLUSION ON THE WORLD HERITAGE LIST

ADDITIONAL INFORMATION ON THE FUTURE MANAGEMENT



Candidature of MONTE SAN GIORGIO for Inclusion on the WORLD HERITAGE LIST

Additional information

for the attention of **IUCN/WHC**

Introduction

After examining the dossier regarding the candidature of Monte San Giorgio for inclusion on the World Heritage List, and carrying out a site evaluation visit from 15 to 17 July 2002, the IUCN made a written request on 12 December 2002 for additional information on the dossier in order to complete its own final candidature evaluation report, to be presented to the World Heritage Committee.

The management of the IUCN Protected Areas Programme made two specific requests:

- a comparative study on the scientific significance of Monte San Giorgio in relation to other fossil-bearing sites around the world, particularly from the Triassic period;
- certain information regarding the management of the candidate site and, in particular, the Draft Site Management Plan.

For the first request, the reader is referred to the ***COMPARATIVE ANALYSIS***, drawn up by a special group of experts and enclosed with this document. The additional information requested on the future management and integrity of Monte San Giorgio is reported hereunder.

1. Protection, management, and presentation of palaeontological components

We would again like to stress that all matters relating to the palaeontological heritage of Monte San Giorgio are already subject to management and periodic statutory monitoring by state authorities, if only because all fossil remains are the exclusive property of the state.

Specifically, it is the task of Canton Ticino – acting through the cantonal museum of natural history (CMNH) of the department responsible for the territory – to supervise palaeontological excavations, to identify the fossil remains discovered, to provide for their conservation, and to decide how they should be employed for the purpose of display.
In 1994, the CMNH re-opened scientific excavations in the Swiss area of Monte San Giorgio. Previously, excavations had been conducted by the University of Zurich since 1924. Work was suspended in 1975, except for a brief interlude in 1983, on the occasion of a conference.

Excavations were restarted after about two decades of inactivity thanks to the contribution of two institutes:

- the Paläontologisches Institut and Museum of the University of Zurich (PIMUZ, Dr. Heinz Furrer), which in 1994 began a series of trial excavations at Val Mara (Kalkschieferzone, in

the Uppermost Meride Limestone), and then in 1995 opened the current dig at Acqua del Ghiffo (Lower Meride Limestone). Studies focus principally on marine reptiles (Ceresiosaurus, Neusticosaurus) and reconstruction of the environment.

- the department of earth sciences at the University of Milan (UNIMI, Prof. A. Tintori), which in 1996 inaugurated the current dig at "Site D" in Val Mara (Kalkschieferzone). Research is concerned mainly with fossil fishes and reconstruction of the palaeoecology.

At present, the above two institutes do not have any long-term agreements. Relationships are defined year-by-year through study mandates formulated from projects proposed by the institutes themselves. In this context, the CMNH finances excavation-related expenses (generally two excavation campaigns each year for a total of three to four weeks) and the preparation of part of the material (through the institutes or external preparers).

After completion of analysis and related publications, the fossils pass to the CMNH collections, under the canton's law of property.

In the future, Monte San Giorgio will remain a pivotal site and a major element in the scientific activity promoted by the CMNH. In consequence, CMNH's intention is to carry out research activities at Monte San Giorgio to acquire better knowledge of the geopalaeontological aspects of the site, and to build up, patiently and in the long term, a fossil collection worthy of an institute responsible for the conservation of one of the most important palaeontological heritages anywhere in the world.

CMNH will continue to support collaboration with the two institutes, such support being conditional upon the institutes' willingness to participate and the availability of finance. Finally, depending on developments regarding the proposed expansion of the CMNH structure, it is not to be excluded that CMNH may in future seek new synergies (for example, to replace any such relationships that might be terminated) with other scientific institutes, or indeed be capable of undertaking directly excavation campaigns on Monte San Giorgio.

The Monte San Giorgio management plan will include the information on the planning of research campaigns, the conservation of fossil remains, and their presentation, and will stress the guiding role that will continue to be played in future by the cantonal museum of natural history (CMNH) at Lugano.

2. The new fossil museum

After the recent meeting between a delegation from the Meride local authority and the committee for the Meride fossil museum, the Ticino cantonal department with responsibility for the territory stressed the importance of a fossil museum as a space for sharing knowledge of the extraordinary palaeontological value of Monte San Giorgio.

Over the next few months, a mixed working party from the department of the territory and the Meride local authority will develop the 2002 project for the new fossil museum (already forwarded to IUCN for information on 30 August 2002), specifically examining logistical, functional, organizational, and financial aspects.
It is already felt that the new museum should not merely offer a context for acquiring knowledge of the palaeontological and naturalistic heritage. It should also be a complete visitor centre for local and international users of the mountain.

The subject of staff to be assigned to the museum at Meride (manager/events co-ordinator, caretaker/museum technician, territory guides) will be dealt with in the framework of the working party.

3. Territorial management, planning, and co-ordination

As many as 36 bodies, including 14 Swiss and Italian local authorities from the Monte San Giorgio area, supported the *Monte San Giorgio - Orsa – Pravello* protocol of understanding, initialled at Varese on 21 September 2002, which replaces and expands the Besano protocol, dated 10 May 2001.

The same bodies have taken advantage of the European Union INTERREG III A initiative to activate nine projects for cross-border collaboration, eight of which have been approved. The corresponding actions are operational and under way. A document (CD ROM) containing details of all the INTERREG projects was forwarded to IUCN on 30 August 2002.

These cross-border collaboration projects are all linked, in one way or another, to the protection, management, and promotion of the geopalaeontological heritage of Monte San Giorgio.

The aim of work carried out under the aegis of INTERREG is to make available a model for cross-border territory management. This overview, accompanied by detailed sectoral analyses, will provide sufficient knowledge to enable the inauguration of a sustainable management programme that will above all take into account the characteristics that make the site unique worldwide while ensuring that the environment remains habitable.
The inclusion of the human component in the candidature is instrumental to the management objective. The proposed model links legal constraints to the development of a culture and living pattern that are compatible with protection needs. Ensuring bottom-up protection, involving all levels of society, means that cultural, social, and economic repercussions must be taken into account.

The appropriate promotion of Monte San Giorgio involves identifying a protection zone and a buffer zone. This is essential, and is regarded as a mainstay of future site management. In this context, the legal protection already enjoyed by palaeontological remains will be extended, after the co-ordination activity carried out in the framework of the INTERREG III A project, thanks to the emerging overview of the territory.

In the protection zone, fossil beds, as well as fauna, flora, and mycological resources, will be completely protected and managed essentially for the purposes of scientific research, the dissemination of scientific knowledge, and compatible recreational activities (hillwalking, geology tourism, and so on).

Planning regulations and, in particular, visitor codes of conduct will be specified in a management and co-ordination document. These will also be clearly indicated on the territory with special notices. Access to the protection zone will be marked at border crossings.

The aim of the buffer zone is to guarantee preservation of the landscape and cultural features developed during the long interaction of humanity and the environment. In this respect, the focus of attention will be to weigh the interests of economic requirements and the road system against protection of the features described above and the necessary conservation of the high quality of life currently enjoyed in the region. To consolidate the protection strategy, the INTERREG III A project will evaluate the appropriateness of restricting, to a ring of local authorities outside the candidature area, the possibility intervening directly on the territory of Monte San Giorgio (leisure and mobility). In consequence, regulations regarding the buffer zone will also be drafted to encourage suitable use of the nature resources of Monte San Giorgio.

Work carried out so far for the candidature and the for the INTERREG III A project, as well as other initiatives of a local nature (for example, the project for the new fossil museum at Meride, in addition to territory-oriented activities by regional associations) has laid the foundations for the comprehensive, cross-border management of the entire Monte San Giorgio area. Although some of the proposals contained in this initiative are at the project stage, the intended lines of development are clear.

The cross-border territory management model will encourage the implementation of the following actions:

- codifying decisions made in the context of the INTERREG III A initiative, and subsequent in-depth studies, into higher-order territorial co-ordination tools;
- adding implementation forms to local authority long-term land-use plans to execute, at local level, cross-border co-operation actions for the sustainable development of the area;
- setting up a management body with clear competencies acknowledged at all institutional and national levels (there are already several examples in Ticino, the most apposite being the bodies with responsibility for the Bolle di Magadino, the Gole della Breggia park, and the Valle Bavona park).

One of the most practical and easily implemented proposals is the creation of a foundation, constituted under public law, with the participation of the local actors, both private and public, present on the territory (local authorities, mountain communities, museums) and competent supra-local authority bodies (confederation and canton, on the Swiss side; regional and provincial authorities in Italy). The foundation structure would report to a strategic organ, performing the functions of a board, flanked by a technical and administrative management with the task of implementing decisions. The internal structure would reflect, for example in working parties, the various sectors involved (nature, farming, leisure, tourism, and so on), with special focus on geopalaeontological matters. In the context of INTERREG III A co-ordination, the collaboration project involving three museums in the region (Meride, Besano, and Induno Olona) set up in the month of December 2002 a permanent scientific forum to manage territory-related, didactically significant, museum-relevant geopalaeontological matters, also ensuring co-ordination of initiatives under way with other projects. The forum will be incorporated into the proposed management structure, making an important scientific, technical, and above all operational, contribution.

In conclusion, we may state that although no body has yet been officially set up, the various co-operative efforts described above already constitute a skeleton management of the area in a spirit of active collaboration. The groundwork has been carried out for an even more efficient, systematic, and integrated management of the geopalaeontological heritage of the area as a whole in the future. Thanks to cantonal and federal co-ordination of the public and private sectors, the nine Swiss local authorities supporting the candidature have been able to develop, from the beginning and with the five local authorities in Italy, a unified, cross-border vision of the management of Monte San Giorgio. Co-ordination of the repeatedly expressed political decisions is underpinned by academic institutions and public bodies, like the local museums and the universities of Zurich and Milan, which guarantee the necessary scientific foundation.

