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REPTILE REMAINS FROM THE MIDDLE-UPPER TRIASSIC OF THE CARNIC AND JULIAN ALPS (FRIULI-VENEZIA GIULIA, NORTHEASTERN ITALY)

RESTI DI RETTILI NEL TRIASSICO MEDIO-SUPERIORE DELLE ALPI CARNICHE E GIULIE (FRIULI VENEZIA GIULIA, ITALIA NORDORIENTALE)

Abstract - Reptilian remains from Upper Ladinian (Middle Triassic) and Lower Carnian (Late Triassic) of the Carnic and Julian Alps (Friuli-Venezia Giulia region, Northeastern Italy) stored at the Museo Friulano di Storia Naturale (Udine) are described. A large nothosaur similar to *Paranothosaurus* is identified for the first time in the Carnian. The placodont *Cyamodus* is reported for the first time from the Upper Ladinian.

Key words: Reptilia, Nothosauria, Placodontia, *Cyamodus, Paranothosaurus*, Thalattosauria, Middle-Upper Triassic, Carnic Alps, Julian Alps.

Riassunto breve - *Vengono descritti alcuni resti di rettili provenienti dal Triassico medio (Ladinico superiore) e superiore (Carnico inferiore) delle Alpi Carniche e Giulie, custoditi al Museo Friulano di Storia Naturale. Viene segnalata per la prima volta la presenza nel Carnico di un notosauro di grandi dimensioni confrontabile con* Paranothosaurus. *La probabile presenza del genere* Cyamodus *viene segnalata per la prima volta nel Ladinico superiore.*

Parole chiave: *Reptilia, Nothosauria, Placodontia,* Cyamodus, Paranothosaurus, *Thalattosauria, Triassico medio-superiore, Alpi Carniche, Alpi Giulie.*

Introduction

During recent years, thanks to the fieldwork and enthusiasm of the Museo Friulano di Storia Naturale (Udine) and its collaborators, we have seen a rising interest in mesozoic vertebrates, mainly reptiles, in the Friuli-Venezia Giulia Region (Northeastern Italy). Attention to date has been focused mostly on Norian fossils (Calzavara et al., 1981; Wild, 1984; Pinna, 1987; Dalla Vecchia et al., 1989). At the Museo Friulano di Storia Naturale are collections of reptilian remains of Anisian, Ladinian and Carnian age from the Carnic and Julian Alps. These have been found only recently, have never published and part of the collection forms the subject of this note. Ichthyopterygian remains will be treated in a separate contribution.

I prefer to use here the "traditional" classification of Carrol (1988) instead of the recent classifications based on cladistic analysis (Tschanz, 1989; Storrs, 1991; Rieppel,

1993). This choice was made in the interest of clarity and simplicity: the classification used by CARROL is familiar to most paleontologists because it has been used for a long time while recent classifications are subject to rapid modification and are still relatively little known. This implies no judgment about the validity of recent classifications.

Systematic description

Order	Placodontia OWEN, 1860
Superfamily	Cyamodontoidea PEYER & KUHN-SCHNYDER, 1955
Family	Cyamodontidae PEYER & KUHN-SCHNYDER, 1955
Genus	*Cyamodus* PEYER, 1931

cf. *Cyamodus*

(figg. 2, 3)

L o c a l i t y   a n d   a g e: the specimen was collected by dr. C. Rosenfeld at about 1000 mt. a.s.l. in the upper part of Rio Fus, Aupa valley (Moggio Udinese, fig. 1) and is stored with the number 16848 MFSN.

