

THE TRIASSIC FOSSIL FISHES LOCALITIES IN ITALY

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Riassunto. Nel presente lavoro vengono raccolti i più recenti dati stratigrafici relativi alle principali località fossilifere a Vertebrati del Triassico Medio e Superiore in Italia. Per alcune di esse, conosciute già da lungo tempo, si tratta di una puntualizzazione necessaria, in quanto spesso vengono utilizzati dati non più attuali; per le altre località invece, di più recente scoperta, si è cercato di dare un completo supporto stratigrafico alle datazioni solitamente citate nei lavori strettamente paleontologici. Le località prese in esame sono: Besano—Mte S. Giorgio (Anisico—Ladinico), Perledo (Ladinico—? Carnico Inferiore), Raibl (Carnico Inferiore), Ca' del Frate (Carnico Inferiore), Val Preone (Norico Inferiore), Prealpi Bresciane (Norico), Prealpi Bergamasche (Norico) e infine Giffoni Valle Piana (Norico). Nella maggior parte dei casi gli scavi sono ancora in corso da parte degli scriventi o di altri Enti, con le apposite concessioni delle relative Soprintendenze Archeologiche.

Abstract. This paper is dealing with the stratigraphical position of the main fossil Vertebrate localities from the Italian Triassic. Recent and new data are summarized to give a sure age to old-known localities as well as to recently discovered ones. Besano—Mt. S. Giorgio (Anisian—Ladinian), Perledo (Ladinian—? Lower Carnian), Raibl (Lower Carnian), Ca' del Frate (Lower Carnian), Preone Valley (Lower Norian), Brescia and Bergamo Prealps (Norian) and Giffoni Valle Piana (Norian) are the investigated localities. Field works are still in progress in several sites, mainly by the authors.

Introduction.

In the last few years several new vertebrate bearing beds have been discovered in the Southern Alps (Fig. 1). The age of most of them is Triassic and they are very rich in well preserved specimens. At the same time new specimens have been collected in a few already known localities, often forgotten since the last century. The stratigraphical position of these sites is now better established and we found interesting to point out the available data for all of them.

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Middle Triassic (Anisian—Ladinian).

Besano—Mte S. Giorgio (Fig. 2—1c).

In the Middle Triassic lies one of the most famous Italian vertebrate levels, the Besano—Mte S. Giorgio at the Italy—Switzerland boundary near Varese. Here different groups of invertebrates indicate a very precise stratigraphic position. Ammonites (Rieber, 1973) belong to the *Parakellnerites* (ex *Ticinites polymorphus*) and «*Ceratites*» *reitzei* zones i.e. at the Anisian/Ladinian boundary. Bivalvia, especially with the genus *Daonella*, are very common (Rieber, 1968, 1969) in the upper part of the Scisti Ittiolitici di Besano (Grenzbitumenzone of the Swiss authors) and suggest a lowermost Ladinian age too. The age of this level will be even further defined by conodonts, which are now under study.

Fishes from Besano—Mte S. Giorgio have not been much studied: only De Alessandri (1910) and Brough (1939) gave large accounts of this fish fauna. Since reptiles were more attractive several papers were published, mainly by