4. Management and protection of the Italian area

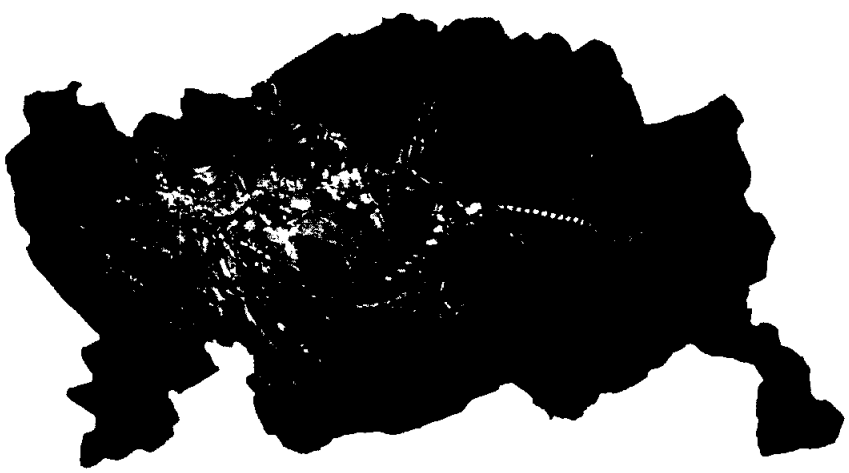
The provincial and local authorities in Italy have recently signed a declaration of intent – a copy of which is annexed to this document – **for the future candidature of the Italian area of Monte San Giorgio** for inclusion on the World Heritage List.

Extension on the Italian side further strengthens the preconditions for sustainable management of the entire site. Close cross-border collaboration permits the formulation of a consistent regionwide policy that encompasses the entire geological formation, which does not come to an end at national borders.

11.02.03/SBMA/Mol

MONTE SAN GIORGIO

PROTOCOL REGARDING THE EXTENSION TO ITALIAN TERRITORY OF THE AREA PROPOSED FOR INCLUSION ON THE UNESCO WORLD HERITAGE LIST



PROTOCOLLO CONCERNENTE L'ESTENSIONE AL TERRITORIO ITALIANO, DELL'AREA CANDIDATA ALL'INSERIMENTO NELLA 'WORLD HERITAGE LIST' DELL'UNESCO

I Sottoscritti Sindaci dei Comuni di Besano, Porto Ceresio, Viggiù, Saltrio, Clivio, il Presidente della Comunità Montana della Valceresio ed il Presidente della Provincia di Varese per i rispettivi territori di loro competenza;
anche in qualità di sottoscrittori del Protocollo di intesa per un programma congiunto di sviluppo integrato del Monte S. Giorgio - Orsa - Pravello

vista

la candidatura della Confederazione Elvetica e del Cantone del Ticino, presentata all'UNESCO per ottenere l'inclusione dell'area del Monte San Giorgio nella "World Heritage List" dell'UNESCO per ragioni di carattere scientifico,

visti

i risultati dei sopralluoghi eseguiti dalla Commissione scientifica dell'UNESCO che confermano le premesse contenute nell'istanza di candidatura

vista

la carta geologica della regione

visto

che la perimetrazione dell'area candidata é stata condizionata dalla presenza del Confine di Stato a che pertanto non tiene conto di rilevanti ed obiettivi fattori topografici, geologici e paleontologici, limitandone il significato e condizionando lo sviluppo di studi e ricerche

visti

i ritrovamenti paleontologici avvenuti in territorio italiano, con la collaborazione del Museo di Storia Naturale di Milano e conservati nel Museo Civico dei Fossili di Besano

visti

i ritrovamenti paleontologici avvenuti in territorio italiano, con la collaborazione del Dipartimento di Scienze della Terra dell'Università degli Studi di Milano e conservati nel Civico Museo Insubrico di Induno Olona

dichiarano

il rispettivo intendimento di collaborare al fine di estendere al territorio italiano (Comuni di Besano, Porto Ceresio, Viggiù, Saltrio e Clivio) il riconoscimento di "area patrimonio dell'umanità"

A tale fine viene intendono istituire i necessari contatti per accertare:

a) le possibilità effettive di raggiungere l'obiettivo
b) le modalità e le pratiche a ciò necessarie
c) che l'iniziativa non interferisca con la procedura in corso concernente il solo territorio elvetico
d) se può essere - in via di principio - garantito l'appoggio delle competenti autorità sia elvetiche che italiane

ritengono

di presentare entro il 31 marzo 2003 una breve relazione iniziale sugli accertamenti richiesti al punto precedente;
a seguito di tale relazione, i sottoscritti. si riservano di dare inizio alla istruzione del dossier e del le pratiche necessarie

intendono deliberare

di estendere il campo di azione del Protocollo di Intesa "all'ampliamento in territorio italiano dell'area svizzera già candidata all'iscrizione nella "World Heritage List" dell'UNESCO.

Monte San Giorgio, 5 febbraio 2003.

Comune di Besano, ...

Comune di Clivio, ...

Comune di Porto Ceresio, ...

Comune di Saltrio, Poleja .....

Comune di Viggiù, ...

Comunità Montana della Valceresio, delega .....

Provincia di Varese, Assessore .....

Azienda di promozione turistica di Varese .....

(Translation)

PROTOCOL REGARDING THE EXTENSION TO ITALIAN TERRITORY OF THE AREA PROPOSED FOR INCLUSION ON THE UNESCO WORLD HERITAGE LIST

The undersigned mayors of the local authorities of Besano, Ceresio, Viggiù Saltrio, and Clivio, the president of the mountain community of Valceresio and the president of the provincial authority of Varese, for the territories falling within their respective jurisdictions;
and as subscribers of the protocol of understanding for a joint integrated development programme of Monte San Giorgio - Orsa - Pravello

whereas
the candidature of the Swiss Confederation and Canton Ticino has been presented to UNESCO to secure the inclusion of the Monte San Giorgio area on the UNESCO World Heritage List for reasons of a scientific nature,

whereas
the results of the site inspections carried out by the UNESCO scientific committee confirm the premises contained in the candidature application

whereas
the geological map of the region has been taken into consideration by the signatories

whereas
the site definition of the candidate area was influenced by the presence of an international border and does not take into account relevant, objective, topographical, geological, and palaeontological factors, thus restricting the significance of the area and prejudicing the development of study and research

whereas
palaeontological finds have been made on Italian territory, with the collaboration of the museum of natural history in Milan, and are conserved at the civic fossil museum at Besano

whereas
palaeontological finds have been made on Italian territory, with the collaboration of the department of earth sciences at the university of Milan, and are conserved in the Insubric civic museum at Induno Olona

hereby declare
their respective intention to collaborate for the purpose of extending recognition as a "world heritage area" to Italian territory (local authorities of Besano, Porto Ceresio, Viggiù, Saltrio, and Clivio).

To that end, the undersigned declare their intention to establish the contacts necessary to ascertain:

a) the actual probability of achieving this objective
b) the procedures and formalities necessary to that end
c) that the initiative shall not interfere with the procedure under way exclusively concerning Swiss territory
d) whether – in principle – the support of the appropriate Swiss and Italian authorities can be guaranteed

hereby affirm

that, before 31 March 2003, the undersigned will present a brief initial report on the points to be ascertained listed above;
following presentation of that report, the undersigned reserve the right to commence preparation of the dossier and formalities required

intend to resolve

to extend the scope of the protocol of understanding "to the extension into Italian territory of the Swiss area already proposed for inclusion on the World Heritage List" of UNESCO.

Monte San Giorgio, 5 February 2003.

Bresano local authority,	*Signature*
Clivio local authority,	*Signature*
Porto Ceresio local authority,	*Signature*
Saltrio local authority,	*Signature*
Viggiù local authority,	*Signature*
Valceresio mountain community,	*Signature*
Varese provincial authority,	*Signature*
Varese tourism office	*Signature*

MONTE SAN GIORGIO

SWITZERLAND

WORLD HERITAGE NOMINATION – IUCN TECHNICAL EVALUATION

MONTE SAN GIORGIO (SWITZERLAND) ID Nº1090

1. DOCUMENTATION

i) **IUCN/WCMC Data Sheet:** 8 references

ii) **Additional Literature Consulted:** Hauschke, N. & Wilde, V. (ed.) 1999. **Trias - Eine ganz andere Welt. Mitteleuropa im frühen Erdmittelalter**. Verlag Dr.F.Pfeil, München, 636pp; IUCN (2002). **A global strategy for geological world heritage**. Gland, 51 pp; Sill, W. 2000. **Comparison of the world's Triassic vertebrate localities - a synopsis**. Unpublished Ms., 2pp; Felber M., Tintori A., Lombardo C., Furrer H., and Rieppel O. (2002) **Comparative Analysis** (Unpublished); Weidert, W.K.(ed.) 1995. **Klassische Fundstellen der Paläontologie - Band III**. Goldschneck Verlag, Korb, 70-75pp; Wells, R.T. (1996). **Earth's geological history - A contextual framework for assessment of world heritage fossil site nominations**. IUCN, Gland, 43 pp; Etter, W. 2001. **Monte San Giorgio: Remarkable Triassic Marine Vertebrates**, in Bottjer *et al.* (ed.) 2001 Exceptional Fossil Preservations, Columbia University press.

iii) **Consultations:** 9 external reviewers. The mission also met with specialists from the Paläontologisches Institut der Universität Zürich, Universita degli Studi di Milano/Dipartimento di Scienze della Terra, Museo naturale del Cantone di Ticino, and local and national authorities.

iv) **Field Visit:** Tim Badman and Gerhard Heiss. July 2002.