Fig. 1 - Northeastern Italy and the position of the fossiliferous outcrops: 1) Rio Fus, Late Ladinian; 2) Fusea, Early Carnian; 3) Rio Freddo, Early Carnian.
- *L'Italia nordorientale e le località di rinvenimento dei reperti: 1) Rio Fus, Ladinico superiore; 2) Fusea, Carnico inferiore; 3) Rio Freddo, Carnico inferiore.*

It was preserved in an angular rocky fragment found on the bed of one of the uppermost branches of the Rio Fus. Its position suggests that it cannot have been subject to much fluviatile transportation. The enclosing rock is a dark gray, matrix-supported conglomerate with flat, dark brown silty clasts and ball-like, grey biocalcarenitic clasts.

A study of the local regional geology (JADOUL & NICORA, 1979) shows that a single lithostratigraphic unit outcrops near the locality. This unit known informally as the "Terrigeno Ladinico" (JADOUL & NICORA, 1979) has the same lithology as the matrix enclosing the specimen, and, considering the topographic location of the find, must be the provenance of 16848 MFSN. The stratigraphical position of the "Terrigeno Ladinico" is directly above the Buchenstein Formation and below and partly laterally equivalent to the Dolomia Cassiana Formation; its age is considered to be Late Ladinian (JADOUL & NICORA, 1979).

D e s c r i p t i o n: the specimen is an isolated, uncrushed left palatine bearing two teeth. The outline of the bone in palatal view is very similar in general shape to the palatine of *Placochelys placodonta* (JAECKEL, 1907, Tav. III, fig.1; PEYER & KUHN-SCHNYDER, 1955a, fig. 17B) and other placodonts such as *Psephoderma alpinum* (PINNA & NOSOTTI, 1989, fig.1A) and *Protenodontosaurus italicus* (PINNA, 1990, fig. 2; pers. obs.). This suggests that the
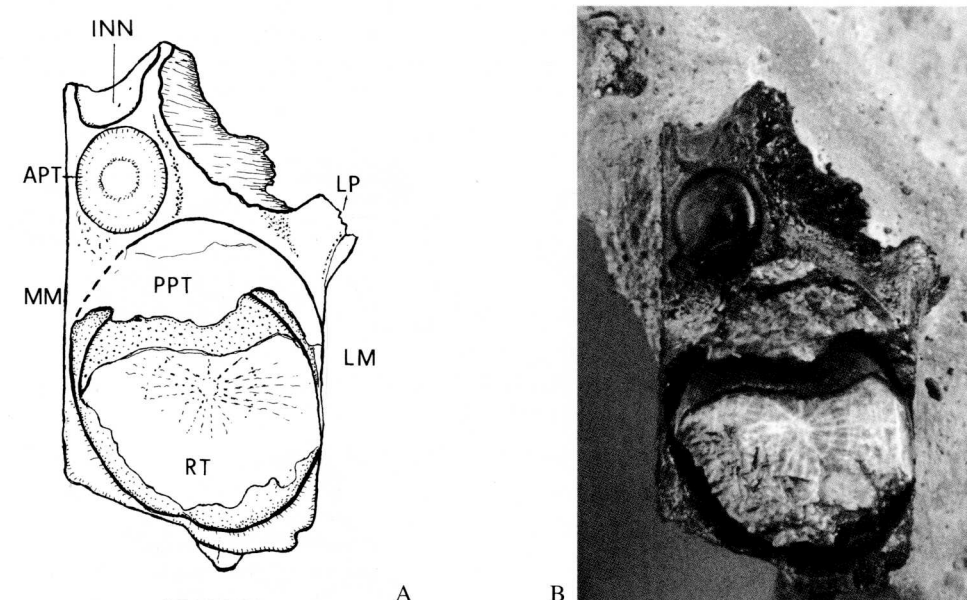

Fig. 2 - Palatine of cf. *Cyamodus* (16848 MFSN), palatal view. A) drawing, B) photograph. Abbreviations: APT: anterior palatine tooth; INN: internal narial opening; LM: lateral margin of the palatine; LP: lateral process of the palatine; MM: medial margin of the palatine; PPT: posterior palatine tooth; RT: replacement tooth. Scale bar = 1 cm.
- *Palatino di cf.* Cyamodus *(16848 MFSN) in visione palatale. A) disegno, B) fotografia. Abbreviazioni: APT: dente palatino anteriore; INN: apertura nasale interna; LM: margine laterale del palatino; LP: processo laterale del palatino; MM: margine mediale del palatino; PPT: dente palatino posteriore; RT: dente di sostituzione. Scala di riferimento = 1 cm.*

Ladinian specimen is not broken and that its rough, indented margins correspond to the suture surfaces with the surrounding elements.