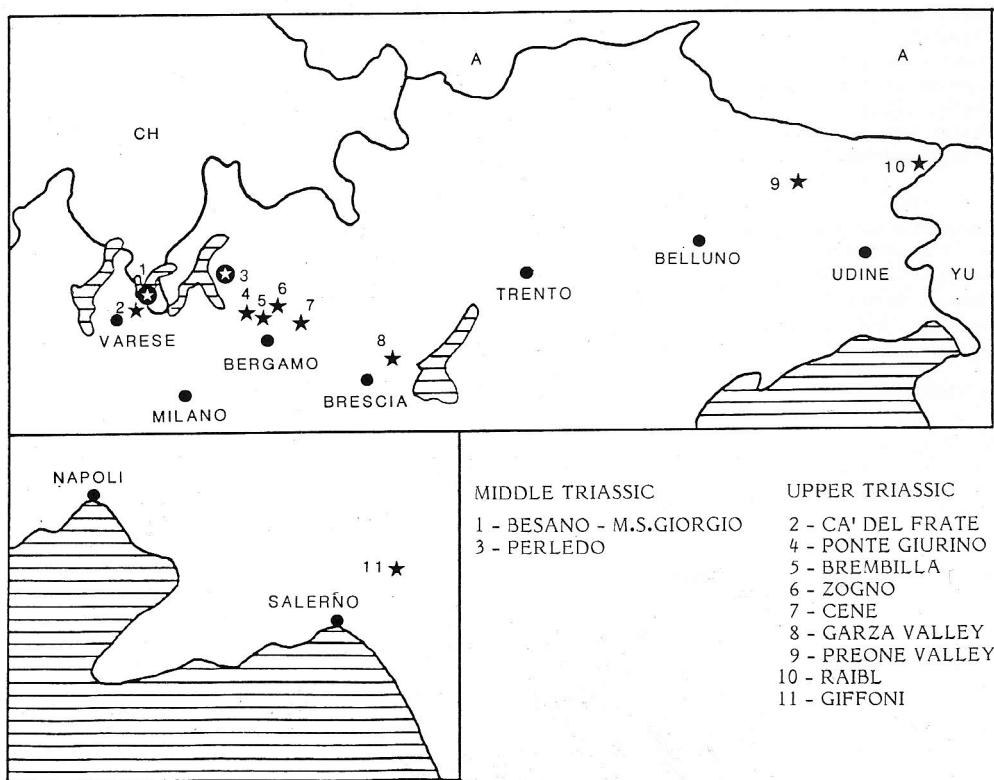


Fig. 1 — Index maps of the fossiliferous localities.

Swiss authors. The most important collection is now stored in Zürich (Paläontologisches Institut und Museum der Universität). Fishes described by Brough are at the London British Museum (N.H.), while in the Milano Museo Civico di Storia Naturale collection there is only recently collected material. The specimens described by De Alessandri have been mostly destroyed during the Last War and only few of them are housed in Roma at the Servizio Geologico Italiano.

Perledo (Fig. 2–3m).

Somewhat younger than Besano–Mte S. Giorgio is Perledo, along the Western slope of the Grigna Mountain, East of the Como Lake. A number of fossil vertebrates were collected from this locality mainly in the last century and at the beginning of the present one. Recently a few stratigraphical data were achieved by University of Milano geologists; they show that the age of the Calcare di Perledo, yielding the fossils, is Ladinian, perhaps Carnian in its uppermost part (Gaetani, pers. comm.; Brusca et al., 1982). So far conodonts (*Gondolella trammeri* Kozur and *Metapolygnatus hungaricus* (Kozur & Vegh) (Nicora, pers. comm.)), which are the only fossils providing good biostratigraphical data, confirm a Ladinian age at least for the lower part of the unit.