2. SUMMARY OF NATURAL VALUES

Monte San Giorgio (MSG) is a pyramid-shaped, wooded mountain (peak 1,096 metres above sea level), which lies to the south of Lake Lugano in Canton Ticino, Switzerland. The natural values proposed for inscription on the World Heritage List arise because of its internationally important fossil remains from the Mid Triassic Period (245-230 million years ago). The nominated Site lies within an area identified as a Landscape Protection Zone (LPZ) under Swiss law, and comprises the part of this protected Zone that contains the main fossiliferous deposits. The total area of the nominated Site is 849 ha, lying within the Communes (or communities) of Meride, Riva San Vitale and Brusino Arsizio. The remaining parts of the LPZ are identified as the buffer zone for the nominated Site, comprising a further 1,389 ha of land, and territory within a further six communities

The Mid Triassic rock succession proposed for inscription rests unconformably on older, Permian volcanic rocks exposed on the north face of MSG, and is overlain by Upper Triassic, and Lower Jurassic rocks. The Mid Triassic sequence consists of approximately 1,000 metres of reef limestones, dolomites and bituminous shales which formed in marine conditions on the margins of the Triassic 'Tethys' Ocean. The exceptional fossil interest within the sequence arises because of the presence of five distinct, fossiliferous formations, the 'Grenzbitumenzone', the Cava Inferiore, Cava Superiore, Cassina Beds and the 'Kalkschieferzone'. The sequence records life in a tropical lagoon environment, sheltered and partially separated from the open sea by an offshore reef. Diverse marine life flourished

within this lagoon, including reptiles, fish, bivalves, ammonites, echinoderms and crustaceans. A stagnant and undisturbed seabed provided the conditions necessary for the preservation of these animals, when they died and fell to the sea-floor, to accumulate as abundant and exceptionally detailed fossils. Because the lagoon was near to land, the fossil remains also include some land-based fossils including reptiles, insects and plants. The fossiliferous rock succession is exposed in Switzerland on MSG, and also in the immediately adjacent area of Italy, in the area around Besano.

The result is a fossil resource of great richness. Fossils from MSG have been known to science for over 150 years. The resource is finite, and stable, so that excavation is necessary to produce fossil finds. Historically many finds were brought to light through commercial extraction of the carbon-rich layers to produce oil; however there is also a long history of scientific excavations dating from 1863 on the Italian deposits, and 1924 on the Swiss side. In summary, the current extent of discoveries includes more than 10,000 fossil specimens, representing 30 species of reptiles, 80 species of fish, c.100 macro-invertebrates, and 3 plant species, in addition to microfossil material which includes spores, pollen and marine micro-organisms.

The distribution and abundance of different fossil groups in the five different levels is variable, with the greatest diversity of material having been found within the Grenzbitumenzone. The vertebrate material includes particularly spectacular specimens, including large, articulated skeletons up to 6 metres in length. Complete skeletons include ichthyosaurs, nothosaurs, placodonts, and the remarkable 'giraffe necked' saurian, *Tanystropheus*. The land-based fauna is more restricted, but includes a significant and unique complete skeleton of the archosaur, *Ticinosuchus*, the first complete skeleton from this group to be discovered in the northern hemisphere.

There are a number of additional features that render exceptional importance to the fossil resource of MSG. First, there is the exceptional quality of preservation of material, including both complete skeletons of marine and land reptiles, and the display of minute detail including internal features such as stomach contents and embryos. Second, there are a number of unique and 'first' discoveries of species that have been made at the Site. A third feature is the presence of five superimposed fossil layers, allowing evolutionary and comparative studies, and a number of features within the sedimentary sequence that allow precise dating. Finally, it is significant that the area has been the subject of detailed study for over 75 years (150 years in Italy), resulting in a rich scientific literature of over 800 papers reviewing the fossils and many aspects of the detailed geology of the deposits. During that time the research and collection activity has been conducted by the universities of Zürich and Milan and the Milan Museum of Natural History. As a result, the fossils that have been found form a unique, consolidated, well-preserved and catalogued resource.

Although it is the geological significance of MSG that is the basis for its nomination as a World Heritage Site, it also displays significant other natural values, as well as cultural links between the geology and the life of the local community. These include quarrying of building stones, past production of mineral oils, and the establishment of a local fossil museum in Meride. Noteworthy local features include dry meadows on limestone sub-soils which are home to plant populations not found elsewhere in Switzerland or in the entire southern-Alpine zone of Italy. The site is rich in fungi (554 species), including 30% of known European species of *Boletus*. 37 of the modern vertebrate species found within the nominated Site are on the national red list, and 21 are protected under the Berne Convention. Three spider and one fungus species, previously unknown to science, have also been found here.

3. COMPARISONS WITH OTHER AREAS

The nomination document contains only a superficial comparative analysis, which claims a 'unique' status for the nominated site. As a result, IUCN:

1) undertook a review of the comparative values of the nomination itself through a number of leading international experts, and
2) requested the State Party to provide a more detailed comparative analysis, which was received in February 2003.

These analyses record that two sites are already inscribed on the World Heritage list which contain notable aspects representative of the Triassic period: Ischigualasto-Talampaya (Argentina), and the Dorset and East Devon Coast (UK). Ischigualasto-Talampaya is inscribed expressly for its Triassic fossil values, and is regarded as the best fossil record of terrestrial life in Triassic times, displaying a complete Triassic section. However, the values of this Site do not provide any insight into the marine fauna of this period, and are therefore clearly differentiated from MSG, where the fossil record is primarily marine. Thus the two sites may be said to complement each other. The Dorset and East Devon Coast includes a Triassic succession as part of a full exposure of the Mesozoic period, and within a site with diverse geological and geomorphological values. Whilst the Triassic succession in this Site is more complete than Monte San Giorgio, the fossil record in terms of both quantity and quality is much lower and primarily restricted to terrestrial aspects.

Other significant Triassic fossil sites that are well known and studied world-wide are also primarily representative of terrestrial interests. Such sites include localities in Australia, the USA, the Karoo of South Africa, Russia, East and North Africa and Brazil. Elsewhere in the Alps, Spain and Central Europe there are important marine fossil deposits of the Triassic period, but it appears that the most significant Triassic marine fossil material, apart from that at MSG, is now being discovered in Guizhou, China. Whilst the total extent and quality of this new material is not yet known, it is apparent that the composition of fossils differs a great deal from the contemporary collection at MSG. Moreover, it is clear that MSG has a pre-eminent importance given its long history of study and exceptional, rich and diverse remains.

The fossil values of the Site are at least comparable with other fossil sites of different era on the World Heritage list in terms of the global representivity of the fossil remains, and the range of time represented. Indeed MSG is more globally representative and covers a longer period of time than the exceptional Eocene lagoon deposits at Messel in Germany. The nominated Site can be regarded as a Triassic equivalent of the Devonian fish site at Miguasha, Canada, in representing life in the marine realm, and complements the exceptional records of the Jurassic marine environments represented on the Dorset and East Devon Coast.

In summary, IUCN considers that MSG can be accepted as unique in the world as the best single fossil record of Triassic marine life. The strict, systematic and continuous scientific research that has been carried out for over 75 years in Switzerland, almost exclusively by the Universities of Zürich and Milan, have resulted in a remarkably complete and co-ordinated record of the Site. Despite the fact that the comparative analysis submitted by the State Party in February 2003 at the request of IUCN contains some gaps on information, it is considered by the majority of the independent experts that MSG has a clear and fully substantiated claim as the principal global reference site for marine palaeontological sciences of the Triassic period.

4. INTEGRITY

4.1 Boundaries

The nominated Site and its buffer zone together correspond to the area of the MSG Landscape Protection Zone, defined under Swiss Law and identified in the Cantonal Development Plan. The nomination document is ambiguous about the precise area to be nominated with contradictory statements in sections 1e and 1f. However, it was confirmed during the field inspection that the area to be nominated for inscription is solely that of the outcrop of the Mid Triassic rock formations, with the remainder of the Landscape Protection Zone forming the buffer zone for the Site. The buffer zone adjoins the Site on three sides; the fourth side of the Site is marked by the Swiss-Italian border.

This approach to definition of the Site boundary is supported in principle, and is appropriate in relation to the integrity criterion in the operational guidelines. In practice on the mountainous and wooded terrain of MSG, and given the discontinuous nature of the rock exposures, the boundary cannot be traced in the field, and the precise extent of the nominated Site is therefore not clearly defined at present. It should at least be clearly marked upon paths etc., and the overall boundary should correspond to identifiable landscape features that conform most closely to the limits of the Mid Triassic exposures.

The nomination document describes the Swiss and Italian deposits as a single entity, although only the Swiss exposures are proposed for inscription. Important elements of the 'story' of the discovery and study of fossil resource of MSG relate to the Italian exposures. The first scientific excavations were carried out in Italy, resulting in the first discoveries and descriptions of several species. However, the fossil material recovered from these early Italian studies was almost all destroyed when the Milan Museum of Natural History was bombed in 1943. Systematic fossil excavations began in Switzerland in 1924, and have continued to the present day with 17 sites having been excavated, in over 50 different campaigns. Most of the spectacular finds within the Mid Triassic rocks of the area have been made in Switzerland, although significant finds have also been made in Italy since excavations (involving a total of three sites) recommenced from the 1950s, including two spectacular skeletons of marine reptiles that are only known from Italy. A further Italian discovery of a partial Jurassic dinosaur at Saltrio, only 200m from the border and on the mountain adjacent to MSG is also noteworthy. The fossil remains in Italy have a high public profile, with a significant local museum at Besano, and a small museum at Induna Olona. Finally, there are equivalent scientific excavations underway in both Switzerland and Italy, and there has been considerable cross-border co-operation between research institutes. The prospects for further finds being made in either Switzerland or Italy depend on the future levels of excavation and study.