The palatine is 58 mm long and its greatest width is 33 mm. It has a prominent lateral process situated rather anteriorly, in correspondence with the anterior end of the posterior palatine tooth. This process was sutured anteriorly to the maxilla and laterally to the jugal. Anteriorly with respect to this process, the lateral margin of the palatine is concave and was sutured to the maxilla. The anterior tip presents a large notch which is the posterior part of the left internal narial opening. The medial side of the palatine is straight and was sutured to the corresponding side of the right palatine. The posterior side is oriented diagonal to the long axis of the bone and part of it only represents sutured margin. Only the medial-dorsal part and a posterior (probably broken) projection in the more lateral part were sutured to other bones; the median tract of this side formed the wall of the fenestra palatino-pterygoidea. The morphology of this posterior-dorsal region of the palatine is rather complex and needs detailed study after its extraction from the enclosing matrix.

The lateral side posteriorly to the lateral process is not a sutured margin. It formed the medial margin of the anterior part of the subtemporal fenestra. The latter, therefore, was not edged by the ectopterygoid as in *Psephoderma* (PINNA & NOSOTTI, 1989, fig.1A) and probably *Placochelys* (PEYER & KUHN-SCHNYDER, 1955a, fig. 17B).

On the medial side, below the space between the two palatine teeth, there is a deep semicircular notch; a corresponding notch on the maxillary side is placed more anteriorly.
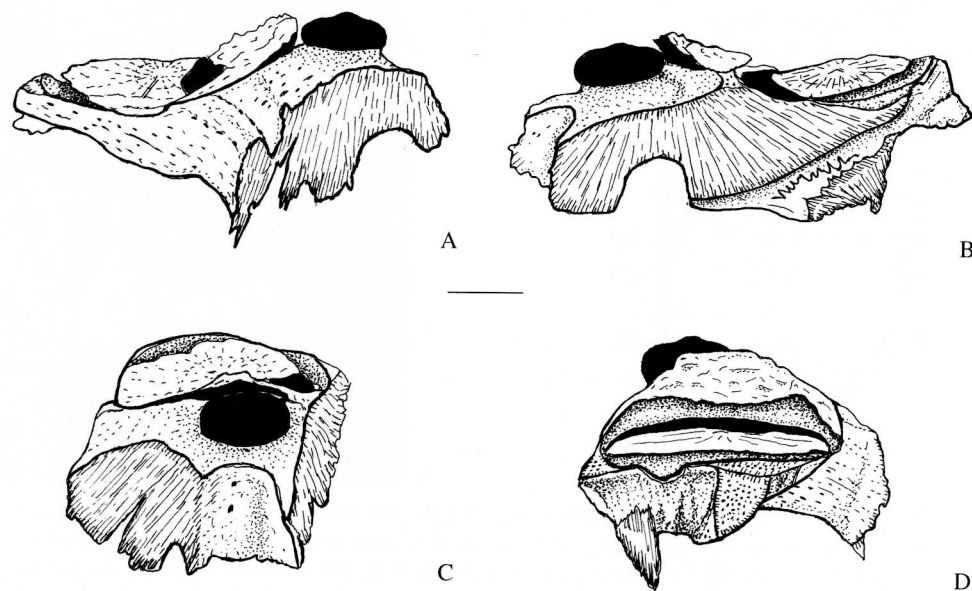