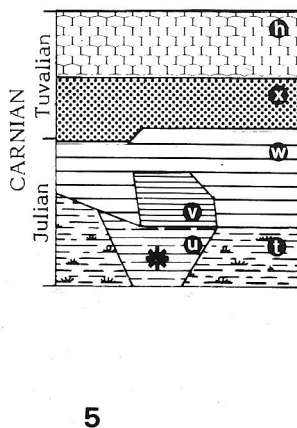
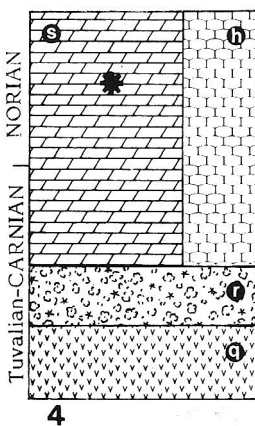
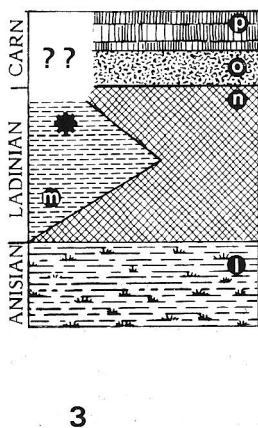
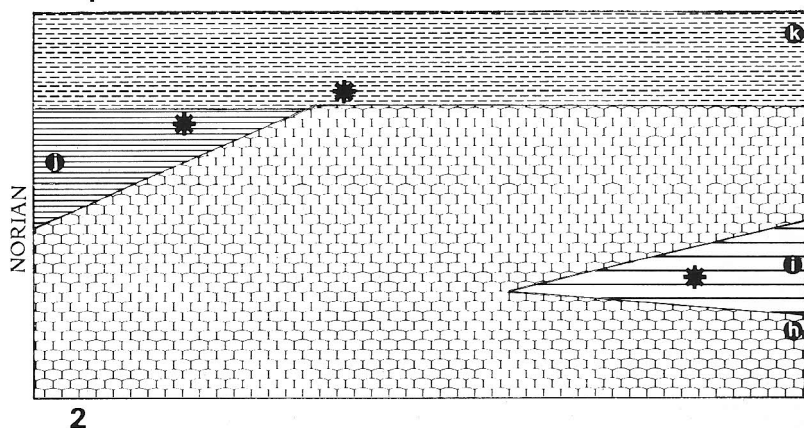
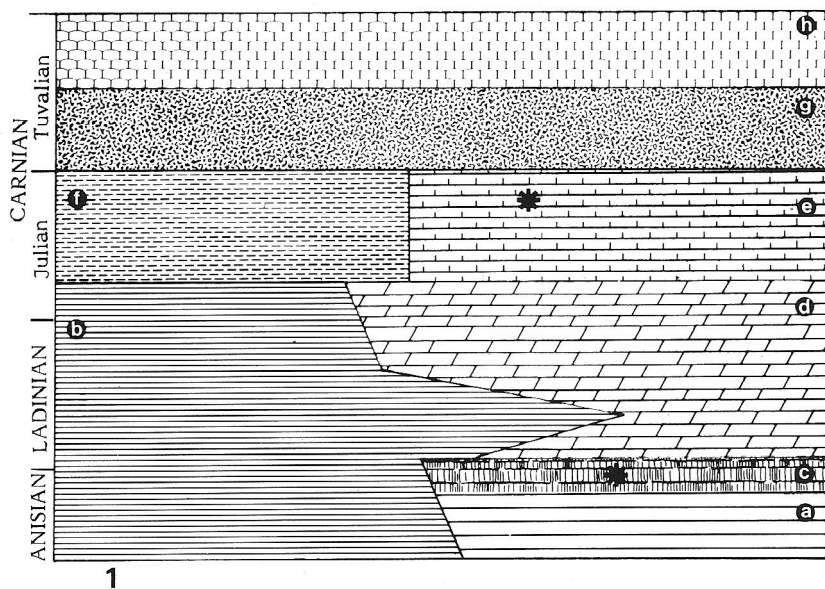
Fossil vertebrates were found in the surrounding of the Perledo village during quarry work before the Last War, mainly in the upper part of the Calcare di Perledo. No more specimens are now collected other than casually. Since the largest collection, lying at the Milano Museo Civico di Storia Naturale, was destroyed during the Last War, available material is now scarce and scattered in several Museums (Tintori, in press). The most comprehensive paper about the Perledo fishes is by De Alessandri (1910) while Peyer (1934) dealt with the reptiles.

At present preliminary field work is being carried on by one of us (A.T.) in order to detect new Upper Ladinian fish levels in this area; so far only few, very bad preserved fossils have been collected.

Upper Triassic (Carnian–Norian–Rhaetian).

Raibl (Fig. 2–5 u).

Concerning the Upper Triassic, around the Raibl mines (SE of Tarvisio, Julian Alps) dark–grey to black, sometimes bituminous limestones outcrop. They are thin bedded and are ascribed to the lower part of the Raibl Group, the so called «Scisti Ittiolitici di Raibl» or better the Calcare di Predil (Selli, 1962; Assereto et al., 1968; Brusca et al., 1982). In this unit, which was deposited in a lagoonal environment with anoxic bottom conditions, a vertebrate fauna was found mainly during the last century. Few authors were interested in the Raibl fishes: among them Bronn (1858) and Kner (1866). Recently only Grif-



fith (1959) added some remarks on few specimens of *Saurichthys striolatus* (Bronn), from the British Museum (N.H.) collection. Some new specimens have now been collected: mainly fishes, but also crustaceans and plant remains; among fishes *Saurichthys* and *Pholidopleurus* are the most common. For some fossiliferous beds the organic carbon contained in the rock (average 0.52%) was analyzed. Its origin appears to be both marine and continental; an average 60% of the organic carbon coming from continental sources suggests the presence of a close terrestrial environment.

In this site field work is progressing and some of the collected material is already being studied at the Paleontological Museum «La Rocca» in Monfalcone (Gorizia). The most part of the material collected in the last century lies at the Geologische Bundesanstalt in Wien, being at the time Raibl under Austrian sovereignty.

Ca' del Frate (Fig. 2—1 e).