Ideally, then, the boundary for MSG should encompass the deposits in both Italy and Switzerland. It is accepted, however, that at present there is not the same level of public and community commitment to a nomination for Italian territory. It is also the case that the Swiss portion of the fossil resource provides an adequate representative sample of the fossil resource of MSG, and that activity in Switzerland has produced most of the discoveries. IUCN, therefore, considers that the nominated Site fulfils adequately, but not optimally, the condition of integrity for site boundaries. Nonetheless, there should be strong encouragement for future extension of the Site to cover the interests that lie in Italy. It is welcome that a Protocol on a possible extension of the Site to include the Italian part has recently been signed (5 February 2003) by representatives of local authorities and communes in Italy, declaring their intent to collaborate for the purposes of extending the boundaries of the Site across the border.

4.2. Legal Status

Although the nominated Site does not have a distinct legal status in its own right at present, both it and the buffer zone are treated as a single site under Swiss law, and receive identical protection. Thus at the federal level, MSG is defined and mapped in the 'Federal Inventory of Landscapes, Sites and Natural Monuments', declared and ratified in 1977. The protected area is in essence the same as the combined area of the nominated Site and buffer zone (the one minor exception is a proposal for an additional area of buffer zone at its extreme southern point). The inventory binds all federal authorities to respect the values for which the site is listed, and also applies to bodies to whom cantonal powers are delegated.

The Cantonal Development Plan (CDP) identifies this same area of land as a Landscape Protection Zone (LPZ). In such zones, the protection of natural landscape features has the highest priority amongst different human uses. The CDP sets out six general objectives for protection, promotion of research and preparation of management plans. The protected area is also translated into the Local Development Plans of the Communes, which include plans providing for different land uses. Within these plans, the significant natural areas within the LPZ are identified as nature reserves, although the detailed policies for protection in both the cantonal and local plans are not recorded in the nomination documentation.

All fossil remains in Canton Ticino are protected through the 'Cantonal Regulations for the Protection of Flora and Fauna' which were passed in 2002. These regulations include sections which replace a legislative decree passed in 1974, which protects fossil remains. Under the regulations, important fossil material throughout the Canton is identified as the property of the State. A cantonal permit is required for all fossil excavation and collection activities, providing a very strict regulatory system which has been applied to fossil excavations on MSG for many years – with permits only having been granted to universities with a proven research record (principally Zürich and Milan). It is difficult to conceive of a stricter regime of fossil protection, which is clearly challenging to implement on a widespread basis throughout the Canton. In relation to the very special and finite resources of MSG, which require excavation if they are to be realised, this level of protection provides an appropriate and workable legal solution to the protection of the resource.

4.3. Ownership

The nominated Site is in the ownership of three different local Communes. Around 10% is cultivated, privately-owned land, mostly near Meride and Riva San Vitale. Some private dwellings lie within the Site along the narrow road that connects Meride with Serpiano. The ownership position is not optimal; however the legislative umbrella of the Canton provides sufficient support for necessary management and protection of the fossil interests of the Site if required.

4.4. Management

Management responsibilities for the nominated Site are divided between the federal, canton and commune levels, with no single management authority. However management of the fossil resource is exclusively the task of the Canton Ticino, within the legal framework described in 4.2.

The site does not currently have a management plan, but a draft management plan was submitted subsequent to the submission of the nomination document. At this stage the draft plan sets out broad statements of intent, and details of current programmes that are being developed by the Canton, in some cases with the support of the Federal and local authorities, and partners in Italy. The plan is not yet at a sufficiently advanced stage to be able to identify the specific management requirements of the nominated Site, as distinct from the wider buffer

zone, nor to make links between management and the land use and regulatory aspects of the commune plans in particular.

As noted, the management of the fossil resource is based on a system of strict legal protection, with regulation of scientific excavation through permits, and strict conditions on the protection, preparation and curation of specimens found. Canton Ticino has shown determination in its management of excavations in the past, as is evident in the exceptional collection of fossils held principally in only three institutions. However, the nature of this management, and the future plans, are not set down in a clear written statement, and thus the expectations of the World Heritage Convention in relation to the conditions of integrity are not fully met on this point. IUCN recommends that the Canton, as the responsible management authority, should prepare a binding written statement to identify clearly to the World Heritage Committee the approach that will be taken to the management of palaeontological material and excavations from MSG. The State Party is requested to give particular attention to ensuring that this aspect continues to be fully supported in the future. These statements would form the first stage to the development of a wider management plan for the Site and the surrounding area. The State Party has indicated that the MSG management plan will include information on research campaigns, the conservation of fossil remains and their presentation.

Interpretation and presentation of the fossil material is particularly important to communicate the special interests to a widespread audience. There are currently good off-site displays of material from MSG at Zürich and Lugano (as well as at Besano and Induna Olona in Italy). Within the buffer zone, a small local museum has been established in Meride, and there are plans to restructure and increase this facility in view of the international interest in the area. A decision on funding for this project is awaited, and IUCN considers that this would be an important development in providing for the needs of visitors to the Site. It is noted in particular that there are no dedicated staff identified for managing MSG at present, and provision of permanent staff based at the museum would be of great benefit, in order to supervise the property, and relate to visitors. The State Party has since confirmed that the staff assigned to the museum at Meride will have a role in guiding visitors on-site.

A project to promote an integrated development plan for the MSG area has recently been agreed through the INTERREG IIIA programme (jointly funded by the EU and Swiss Government), which includes as partners not only the Swiss Communes and Canton partners, but also the equivalent bodies in Italy. The preparation of a management plan is one of the tasks of this project. CHF 100,000 has been identified for this work within Switzerland, with a matching amount in Italy. The plan should be completed by 2005. This is a welcome initiative, especially the cross-border nature of the partnership. It is hoped that this will encourage a common approach to the fossil resources of the Swiss and Italian parts of MSG. The recently-signed protocol amongst the Italian local authorities and communes suggests that progress is taking place.

4.5. Human Impact

At present there do not appear to be significant threats to the Site's natural values in general, and strict protection and regulation of the fossil resource is in place. In contrast to other forms of conservation, palaeontology is by its nature invasive, and in the case of MSG requires active programmes of excavation. These are well regulated at present, and have been so for many years. Extraction of fossil material for oil production has ceased, and whilst it presumably resulted in some losses, it was also the reason that the fossil remains were first recognised.

5. APPLICATION OF CRITERIA/STATEMENT OF SIGNIFICANCE

Monte San Giorgio is nominated for inscription under natural criterion (i).

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

MSG is the single best known record of marine life in the Triassic period, and records important remains of life on land as well. The Site has produced diverse and numerous fossils, many of which show exceptional completeness and detailed preservation. The long history of study of the Site, and the disciplined management of the resource have created a well documented and catalogued body of specimens of exceptional quality, and are the basis for a rich associated geological literature. As a result MSG provides the principal point of reference, relevant to future discoveries of marine Triassic remains throughout the world. Based on its own analysis and a supplementary comparative analysis by the State Party regarding the exceptional comparative value of the site, IUCN considers that the nominated site meets this criterion.

6. RECOMMENDATION

IUCN recommends that the Committee **inscribe** Monte San Giorgio on the World Heritage List under natural criterion (i).

In addition IUCN suggests that the State Party should be requested by the Committee to:

- continue its efforts to include the Italian part as an extension, to be added once satisfactory levels of political commitment have been attained and it is clear that the conditions of integrity can be met;
- ensure that the boundaries of the Site are marked clearly on the ground;
- develop on-site interpretation, so that visitors to the site can readily appreciate its significance, linking this interpretation to the development of the Meride museum.

IUCN would also like the Committee to remind and emphasise to State Parties that all sites nominated for inclusion on the World Heritage List on geological grounds should be accompanied by a thorough global comparative analysis.

APPENDIX 1: IUCN FOSSIL SITE EVALUATION CHECKLIST

Coverage of an extended time period

The site provides fossils of Mid Triassic age, from within a complete Mid Triassic succession covering a period of 15 million years. The presence of five distinct fossiliferous levels provides the opportunity for comparative and evolutionary studies through time.

Richness of species diversity

MSG is the richest known site for marine Triassic vertebrate fossils in the world, providing fossils of reptiles, fish, bivalves, ammonites, echinoderms and crustaceans. Around 110 species of marine reptiles and fish are known from the site, together with c.100 macro-invertebrates. Terrestrial vertebrate, insect and plant species are also known from the site, although in smaller quantities, but include a spectacular complete skeleton of an archosaur. There is an important microfossil fauna.

Uniquely representative of a geological time period

Amongst numerous Triassic fossil sites world wide, MSG has yielded a uniquely rich fauna of marine fossils, and is considered a pre-eminent 'type locality'. Other significant Triassic fossil sites of equivalent international importance provide evidence of terrestrial, rather than marine life.

Existence of other comparable sites

No sites of greater importance are known. Recent finds of marine Triassic fossils have been made in China but are yet to be properly studied, and MSG provides the major reference point for comparative assessment of the significant and interpretation of these and other sites. The nominated Site includes only the Swiss parts of MSG, whilst the deposits extend over the border into Italy. The majority of discoveries have been made within the Swiss area, although significant parts of the 'story' or MSG relate to the Italian part. The Swiss exposures therefore provide an adequate, but not optimal, sample of the scientific interests of MSG, and it is recommended that a future extension of the nominated Site into Italy should be sought.