Fig. 3 -   Palatine of cf. *Cyamodus* (16848 MFSN). A) lateral view, B) medial view, C) anterior view, D) posterior view. Scale bar = 1 cm.
   - *Palatino di cf.* Cyamodus *(16848 MFSN) A) visione laterale, B) visione mediale, C) visione anteriore, D) visione posteriore. Scala di riferimento = 1 cm.*

Only small fragments of the posterior palatine tooth are preserved but nevertheless it is possible to reconstruct its shape. It was elliptical with a greatest diameter of about 38 mm. A slightly smaller replacement tooth can be seen beneath its base. Only the anterior part of this tooth retains the thick enamel layer while the posterior part shows the underlying dentine. The latter presents radial ridges originating from a low central swelling. Therefore the tooth was not centrally concave as in other placodonts (*Psephoderma* and *Placochelys*). The posterior palatine tooth occupies the whole width of the palatine.

There is only one, very small anterior palatine tooth. It is elliptical, with a maximum diameter of 12 mm; it is mushroom-shaped, with a blunt central point. It is nearly in contact with the large posterior tooth. Its main axis is directed anteriorly and slightly laterally while that of the posterior tooth runs anteriorly and slightly medially; the two axes form an angle of about 35°.

D i s c u s s i o n: comparison of the Ladinian specimen with the palatine dentition of *Paraplacodus* (Anisian), *Placodus* (Anisian-Ladinian), *Cyamodus* (Anisian-Ladinian), *Placochelys* (Early Carnian), *Protenodontosaurus* (Late Carnian) and *Psephoderma* (Norian-Rethian) excludes *Paraplacodus* and *Placodus* (JAECKEL, 1907; MAZIN, 1989; NOSOTTI & PINNA, 1989; PEYER & KUHN-SCHNYDER, 1955a; PINNA, 1990; 1992; PINNA & NOSOTTI, 1989) as potential candidates.

The remaining genera belong to the superfamily Cyamodontoidea and are strictly related (MAZIN, 1989). None of them has been found in the Upper Ladinian.