Of Carnian age is also the new locality near Ca' del Frate (Viggiú—Varese), not far from Besano. The fossiliferous outcrop is very close to the old small quarry from which a few fishes were collected at the beginning of the century (Reposi, 1909; De Alessandri, 1910). People living in the area remember the place of the quarry, inside the Besano communal boundary, where they used to dig out stones, mainly to build underground shelters for the Army which are still partly visible. De Alessandri (1910) described the stratigraphical position of this fish level, in order to distinguish it from the main Besano—Mte S. Giorgio one (bottom p. 25: "The first cited localities (Monte Nave Quarry, Monte Grumello Quarry and Trefontane Quarry) are in the same level at the base of the unit... while Ca' del Frate lies in the uppermost part of the unit, very close to the boundary between the «black shale» and the coloured marls").

On the base of these data, we can say that our new locality certainly belongs to the same fish level, no more than 200 m far in distance from the old

Fig. 2 — Schematic stratigraphical profiles showing the position of the fossiliferous localities.

- 1) Besano—M. S. Giorgio and Ca' del Frate (after Sticca, 1983, modified).
 - 2) Bergamo and Brescia Prealps.
 - 3) Perledo (after Gaetani & Nicora, pers. comm.).
 - 4) Preone Valley (after Pisa, 1972, and Mattavelli & Rizzini, 1974, both modified).
 - 5) Raibl (after Brusca et al., 1982, simplified).
- *Fossiliferous levels. a) Dolomia del Salvatore inferiore; b) Dolomia del Salvatore; c) Scisti Ittiolitici di Besano=Grenzbitumenzone; d) Calcare di Meride; e) Calcare di Meride—Kalkschieferzone; f) Formazione di Cunardo; g) Marne del Pizzella; h) Dolomia Principale =Hauptdolomit; i) thin-bedded black dolostones inside the Dolomia Principale North of Brescia; j) Calcare di Zorzino; k) Argilliti di Riva di Solto; l) Dolomia dell'Albigo; m) Calcare di Perledo; n) Calcare di Esino; o) Metallifero Bergamasco; p) Formazione di Gorno; q) Carnian gips; r) Carnian vuggy dolostones; s) Dolomia di Forni; t) Dolomia Casiana; u) Calcare del Predil; v) Formazione di Rio del Lago; w) Calcare di Rio Conzen; x) Formazione di Tor.

quarry, in the upper part of the Kalkschieferzone. The latter unit (the «black shale» of De Alessandri) is the uppermost part of the Calcare di Meride and is usually aged as Middle Carnian (Allasinaz, 1968) by means of its stratigraphical position. The Marne del Pizzella (the «coloured marls» of De Alessandri) follow upwards and they are related to the end of the Mesotriassic Cycle in the Southern Alps (Allasinaz, 1968; Casati & Gaetani, 1979) whose age is considered Upper Carnian. So far no fossil of stratigraphical interest has been found in the Kalkschieferzone so that the age cannot be directly stated. However the lower member of the Calcare di Meride contains *Protrachyceras* cf. *archelaus* (Mojsisovics) among other fossils (Senn, 1924) in its lowermost part and *Celtites buchi* (Mojsisovics) and *Lecanites glaucus* (Mojsisovics) (Airaghi, 1912) in its upper part, showing an age close to the Ladinian/Carnian boundary. Therefore, even if mainly on the base of lithostratigraphical and indirect paleontological data, the age of these fossil fish may be considered to be Middle Carnian or, following the proposal for a new Triassic time scale (Visscher, 1983) toward the top of the Julian (Lower Carnian).

As already pointed out, this site was known, but usually its fossils were identified as coming from the Besano—Mte S. Giorgio level (Brough, 1939; Patterson, 1981). Yet the matrix in the two localities looks very different, the Besano one being black bituminous shales or dark grey laminated dolostones, with black or partially piritized fossils, and the Ca' del Frate one being clearer, white or grey, light brown or seldom black. Fossils from Ca' del Frate are always brown, even on black surfaces and pyrite is usually absent. Some old collections' specimens, which are labelled as from Viggìu rather than from Besano, are likely from this outcrop rather than from the old Ca' del Frate quarry. A paper dealing with the most common fish, *Prohalecites porroi* (Bellotti, 1857) is now in preparation by one of us (A.T.). Other genera such as *Semionotus*, *Perleidus* and *Peltopleurus* are well represented in the material till now collected. A single specimen of a new *Legnonotus* species, *L. obtusus* has been also described (Tintori & Renesto, 1983).