Ischigualasto-Talampaya (Argentina) is inscribed on the World Heritage List and provides an exceptional record of terrestrial Triassic environments and fossils; MSG provides a complementary record of marine environments.

Contribution to the understanding of life on earth

MSG is the only site where Triassic marine deposits have been studied through continuous disciplined scientific excavation over a period of more than 75 years, and can be considered the main location where a complete, well-preserved record of Triassic marine life has been made. The quantity and quality of fossil biota enables interpretation of species evolution, palaeoenvironments and landforming processes that existed 200 million years ago. The site provides a record of marine life during a critical period in vertebrate evolution on earth, and has an importance that extends beyond representation of life in the Triassic 'Tethys' Ocean, to provide a global reference point for comparative studies of evolution.

Prospects for ongoing discoveries

More than 10,000 fossil specimens have been recovered from the nominated Site to date, and recent excavation campaigns have shown a continued pattern of new discoveries of fossil

material. Much material that has been collected awaits study. Prospects of new discoveries of spectacular reptiles appear to be greatest in the Grenzbitumenzone, but studies at all of the main levels are capable to producing new information. The depth of study of the deposits is capable of providing an increasingly precise and well understood document of Mid Triassic marine life. Recent discoveries of stratigraphic markers such as microfossils and datable volcanic clays are important in establishing the overall precision of the information being gathered from the Site.

International level of interest

MSG is of global importance for geology in general, and palaeontology and evolutionary biology in particular. Its geological interests are documented in over 800 scientific and popular publications. It is internationally renowned to geological science as a uniquely important occurrence of fossiliferous marine Triassic deposits, which has been the subject of focussed and disciplined scientific study and management.

Associated features of natural value

There are other features of natural value (e.g. the contemporary flora and fauna) associated with the nominated Site, which include three spider and one fungus species first discovered there. The nominated Site is an area of attractive landscape, with a range of natural, archaeological and historic features - particularly in the buffer zone. The landscape features and modern processes in an Alpine mountain setting do not relate to the marine environments recorded in the Triassic fossil record.

State of preservation of specimens

The specimens found in the nominated Site include many examples that are complete and fully articulated, ranging from large marine reptiles to insects. Generally the state of preservation of the specimens is outstanding.

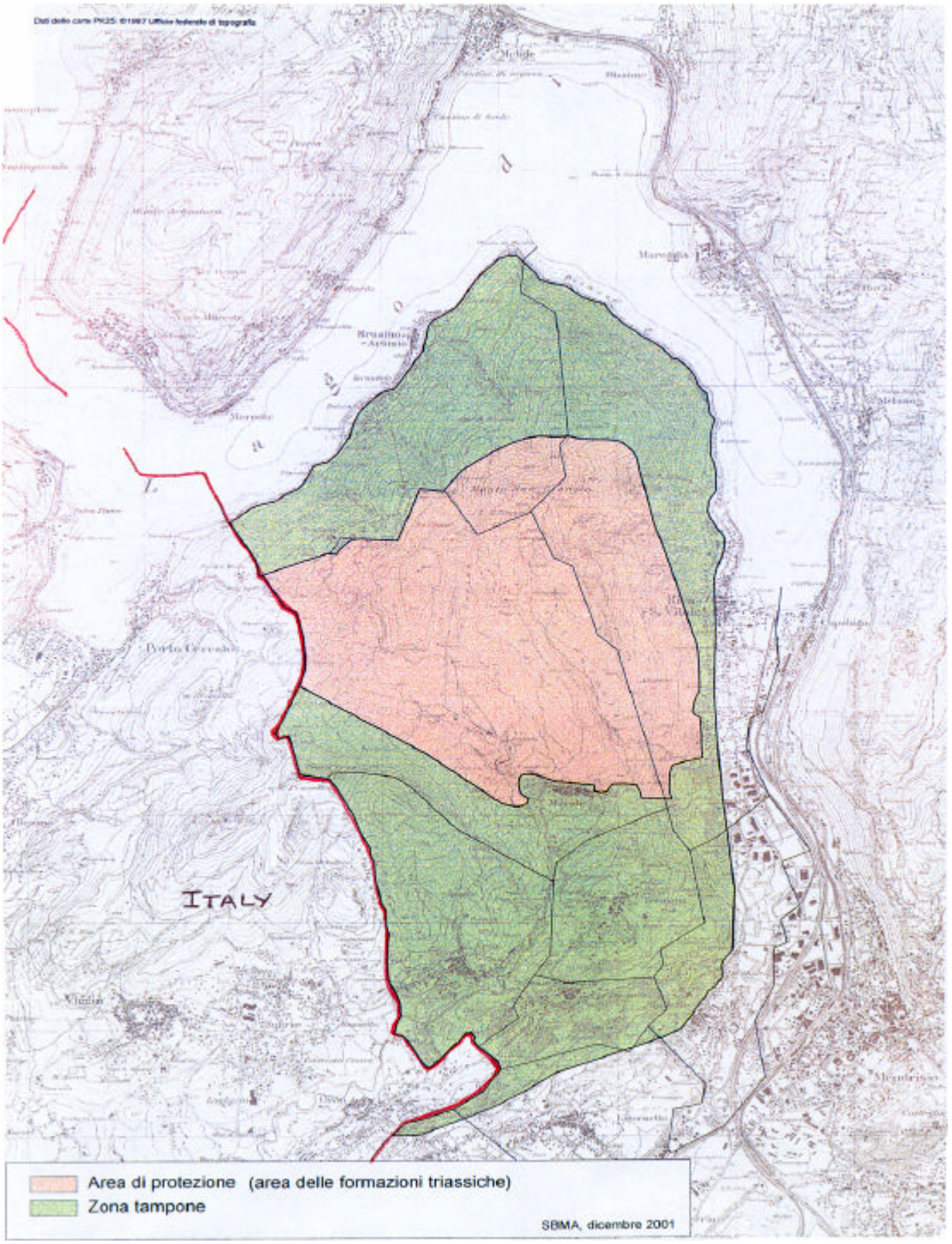
Curation, study and display of fossils

Excavations of the nominated Site are carried out exclusively under the regulation of Canton Ticino, and all excavations have been made under the supervision of the University of Zürich, in cooperation with the Cantonal Museum of Natural History, Lugano and the University of Milan. Fossil finds are curated, catalogued and displayed in both Zürich and Lugano, to excellent standards. An additional exhibition is available immediately adjacent to the Site in Meride (within the buffer zone), which forms the main starting point for visitor excursions to MSG. This facility provides only for interpretation and has no permanent staff at present; however there are plans to develop it further in the future.

Local museums at Induna Olona and Besano in Italy also display finds and information about the fossils of the Monte San Giorgio area.

Map 1: General Location of Site

Map 2: Detailed Map of Site



CANDIDATURE AU PATRIMOINE MONDIAL – ÉVALUATION TECHNIQUE DE L'UICN

MONTE SAN GIORGIO (SUISSE) ID N°1090

1. DOCUMENTATION

i) Fiches techniques UICN/WCMC: 8 références

ii) Littérature consultée: Hauschke, N. & Wilde, V. (ed.) 1999. **Trias - Eine ganz andere Welt. Mitteleuropa im frühen Erdmittelalter**. Verlag Dr .F. Pfeil, München, 636pp; IUCN (2002). **A global strategy for geological world heritage**. Gland, 51 pp; Sill, W. 2000. **Comparison of the world's Triassic vertebrate localities - a synopsis**. Unpublished Ms., 2pp; Felber M., Tintori A., Lombardo C., Furrer H., and Rieppel O. (2002) **Comparative Analysis** (Unpublished); Weidert, W.K.(ed.) 1995. **Klassische Fundstellen der Paläontologie - Band III**. Goldschneck Verlag, Korb, 70-75pp; Wells, R.T. (1996). **Earth's geological history - A contextual framework for assessment of world heritage fossil site nominations**. IUCN, Gland, 43 pp; Etter, W. 2001. **Monte San Giorgio: Remarkable Triassic Marine Vertebrates**, in Bottjer *et al.* (ed.) 2001 Exceptional Fossil Preservations, Columbia University press.

iii) Consultations: neuf évaluateurs indépendants. La mission a aussi rencontré des spécialistes de l'Institut de paléontologie de l'université de Zurich, du département des sciences de la terre de l'université de Milan, du Museo naturale du Canton du Tessin et des représentants des autorités locales et nationales.

iv) Visite du site: Tim Badman et Gerhard Heiss. Juillet 2002

2. RÉSUMÉ DES CARACTÉRISTIQUES NATURELLES

Le Monte San Giorgio est une montagne boisée de forme pyramidale (1096 m au-dessus du niveau de la mer) qui se trouve au sud du lac de Lugano, dans le Canton du Tessin, en Suisse. Les valeurs naturelles qui font l'objet de la proposition d'inscription sur la Liste du patrimoine mondial tiennent aux gisements de fossiles d'importance internationale qui datent du Trias moyen (245 à 230 millions d'années). Le site proposé se trouve dans une Zone de paysage protégé (ZPP) selon le droit suisse et comprend la partie de la zone protégée contenant les principaux gisements fossilifères. Le site proposé a une superficie totale de 849 ha et dépend des communes de Meride, Riva San Vitale et Brusino Arsizio. Le reste de la ZPP sert de zone tampon et couvre 1389 ha supplémentaires sur le territoire de six autres communes.