The comparison with the dentitions of these genera shows that:
- there is a great similarity with the genus *Cyamodus* (see PEYER & KUHN-SCHNYDER, 1955a; PINNA & NOSOTTI, 1989; PINNA, 1992), in particular with the better known species *Cyamodus hildegardis* (Anisian/Ladinian boundary of Tessin and Lombardy). In fact in the adult specimens of this species there are two palatine teeth, a large posterior tooth with a more or less elliptical outline and an anterior, decidedly smaller, elliptical tooth very close to the other. The orientation of the long axes is similar to that of 16848 MFSN and, above all, the anterior tooth develops a low central point (PINNA, 1992; see the specimens MSNM V478 and PIMUZ T4771). Also *Cyamodus rostratus* from the Upper Muschelkalk (Lower to Middle Ladinian) of Germany has elliptical and mushroom-shaped anterior palatine and anterior dentary (fig. 4 C) teeth which are much smaller than the large posteriormost ones. In this species, however, there are 3 palatine teeth.
- *Placochelys placodonta* is different because it has an anterior palatine tooth which is proportionally much larger than the tooth of the described specimen and lacks a central point (on the contrary, sometimes there is a clear depression in the middle of the crown, fig. 5 A).
- *Protenodontosaurus italicus* is different because the anterior palatine teeth are proportionally larger, probably flat and with a more circular rather than elliptical outline (fig. 5 C).
- *Psephoderma alpinum* has palatine teeth with the same relative sizes as the described
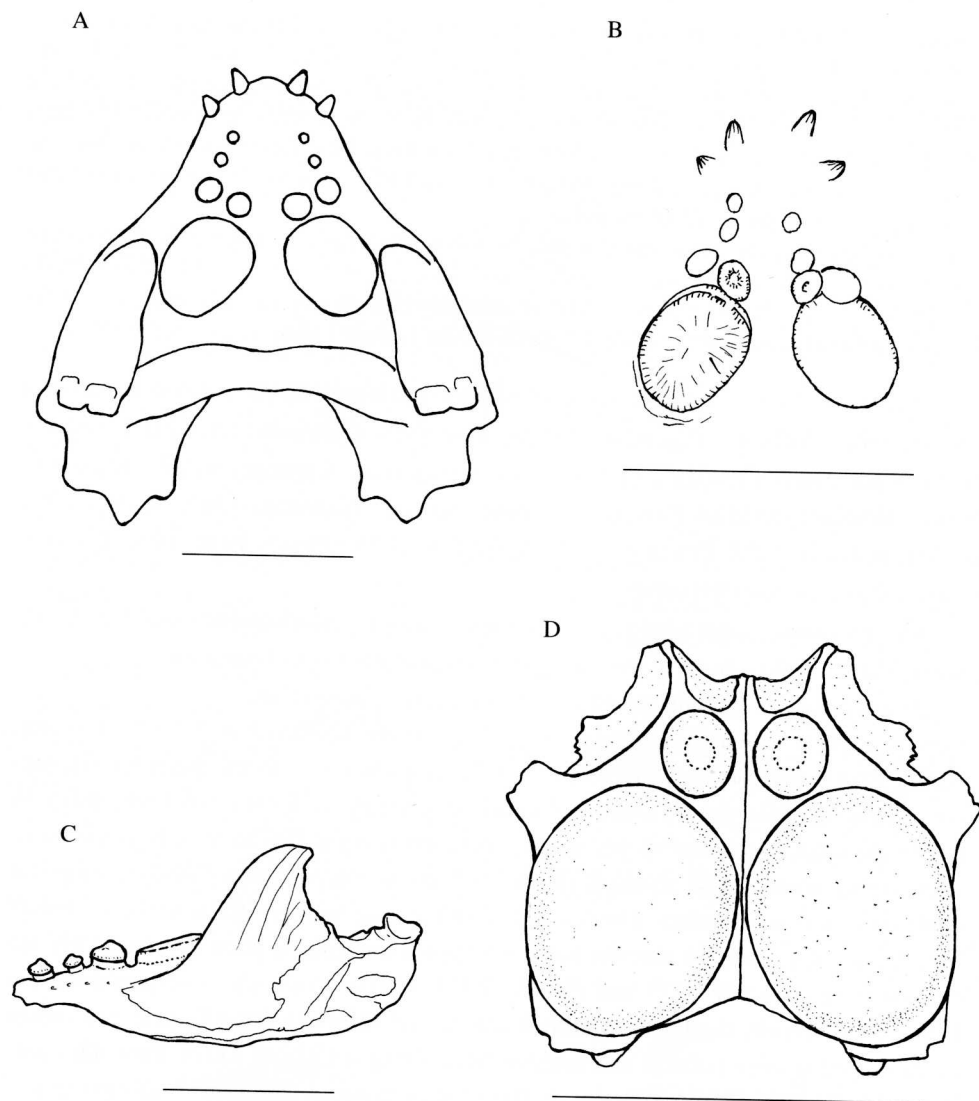
A

B

C

D

Fig. 4 - A) reconstruction of the skull of *Cyamodus hildegardis* in palatal view (after PINNA, 1992, redrawn), B) dentition of *Cyamodus hildegardis*, V478 (drawing obtained after PINNA, 1992, fig. 9), C) lower jaw of *C. rostratus* in lateral view (PEYER & KUHN-SCHNYDER., 1955a, redrawn); D) reconstruction of the palatines of cf. *Cyamodus* (es. 16848 MFSN). Scale bar: = 5 cm.