A few old specimens are at the Museum of the Servizio Geologico Italiano in Roma and some others belong to the British Museum (N.H.) collection. All the new material is at the Induno Olona Museo Civico di Scienze Naturali.

The Norian localities.

The Norian represents the Triassic richest stage in fossil fishes in Italy, while reptiles are not so common. Several localities are spread in the Southern Calcareous Alps; their age ranges about from the base to the top of the Norian stage. Furthermore an old site is known even in the Southern Appennines, near Salerno.

The facies of all the Norian localities is lagoonal and coeval with the

carbonate platform of the Dolomia Principale (Hauptdolomit), whose age is thought to be uppermost Carnian–Norian. The Dolomia Principale carbonate platform was very wide and often its present thickness is more than 1.000 m. Lagoons with anoxic bottom conditions took place at different times inside this platform at least in the Southern Alps. Owing to their stratigraphical position (see below), we can state that the Preone Valley sites are older than the Garza Valley one while Bergamo Prealps and Giffoni fish beds are younger than both the others. Problems in dating the Norian–Rhaetian stages in the Southern Alps exist also for some of the old scattered fossil vertebrate findings, especially in Lombardy. At the present we prefer to use the Rhaetian with a somewhat reduced meaning (Visscher, 1983) so that most of the «Rhaetian» specimens of the AA. may be considered to be Norian (Boni, 1937).

Preone Valley (Fig. 2–4 s).

Between Tolmezzo and Ampezzo (Udine), South of the Tagliamento River, there are rocks where only recently Triassic fossil vertebrates have been found. The outcrops from which several fishes and a few reptiles have been collected are mainly of limited extension; furthermore specimens are only scattered in different levels, so that exploiting in several Preone Valley small outcrops have often got scarce results. The unit yielding the fossils has not a formal name yet, but it is usually known as Dolomia di Forni (Mattavelli & Rizzini, 1974), coeval with the lower part of the Dolomia Principale. The strata consist on the whole of laminated bituminous dolostones; colour ranges from yellow–brown to dark grey and bed thickness varies from 3 to 30 cm. Fossils other than vertebrates are very uncommon owing to the paleoecological conditions in the lagoons (anoxic bottom) and to the strong diagenetic events. So far only a reptile, with terrestrial behaviour, *Megalancosaurus preonensis* (Calzavara, Muscio & Wild, 1981) has been described, while some fishes (coelachants and *Thoracopterus*) are at present under study. The presence of a terrestrial vertebrate is important, allowing a better paleogeographical reconstruction: small islands rised from the carbonate platform of the Dolomia Principale which surrounded the lagoons where the Dolomia di Forni deposited.

Brescia Prealps (Fig. 2–2 i).

The Norian vertebrate faunas from the Brescia Prealps are little known. A few localities have been randomly exploited, most of them being comparable in age and contents to the Bergamo Prealps sites below described. Fishes are found in the Vestino Valley (Zambelli, 1981b) and in the Garza Valley (Tintori & Lualdi, in prep.). The latter locality is very interesting, being in the middle part of the Dolomia Principale, that's to say in an intermediate stratigraphical position between the Preone Valley locality and all the others. Actually the Garza Valley fauna is quite different from the younger ones (Bergamo Prealps)

having only few common genera (*Brembodus*, *Paralepidotus*) and several new taxa which look more primitive. Unfortunately this material is rather poorly preserved and specimens are not numerous. Furthermore most of the new species are represented only by one or two specimens, making accurate restoration nearly impossible.

Bergamo Prealps (Fig. 2–2 j, k).

Certainly the most outstanding new localities for Triassic vertebrates open in both the Calcare di Zorzino and the Argilliti di Riva di Solto, in the Prealps North of Bergamo. Since the beginning of the seventies, several hundreds of specimens have been collected by one of us (A.T. for the University of Milano) and by the Bergamo Museo Civico di Scienze Naturali «Caffi». Four major localities have been exploited, lying more or less in the same stratigraphical position. Nothing can be said about their relative age because it is impossible to state, even locally, whether the Dolomia Principale and/or its anoxic facies (the Calcare di Zorzino) come to the end everywhere at the same time, being then covered by the Argilliti di Riva di Solto. Actually Jadoul (in prep.) shows that the three units are at least partly time-equivalent.