La succession de roches du Trias moyen proposée pour inscription repose, de manière inhabituelle, sur des roches volcaniques plus anciennes, datant du Permien et affleurant sur la face nord du Monte San Giorgio; elle est recouverte par des roches du Trias supérieur et du Jurassique inférieur. La séquence du Trias moyen se compose d'environ 1000 m de calcaires récifaux, de dolomites et de schistes bitumineux qui se sont formés dans un milieu marin, aux marges de l'océan «Tethys» triasique. L'intérêt fossilifère exceptionnel de la séquence est dû à la présence de cinq formations fossilifères différentes, le «Grenzbitumenzone», le Cava Inferiore, le Cava Superiore, les gisements Cassina et le «Kalkschieferzone». La séquence témoigne de la vie dans un lagon tropical abrité et partiellement séparé de la haute mer par un récif. Diverses formes de vie marine ont prospéré dans ce lagon, notamment des reptiles, des poissons, des bivalves, des ammonites, des échinodermes et des crustacés. Le lit marin stagnant et non perturbé fournissait les conditions nécessaires à la conservation de ces

animaux : lorsqu'ils mouraient et qu'ils tombaient sur le lit marin, ils pouvaient s'accumuler en fossiles abondants et exceptionnellement complets. Comme le lagon était proche de la terre, on trouve aussi des fossiles d'origine terrestre, notamment des reptiles, des insectes et des plantes. La succession de roches fossilifères affleure, en Suisse, sur le Monte San Giorgio mais aussi dans la zone italienne immédiatement adjacente, dans la région de Besano.

Il en résulte une ressource fossilifère très riche. Les fossiles du Monte San Giorgio sont connus des scientifiques depuis plus de 150 ans. La ressource est limitée et stable, de sorte qu'il est nécessaire de procéder à des excavations pour découvrir des fossiles. Du point de vue historique, de nombreuses découvertes ont été mises au jour, à l'origine, par l'exploitation commerciale des couches riches en carbone afin de produire des huiles minérales; cependant l'excavation scientifique a commencé en 1863 dans les gisements italiens et en 1924 sur le versant suisse. En résumé, l'étendue actuelle des découvertes s'élève à plus de 10 000 spécimens représentant 30 espèces de reptiles, 80 espèces de poissons, près de 100 macro-invertébrés et 3 espèces de plantes, outre les microfossiles qui comprennent des spores, du pollen et des micro-organismes marins.

La distribution et l'abondance des différents groupes fossiles, dans les cinq niveaux différents, sont variables. La plus grande diversité a été découverte dans le Grenzbitumenzone. Le matériel vertébré comprend des spécimens particulièrement spectaculaires, y compris de grands squelettes articulés qui atteignent parfois six mètres de longueur. Parmi les squelettes complets, on note des ichtyosaures, des nothosaures, des placodontes et le remarquable saurien «à cou de girafe», *Tanystropheus*. La faune terrestre est plus limitée mais comprend un squelette complet, important et unique de l'archosaure *Ticinosuchus*, premier squelette complet de ce groupe à avoir été découvert dans l'hémisphère nord.

Un certain nombre d'autres caractéristiques donnent à la ressource de fossiles du Monte San Giorgio une importance particulière. Premièrement, il faut noter la qualité de conservation exceptionnelle du matériel, notamment des squelettes complets de reptiles marins et de reptiles terrestres, ainsi que la présence de détails minuscules, y compris de caractéristiques internes telles que le contenu de l'estomac et des embryons. Deuxièmement, plusieurs «premières» découvertes et découvertes uniques d'espèces ont été faites dans le site. Troisièmement, la présence de cinq couches fossilifères superposées permet des études comparatives et des études de l'évolution tandis que plusieurs caractéristiques de la séquence sédimentaire permettent des datages précis. Enfin, il importe de noter que la région a fait l'objet d'études détaillées depuis plus de 75 ans (150 ans en Italie), ce qui a donné une littérature scientifique riche de plus de 800 publications sur les fossiles et de nombreux aspects de la géologie précise des gisements. Les activités de recherche et de collection ont été placées sous l'égide des universités de Zurich et de Milan et du Muséum d'histoire naturelle de Milan. En conséquence, les fossiles découverts forment une ressource unique, assemblée, bien conservée et cataloguée.

Bien que ce soit l'importance géologique du Monte San Giorgio qui fasse l'objet de la proposition d'inscription sur la Liste du patrimoine mondial, le site présente aussi d'importantes valeurs naturelles et illustre les liens culturels entre la géologie et la vie de la communauté locale – carrières de pierres pour la construction, production passée d'huiles minérales et musée local de fossiles à Meride. Parmi les caractéristiques locales importantes, il y a les prairies sèches sur sous-sol calcaire où l'on trouve des populations de plantes qui n'existent pas ailleurs en Suisse ni dans l'ensemble de la zone italienne des Alpes du Sud. Le site est riche en champignons (554 espèces) y compris 30% des espèces européennes connues de *Boletus*. Trente-sept des espèces de vertébrés modernes qui se trouvent dans le site proposé sont aussi inscrites sur la Liste rouge nationale et 21 sont protégées par la Convention de Berne. Trois araignées et une espèce de champignon inconnues jusqu'à présent de la science ont également été découvertes dans ce site.

3. COMPARAISON AVEC D'AUTRES SITES

Pour revendiquer le caractère «unique» du site proposé, le texte de la proposition ne propose qu'une analyse comparative superficielle. En conséquence, l'UICN:

1) a entrepris une étude des valeurs comparatives du site proposé lui-même en faisant appel à plusieurs experts internationaux éminents et
2) a demandé à l'État partie de fournir une analyse comparative plus précise que l'UICN a reçue en février 2003.

Ces analyses indiquent que deux sites déjà inscrits sur la Liste du patrimoine mondial contiennent des aspects représentatifs remarquables de la période du Trias: Ischigualasto-Talampaya (Argentine), et la Côte du Dorset et de l'est du Devon (Royaume-Uni). Ischigualasto-Talampaya est expressément inscrit pour ses valeurs fossilifères du Trias et considéré comme le meilleur assemblage fossilifère représentant la vie terrestre au Trias car il met en évidence une séquence complète du Trias. Toutefois, les valeurs de ce site ne fournissent aucune perspective sur la faune marine de la période et sont donc foncièrement différentes de celles du Monte San Giorgio où l'assemblage fossilifère est surtout marin. On peut donc dire que les deux sites se complètent l'un l'autre. La Côte du Dorset et de l'est du Devon comprend une succession triasique qui fait partie d'une séquence couvrant toute l'ère mésozoïque et se trouve dans un site qui présente des valeurs géologiques et géomorphologiques diverses. La succession triasique de ce site est plus complète que celle du Monte San Giorgio mais l'assemblage de fossiles, tant par la quantité que par la qualité, est bien inférieur et essentiellement limité aux aspects terrestres.

Il existe, dans le monde entier, d'autres sites fossilifères importants du Trias qui sont bien connus et bien étudiés et qui représentent essentiellement aussi des intérêts terrestres. Ces sites comprennent des localités d'Australie, des États-Unis, le Karoo en Afrique du Sud, des sites de Russie, d'Afrique du Nord et de l'Est et du Brésil. Ailleurs dans les Alpes, en Espagne et en Europe centrale, il y a d'importants gisements fossilifères marins de la période du Trias mais le matériel fossilifère marin du Trias le plus important, à part celui du Monte San Giorgio est apparemment en train d'être découvert à Guizhou, en Chine. L'étendue et la qualité totale de ce nouveau matériel ne sont pas encore connues mais il semble que la composition des fossiles diffère énormément de la collection contemporaine du Monte San Giorgio. Il est clair, en outre, que le Monte San Giorgio a une importance suprême en raison des études fort anciennes qui le concernent et des restes exceptionnels, riches et divers qu'on y a découvert.

Les valeurs fossilifères du site sont au moins comparables à celles d'autres sites fossilifères qui représentent des ères différentes et qui sont inscrits sur la Liste du patrimoine mondial en raison de la représentativité mondiale de leurs fossiles et de la période étendue représentée. En fait, le Monte San Giorgio est beaucoup plus représentatif au plan mondial et couvre une période plus longue que les gisements lagunaires exceptionnels de l'Éocène que l'on trouve à Messel, en Allemagne. Le site proposé peut être considéré comme l'équivalent, pour le Trias, du site de poissons du Dévonien de Miguasha, au Canada, du point de vue de la représentation de la vie dans le domaine marin et complète les trésors exceptionnels du milieu marin du Jurassique représentés dans le site de la Côte du Dorset et de l'est du Devon.

En résumé, l'UICN considère que le Monte San Giorgio peut être accepté comme unique au monde pour le meilleur assemblage de fossiles marins du Trias. La recherche scientifique rigoureuse, systématique et continue qui se poursuit depuis plus de 75 ans en Suisse et qui a été menée presque exclusivement par les universités de Zurich et de Milan a donné une collection remarquablement complète et coordonnée du site. Bien que l'analyse comparée soumise par l'État partie en février 2003, à la demande de l'UICN, présente certaines lacunes dans l'information, la majorité des experts indépendants estiment que le Monte San Giorgio peut clairement prétendre, preuves à l'appui, être le principal site de référence mondial pour les sciences paléontologiques marines de l'époque du Trias.

4. INTÉGRITÉ

4.1 Limites

Le site proposé et sa zone tampon correspondent, ensemble, à la Zone de paysage protégé du Monte San Giorgio, définie au sens du droit suisse et identifiée dans le Plan de développement cantonal. Le texte de la proposition est ambigu dans sa description de la zone réellement proposée car on trouve des affirmations contradictoires dans les paragraphes 1e et 1f. Toutefois, il a été confirmé durant la mission d'inspection que la zone proposée pour inscription est uniquement l'affleurement de formations rocheuses du Trias moyen tandis que le reste de la Zone de paysage protégé forme la zone tampon du site. Celle-ci est accolée au site de trois côtés; le quatrième côté est délimité par la frontière helvético-italienne.