- A) *ricostruzione del cranio di* Cyamodus hildegardis *in vista palatale (da* PINNA, *1992, ridisegnato), B) dentatura di* Cyamodus hildegardis, *V478 (disegno effettuato su* PINNA, *1992, fig. 9), C) mandibola di* C. rostratus *in vista laterale (*PEYER & KUHN-SCHNYDER, *1955a, ridisegnato), D) ricostruzione dei palatini di cf.* Cyamodus *(es. 16848 MFSN). Scala di riferimento = 5 cm.*

specimen (ratio of the main diameter of the posterior palatine tooth to the main diameter of the anterior palatine tooth: 3.17 against 3.08); both teeth are depressed, as is the small anterior; the anterior tooth is well separated from the posterior tooth (see fig. 5 D).

Comparison between the palatines of these genera shows that:

- the comparison with the palatine of *Cyamodus hildegardis* and *Cyamodus rostratus* is not possible because there are no detailed descriptions of them (PEYER, 1931, 1935; PINNA, 1992).

- the profile is similar to that of the palatine of *Placochelys placodonta* but in this species the lateral margin is sutured with the ectopterygoid.

- in *Psephoderma alpinum* the palatine is anteriorly sutured with the vomer without taking part in the lateral and medial margins of the internal narial opening; it is sutured laterally to the ectopterygoid.

- in *Protenodontosaurus italicus* the narial notch has the same position and shape as in 16848 MFSN; the lateral margin of palatine is posteriorly sutured to an anterior process of the pterygoid and, perhaps, the "lateral process" is separate from the palatine and belongs to the ectopterygoid.

The palatine described above is best ascribed to the genus *Cyamodus*. However, it is not clear to what extent tooth shape is influenced by wear and ontogeny, if at all. 16848 MFSN could belong to an immature individual with unworn teeth. Therefore I am prudent in the generic attribution of 16848 MFSN.

Placodont remains are quite common in the Alpine Triassic.

In my opinion the teeth found in the Upper Carnian of Dogna (Udine) identified by BASSANI (1892) as *Placodus gigas*, which were not figured and were lost, did not really belong to this species. *Placodus* was never found in the Upper Triassic (PEYER & KUHN-SCHNYDER, 1955a; CARROL, 1988).

In the eastern Carnic and western Julian Alps we have evidence of the probable presence of three placodont genera, which lived in the same region at different times:

- possibly *Cyamodus* during the Late Ladinian;

- *Placochelys* during the Early Carnian (ZUCCHI STOLFA, 1975; PINNA & ZUCCHI STOLFA, 1979);

- *Protenodontosaurus* during the Late Carnian (PINNA, 1990).