Each of the four sites has its own faunal peculiarity, perhaps because of somewhat different environmental conditions. The first fossil fishes in the area are from the Cene quarry (Serio Valley), which was dug in the upper part of the Calcare di Zorzino. A landslide exposed a wide surface which proved to be a 6–7 cm thick laminated bed, very rich in fossils. The preservation is really superb, allowing a very fine preparation and description. Flying reptiles (Wild, 1978) and a large amount of *Pholidophoridae* (Zambelli, 1975, 1978, 1981a) are the best known fossils from this site. Large predators (*Saurichthys* and *Birgeria*) are quite common as well as *Pseudodalatias*, a selachian known only by its tooth-rows (Tintori, 1980). Nectobenthonic fishes, such as pycnodonts and semionotids are scarcely represented as well as benthonic invertebrates. The latter are usually considered to be allochthonous in the fish bearing beds, either moved from the carbonate platform to the lagoons anoxic bottom during storm, or sunk from floating woods. Then the position of the Cene site inside that lagoon must have been far from the edge of the carbonate platform, which was rich in benthonic fauna like molluscs, corals, echinoderms, crustaceans (for the latter see Pinna, 1974).

Two others localities, Brembilla Valley and Zogno–Endenna, open at the boundary between the Calcare di Zorzino and the Argilliti di Riva di Solto; because of a relative large amount of benthonic invertebrates found there, they are thought to have been closer to a margin or to an oxigenic bottom. Pycnodonts (*Brembodus*, *Gibbodon* and *Eomesodon*) (Tintori, 1981) and semionotids with grinding dentition (*Sargodon*, *Dandya*, *Dapedium* (Tintori, 1983) as well as *Paralepidotus* and *Semionotus*) are abundant. *Legnonotus* also is rather

common (Tintori & Renesto, 1983) with *Saurichthys* (Beltan & Tintori, 1980; Tintori, in prep.) as well as other genera identified, but not yet described (*Thoracopterus*, *Birgeria*, *Pholidopleurus*, *Olophagus*). *Pholidophoridae* are as always the most common with several species described on the material from Cene. Among the reptiles a couple of complete specimens of the placodont *Psephoderma* (Pinna, in prep.) has been found in Zogno after the description of a first fragmentary specimen (Pinna, 1979). Other reptiles are *Drepanosaurus* (Pinna, 1980, 1984), *Endennasaurus* (Renesto, 1984) and a fragment of a very large pterosaur (Padian, 1981). Material from the Brembilla Valley is usually poorly preserved and field work was carried on only for a short time. Much more interesting is Zogno where specimens are rather well preserved and the exposure for collecting is good. There the fossiliferous level is about 300 cm thick; matrix ranges from shale to limestone, so that the possibility of preservation and preparation may largely vary (Fig. 3). More than 25 fish species and a few reptiles were found in Zogno and Brembilla Valley, but field work is still far from being over.

The last major locality, Ponte Giurino (Imagna Valley), is the only one opening in the Argilliti di Riva di Solto (Fig. 2–2 k), being some ten meters above the boundary with the Dolomia Principale (the Calcare di Zorzino is lacking in that area). Its fauna consists of numerous small fishes (*Pholidophorus* (Zambelli, 1980) and ?*Pholidopleurus*) and very few other taxa (*Saurichthys*, *Dapedium*, ?*Thoracopterus* and *Pseudodalatias*). Among invertebrates only crustaceans are abundant (Arduini & Brasca, 1984) and a few insects have also been collected. The shaly matrix makes specimens preparation and subsequent preservation difficult; nevertheless a large number of them is now at the Bergamo Museo Civico di Scienze Naturali «Caffi».

As for the Preone Valley, more or less wide carbonatic islands, with fresh water reservoirs, existed during the deposition of both the Calcare di Zorzino and the lowermost part of the Argilliti di Riva di Solto. Infact terrestrial animals (insects from Ponte Giurino, flying reptiles from Cene and Zogno and other reptiles from Zogno) show that land was not far from these localities.

Giffoni Valle Piana (Fig. 1–11).

Only one Triassic vertebrate site is known outside the Alps: it lies near Salerno, close to the Giffoni Valle Piana village. This locality was exploited in the last century and yielded a few fishes described mainly by Costa (1853–60, 1862) and Bassani (1892, 1895). The fish bearing beds are now completely destroyed by quarry works (Scorziello, University of Napoli, pers. com.). All the Giffoni material published by the Italian authors is in the Museo Paleontologico of the University of Napoli. The age of the Giffoni fishes is comparable with that of the Bergamo or Brescia Prealps faunas, the bituminous beds being included in the middle–upper part of the Dolomia Principale (Sgrosso, 1971).