Cette approche de la définition des limites d'un site est justifiable en principe et conforme au critère d'intégrité contenu dans les principes opérationnels. En pratique, sur le terrain montagneux et boisé du Monte San Giorgio et en raison de la nature discontinue des roches affleurantes, les limites ne peuvent être tracées physiquement et l'étendue précise du site proposé n'est donc pas, à l'heure actuelle, clairement définie. Il faudrait au moins qu'elle soit clairement marquée sur des sentiers, etc. et que les limites globales correspondent à des caractéristiques de paysage identifiables se fondant très étroitement avec les limites des affleurements du Trias moyen.

Le texte de la proposition décrit les gisements suisses et italiens comme une seule et même entité alors que seuls les affleurements suisses sont proposés pour inscription. Des éléments importants de l'«histoire» de la découverte et de l'étude des ressources fossilifères du Monte San Giorgio ont trait aux affleurements italiens. Les premières excavations scientifiques ont, en effet, eu lieu en Italie et ont donné les premières découvertes ainsi que les descriptions de plusieurs espèces. Malheureusement, le matériel fossilifère trouvé dans les premières études italiennes a été presque entièrement détruit lorsque le Musée d'histoire naturelle de Milan a été bombardé, en 1943. Les excavations fossilifères systématiques ont commencé en Suisse en 1924 et se sont poursuivies jusqu'à aujourd'hui, avec 17 sites exploités et plus de 50 campagnes différentes. La majeure partie des découvertes spectaculaires, dans les roches du Trias moyen de la région, ont été faites en Suisse bien que des découvertes importantes – notamment deux squelettes spectaculaires de reptiles marins connus uniquement en Italie – aient également eu lieu en Italie depuis que les excavations (comprenant au total trois sites) ont repris dans les années 1950. Une autre découverte italienne d'un squelette partiel de dinosaure du Jurassique, à Saltrio, à 200 m seulement de la frontière et sur la montagne jouxtant le Monte San Giorgio est également remarquable. Les vestiges fossiles italiens sont très connus du public car il y a un musée local important à Besano et un petit musée à Induna Olona. Enfin, il y a des excavations scientifiques équivalentes en cours, à la fois en Suisse et en Italie, et une coopération transfrontière considérable entre les instituts de recherche. Les perspectives de faire de nouvelles découvertes, que ce soit en Suisse ou en Italie, dépendent de l'ampleur future des excavations et des études.

En bonne logique, les limites du Monte San Giorgio devraient comprendre les gisements italiens et suisses. Il apparaît cependant qu'il n'y a pas, actuellement, le même niveau d'engagement public et communautaire pour rédiger une proposition pour le territoire italien. Il est également vrai que le secteur suisse procure un échantillon représentatif adéquat de la ressource fossilifère du Monte San Giorgio et que l'activité, en Suisse, a produit la plupart des découvertes. L'UICN considère donc que le site proposé remplit correctement, mais peut-être pas de manière optimale, les conditions d'intégrité pour les limites de site. Il serait bon, cependant, d'encourager vivement les autorités à agrandir le site afin de tenir compte du secteur italien. Il faut se féliciter du fait qu'un protocole d'agrandissement possible du site en vue d'inclure le secteur italien ait récemment été signé (5 février 2003) par des représentants des autorités locales et des communes d'Italie qui déclarent leur intention de collaborer dans le but d'agrandir le site de part et d'autre de la frontière.

4.2. Statut légal

Bien que le site proposé n'ait pas de statut juridique particulier actuellement, le site et sa zone tampon sont traités comme un tout dans le droit suisse et reçoivent une protection identique. Au niveau fédéral, le Monte San Giorgio est défini et cartographié dans «l'Inventaire fédéral des paysages, sites et monuments naturels» publié et ratifié en 1977. L'aire protégée correspond donc, en essence, à la zone combinée du site proposé et de sa zone tampon (la petite exception étant une proposition d'agrandissement de la zone tampon à l'extrémité sud). L'inventaire oblige toutes les autorités fédérales à respecter les valeurs pour lesquelles le site est inscrit et s'applique également aux organismes auxquels des pouvoirs cantonaux sont délégués.

Le Plan de développement cantonal (PDC) identifie ce territoire comme une Zone de paysage protégé (ZPP). Dans les ZPP, entre toutes les utilisations anthropiques, c'est la protection des caractéristiques naturelles du paysage qui a la plus haute priorité. La ZPP a six objectifs généraux de protection, promotion de la recherche et préparation de plans de gestion. La zone protégée figure également dans les plans de développement locaux des communes qui prévoient différentes utilisations des terres. Dans ces plans, les zones naturelles importantes, à l'intérieur de la ZPP, sont identifiées comme des réserves naturelles. Toutefois, les politiques précises de protection prévues tant dans les plans cantonaux que locaux, ne sont pas mentionnées dans le texte de la proposition.

Dans le Canton du Tessin, tous les restes fossilisés sont protégés au titre du «Règlement cantonal de protection de la faune et de la flore» promulgué en 2002. Ce règlement contient des chapitres qui remplacent un décret législatif de 1974 protégeant les restes fossilisés. Au titre de ce règlement, le matériel fossilisé important du Canton est propriété de l'État. Il faut un permis cantonal pour procéder à des excavations de fossiles et à des activités de collection : c'est donc un système réglementaire très strict qui est appliqué aux excavations de fossiles du Monte San Giorgio depuis de nombreuses années – les permis n'ont été accordés qu'aux universités ayant une réputation prouvée dans le domaine de la recherche (principalement Zurich et Milan). Il est difficile de concevoir un régime plus rigoureux pour la protection de fossiles, régime qui est, de toute évidence, difficile à appliquer de manière généralisée dans tout le Canton. Les ressources très spéciales et très limitées du Monte San Giorgio nécessitant des excavations, il est clair que si ces excavations doivent avoir lieu, ce niveau de protection fournit un moyen approprié et applicable de protéger la ressource.

4.3. Propriété

Le site proposé appartient à trois communes locales différentes. Environ 10% se compose de terres privées et cultivées, essentiellement près de Meride et Riva San Vitale. Il y a quelques habitations privées dans le site, le long de la route étroite qui relie Meride à Serpiano. La situation concernant la propriété n'est pas optimale mais la législation générale du Canton apporte, au besoin, un appui suffisant à la gestion et à la protection nécessaires des intérêts fossilifères du site.

4.4. Gestion

Les responsabilités de gestion pour le site proposé sont partagées entre le gouvernement fédéral, cantonal et les communes et il n'y a pas d'autorité de gestion unique. Toutefois, la gestion des ressources fossilifères est exclusivement du ressort du Canton du Tessin, dans le cadre juridique décrit au paragraphe 4.2.

Le site n'a pas actuellement de plan de gestion mais un projet de plan de gestion a été soumis après réception du texte de la proposition. À ce stade, le projet de plan contient des déclarations d'intention générales et précise les programmes qui sont actuellement préparés par le Canton, dans certains cas avec l'appui des autorités locales et fédérales et de partenaires italiens. Le plan n'a pas encore atteint une étape suffisamment avancée pour que l'on puisse identifier les besoins de gestion spécifiques du site proposé par opposition à la zone tampon générale, ni pour faire de liens entre la gestion, l'utilisation des terres et les aspects réglementaires des plans communaux en particulier.

Comme indiqué, la gestion des ressources fossilifères est fondée sur un système de protection juridique strict avec une réglementation de l'excavation scientifique au moyen de permis et des conditions rigoureuses de protection, préparation et conservation des spécimens trouvés. Le Canton du Tessin s'est toujours montré déterminé à gérer les excavations comme on peut le constater à travers la collection exceptionnelle de fossiles détenue principalement par trois institutions seulement. Toutefois, la nature de cette gestion et les plans futurs ne sont pas indiqués dans une déclaration écrite claire, de sorte que les attentes de la Convention du patrimoine mondial, du point de vue des conditions d'intégrité, ne sont pas pleinement satisfaites sur ce point. L'UICN recommande que le Canton, en tant qu'autorité de gestion responsable, prépare une déclaration écrite contraignante pour décrire clairement au Comité du patrimoine mondial l'approche qui sera adoptée pour la gestion du matériel paléontologique et des excavations du Monte San Giorgio. L'État partie est prié d'accorder une attention particulière à cet aspect et de continuer à le soutenir pleinement à l'avenir. Ces déclarations formeraient la première étape de la préparation d'un plan de gestion général pour le site et la zone environnante. L'État partie a indiqué que le plan de gestion du Monte San Giorgio comprendrait des informations sur les campagnes de recherche, la conservation des restes fossilisés et leur présentation.

L'interprétation et la présentation du matériel fossilifère ne doivent pas être négligés si l'on veut faire apprécier son importance particulière à un vaste public. Il y a actuellement de bonnes expositions hors site du matériel de Monte San Giorgio à Zurich et à Lugano (ainsi qu'à Besano et Induna Olona, en Italie). Dans la zone tampon, un petit musée local a été établi à Meride et il existe des plans de restructuration et d'amélioration de cet établissement compte tenu de l'intérêt international de la zone. Une décision sur le financement de ce projet est attendue et l'UICN considère que ce serait un progrès important permettant de répondre aux besoins des visiteurs dans le site. Il est noté, en particulier, qu'il n'y a pas actuellement de personnel spécifiquement affecté à la gestion du Monte San Giorgio et qu'il serait extrêmement important d'engager un personnel permanent, basé au musée, pour surveiller la propriété et accueillir les visiteurs. L'État partie a depuis, confirmé, que le personnel assigné au Musée de Meride aura également la tâche de guider les visiteurs sur le site.

Un projet visant à promouvoir un plan de développement intégré pour la région du Monte San Giorgio a récemment été accepté dans le cadre du programme INTERREG IIIA (financé conjointement par l'UE et le Gouvernement suisse) qui comprend, comme partenaire, non seulement les communes et cantons suisses mais aussi les organes équivalents en Italie. La préparation d'un plan de gestion est une des tâches de ce projet. CHF 100 000 ont été assignés à ce travail en Suisse et un montant équivalent en Italie. Le plan devrait être terminé d'ici 2005. C'est une initiative heureuse, notamment en raison de la nature transfrontière du partenariat. Il est souhaitable que cela encourage une approche commune des ressources fossilifères des secteurs suisse et italien du Monte San Giorgio. Le protocole récemment signé entre les autorités locales et communes d'Italie suggère qu'il y a des progrès.

4.5. Impacts anthropiques

Actuellement, il ne semble pas qu'il y ait de menaces importantes pour les valeurs naturelles du site en général, tandis qu'une protection et une réglementation strictes de la ressource fossilifère sont en place. Par contraste avec d'autres formes de conservation, la paléontologie est, par nature, invasive et dans le cas du Monte San Giorgio nécessite des programmes actifs d'excavation. Ces programmes sont bien réglementés actuellement et le sont depuis de nombreuses années. L'extraction de matériel fossilifère pour la production d'huile minérale a cessé et bien qu'elle ait sans doute causé quelques pertes, elle est aussi à l'origine de la découverte des restes fossilisés.

5. APPLICATION DES CRITÈRES DU PATRIMOINE MONDIAL

Le Monte San Giorgio est proposé pour inscription au titre du critère naturel (i).

Critère (i): histoire de la terre et processus géologiques

Le Monte San Giorgio est le témoin le mieux connu de la vie marine au Trias et présente également d'importants vestiges de la vie terrestre. Le site a produit des fossiles divers et nombreux, beaucoup d'entre eux étant exceptionnellement complets et parfaitement bien conservés. La longue histoire de l'étude du site et la gestion disciplinée de la ressource ont créé une collection bien documentée et cataloguée de spécimens de qualité exceptionnelle qui forment la base d'une riche littérature géologique. En conséquence, le Monte San Giorgio fournit la principale référence pour les découvertes futures de fossiles marins du Trias dans le monde. Se fondant sur sa propre analyse ainsi que sur l'analyse comparative supplémentaire fournie par l'État partie en ce qui concerne la valeur comparative exceptionnelle du site, l'UICN considère que le site proposé remplit ce critère.

6. RECOMMANDATION

L'UICN recommande que le Comité **inscrive** le Monte San Giorgio sur la Liste du patrimoine mondial au titre du critère (i).

En outre, l'UICN suggère que le Comité demande à l'État partie:

- de poursuivre ses efforts pour intégrer le secteur italien dans un agrandissement auquel il sera procédé lorsque le niveau d'engagement politique aura été obtenu et qu'il sera clair que les conditions d'intégrité peuvent être remplies;
- de faire en sorte que les limites du site soient clairement marquées sur le terrain;
- de développer l'interprétation *in situ* afin que les visiteurs du Monte San Giorgio puissent apprécier son importance, en associant cette interprétation au développement du Musée de Meride.

L'UICN souhaiterait aussi que le Comité rappelle fermement aux États parties que tous les sites proposés pour inscription sur la Liste du patrimoine mondial pour leur intérêt géologique doivent être accompagnés d'une analyse comparative mondiale rigoureux.

ANNEXE 1: LISTE DE RÉFÉRENCE DE L'UICN POUR L'ÉVALUATION DES FOSSILES

Couverture d'une période de temps étendue

Le site présente des fossiles du Trias moyen, dans une succession complète du Trias moyen couvrant une période de 15 millions d'années. La présence de cinq couches fossilifères distinctes permet de mener des études sur l'évolution et des études comparatives à travers le temps.

Riche diversité des espèces

Le Monte San Giorgio est le site le plus riche que l'on connaisse dans le monde pour les fossiles de vertébrés marins du Trias car on y trouve des fossiles de reptiles, de poissons, de bivalves, d'ammonites, d'échinodermes et de crustacés. On a recensé environ 110 espèces de reptiles et de poissons marins dans le site ainsi qu'environ 100 macro-invertébrés. Il y a aussi des vertébrés, des insectes et des espèces de plantes terrestres, bien que ce soit en plus faible quantité, et l'on a trouvé le squelette complet et spectaculaire d'un archosaure. Il y a aussi une importante faune microfossile.

Représentativité unique d'une période géologique

Parmi les nombreux sites fossilifères du Trias que l'on trouve dans le monde, le Monte San Giorgio a donné une faune extrêmement riche de fossiles marins. Il est considéré comme une «localité type» de premier plan. Les autres sites fossilifères du Trias, d'importance internationale équivalente, présentent la vie terrestre plutôt que marine.

Existence de sites comparables

On ne connaît aucun site de plus grande importance. Des découvertes de fossiles marins du Trias ont récemment été faites en Chine mais elles ne sont pas encore correctement étudiées et le Monte San Giorgio fournit la principale référence pour l'évaluation comparative de l'importance et l'interprétation de ces sites, parmi d'autres. Le site proposé ne comprend que le secteur suisse du Monte San Giorgio alors que les gisements s'étendent de l'autre côté de la frontière, en Italie. Les principales découvertes ont été faites dans le secteur suisse, bien que d'importants pans de l'«histoire» du Monte San Giorgio aient leur source du côté italien. Les affleurements suisses fournissent, en conséquence, une image correcte, mais non optimale, de l'intérêt scientifique du Monte San Giorgio et il est recommandé de chercher à agrandir le site proposé sur le versant italien.

Ischigualasto-Talampaya (Argentine) est inscrit sur la Liste du patrimoine mondial et fournit un témoignage exceptionnel des milieux et fossiles terrestres du Trias; le Monte San Giorgio fournit un témoignage complémentaire des milieux marins.

Contribution à la connaissance de la vie sur Terre

Le Monte San Giorgio est le seul site où des gisements marins du Trias ont été étudiés au moyen d'excavations scientifiques continues et disciplinées pendant plus de 75 ans et peut être considéré comme le principal site où l'on a pu établir une collection complète et bien conservée de la vie marine du Trias. La quantité et la qualité du biote fossilisé permettent d'interpréter l'évolution des espèces, des paléo-environnements et des processus de formation de la Terre il y a 200 millions d'années. Le site fournit un témoignage de la vie marine durant une période critique de l'évolution des vertébrés sur Terre et son importance va bien au-delà de la représentation de la vie dans l'océan «Tethys» du Trias pour servir de référence mondiale à des études comparatives de l'évolution.

Perspectives de nouvelles découvertes

Plus de 10 000 spécimens de fossiles ont été mis au jour jusqu'à présent dans le site proposé et les récentes campagnes d'excavation témoignent de la continuité des nouvelles découvertes de matériel

fossile. Une bonne partie du matériel rassemblé n'a pas encore été étudiée. Il semble que le Grenzbitumenzone offre les meilleures perspectives de nouvelles découvertes de reptiles spectaculaires, mais les études, à tous les niveaux principaux, sont en mesure de produire de nouvelles informations. La précision des études des gisements peut donner une description de plus en plus exacte et de plus en plus claire de la vie marine au Trias moyen. Les découvertes récentes de marqueurs stratigraphiques tels que les microfossiles et les argiles volcaniques datables sont importantes pour établir la précision générale de l'information rassemblée dans le site.

Intérêt international

Le Monte San Giorgio est d'importance mondiale pour la géologie en général et pour la paléontologie et la biologie de l'évolution en particulier. Les caractéristiques géologiques sont décrites dans plus de 800 publications scientifiques et populaires. Il est renommé au plan international dans le domaine de la science de la géologie en tant que site d'importance unique pour les gisements fossilifères marins du Trias qui ont fait l'objet d'études scientifiques et d'une gestion ciblées et disciplinées.

Valeurs naturelles associées

Il y a d'autres caractéristiques naturelles (par exemple la flore et la faune contemporaines) associées au site proposé, notamment trois araignées et une espèce de champignon qui ont été décrites dans ce site. Le site proposé est une région paysagère attrayante présentant une gamme de caractéristiques archéologiques, historiques et naturelles – notamment dans la zone tampon. Les caractéristiques du paysage et les processus modernes, dans le contexte alpin, n'ont aucun rapport avec les milieux marins illustrés dans les fossiles du Trias.

État de conservation des spécimens

Les spécimens que l'on trouve dans le site proposé comprennent de nombreux exemples complets et entièrement articulés de grands mammifères marins ou d'insectes. En général, l'état de conservation des spécimens est exceptionnel.

Conservation, étude et exposition des fossiles

Les excavations dans le site proposé ont lieu exclusivement selon les règlements du Canton du Tessin et toutes ont été réalisées sous la direction de l'université de Zurich, en coopération avec le Musée cantonal d'histoire naturelle de Lugano et l'université de Milan. Les découvertes fossilifères sont conservées, cataloguées et présentées tant à Zurich qu'à Lugano, dans des conditions excellentes. Une autre exposition se trouve immédiatement à proximité du site, à Meride (dans la zone tampon) qui sert de principal point de départ pour les excursions de touristes dans le Monte San Giorgio. Cet établissement ne sert qu'à l'interprétation et ne dispose pas de personnel permanent pour l'instant mais il existe des projets pour son développement futur.

Les musées locaux d'Induna Olona et Besano, en Italie, présentent aussi des découvertes et des informations sur les fossiles de la région du Monte San Giorgio.

Carte 1 : Localisation du Site

Carte 2 : Détail du Site