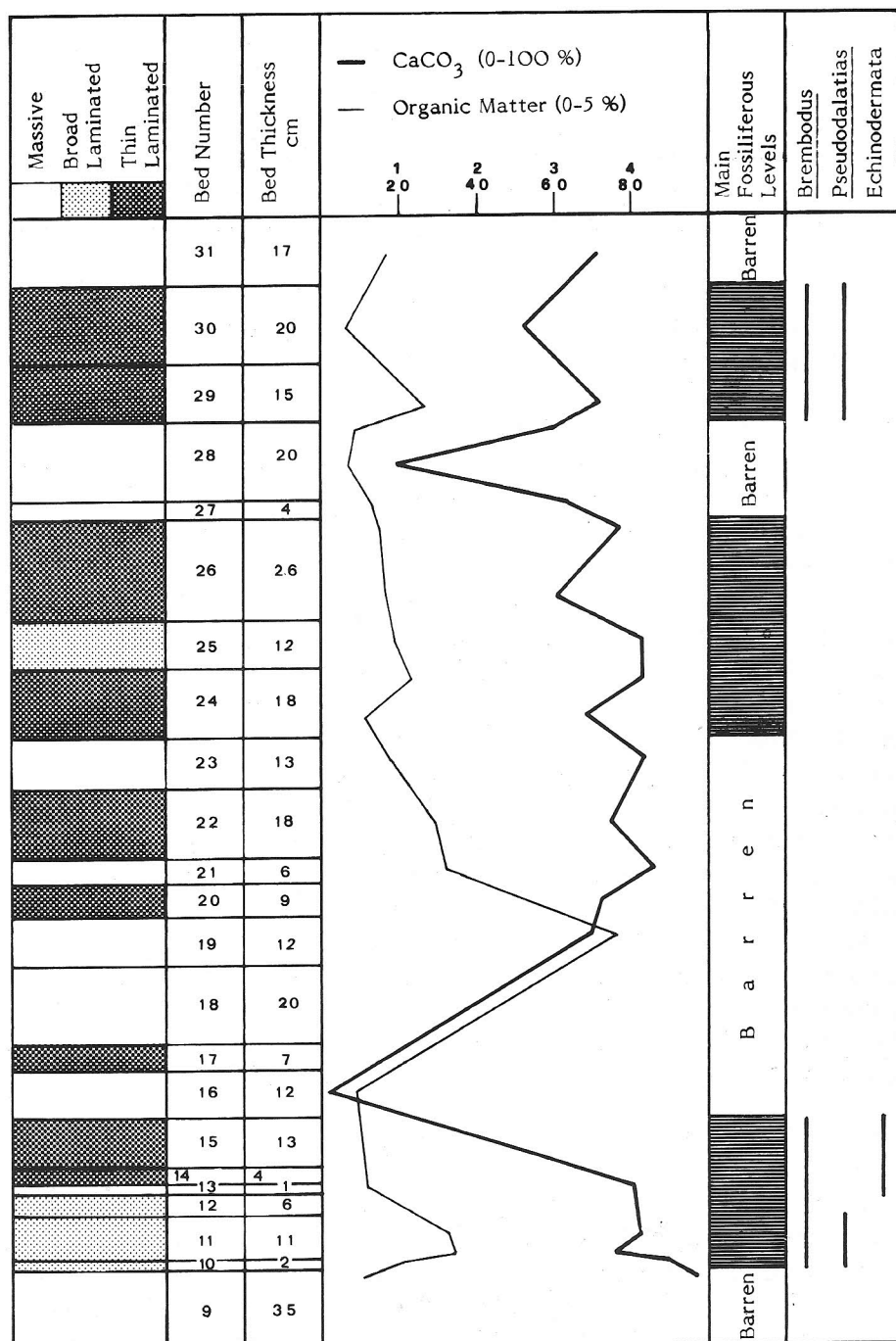


Fig. 3 — The Zogno-Endenna fossiliferous sequence showing the three main fish levels in which most of the taxa are widespread. Only *Brembodus* and *Pseudodalatias* among vertebrates and the echinodermata have a reduced range as stated in the figure. Lithological characters as well as organic carbon content are also shown.

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