The Carnic region is therefore one of the most important for placodont discoveries and studies. There we can observe a taxonomic succession occurring in the same region, potentially covering the entire time-span of placodont evolutionary history, since suitable rocks of shallow water origin from the Scythian to the Rhaetian age are exposed here.
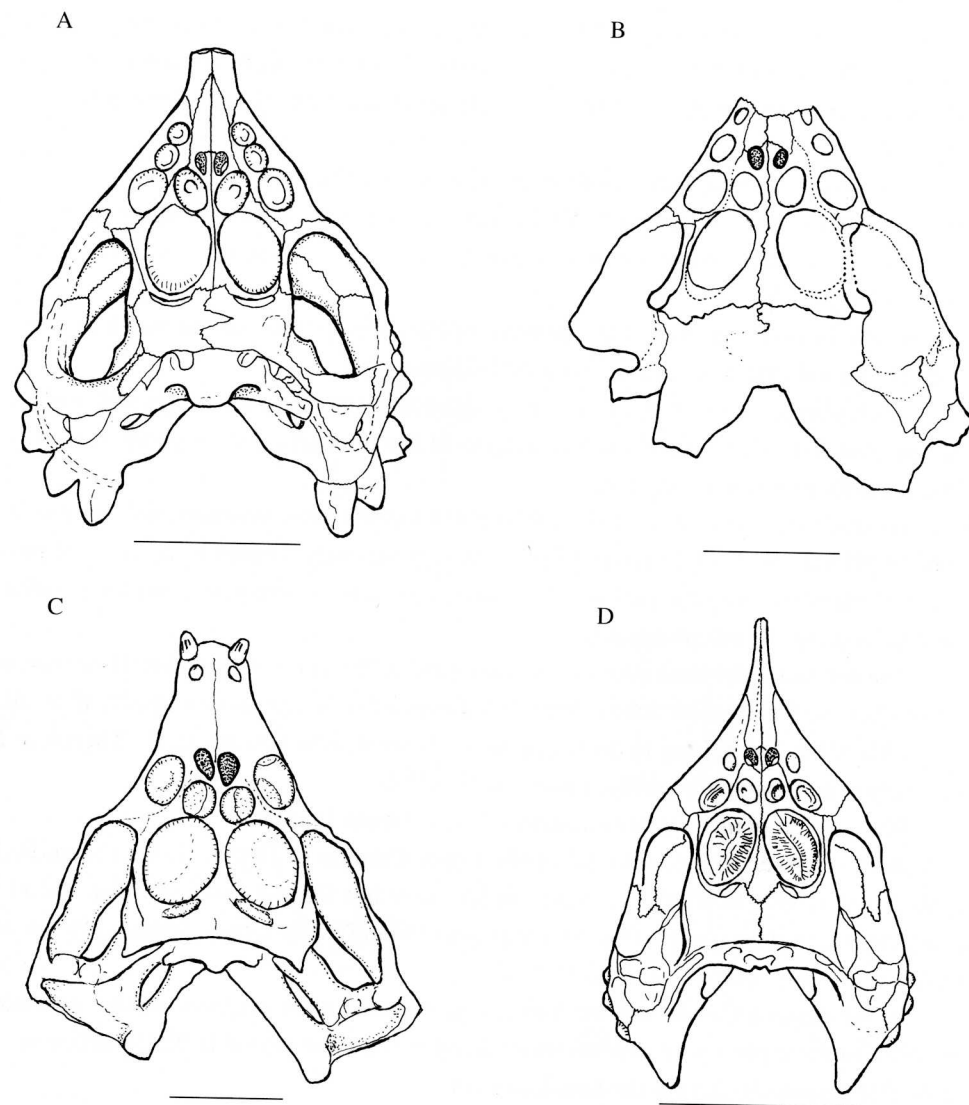
Fig. 5 - Placodont skulls in palatal view: A) *Placochelys placodonta* (after PEYER & KUHN-SCHNYDER, 1955a, redrawn); B) *Placochelys placodonta* from Fusea (after ZUCCHI STOLFA, 1975, redrawn); C) *Protenodontosaurus italicus* (after PINNA, 1990, drawing made on fig. 2 and controlled on the specimen); D) *Psephoderma alpinum* (after PINNA & NOSOTTI, 1989, redrawn). Scale bar = 5 cm.
 - *Crani di placodonti in vista palatale: A)* Placochelys placodonta *(da* PEYER & KUHN-SCHNYDER, *1955a, ridisegnato; B)* Placochelys placodonta *di Fusea (da* ZUCCHI STOLFA, *1975, ridisegnato); C)* Protenodontosaurus italicus *(da* PINNA, *1990, disegno eseguito sulla fig. 2 e controllato sull'esemplare); D)* Psephoderma alpinum *(da* PINNA & NOSOTTI *1989, ridisegnato). Scala di riferimento = 5 cm.*

Superorder	Sauropterygia OWEN, 1860
Order	Nothosauria SEELEY, 1882
Family	Nothosauridae BAUR, 1889
Genus	*Paranothosaurus* PEYER 1939

cf. *Paranothosaurus*

(figg. 6, 7)

Locality and age: the specimens (16849-16850-16851 MFSN) were collected in the environs of the village of Fusea near Tolmezzo (Udine, Friuli-Venezia Giulia). They were fossilized at the top of a 25 cm- thick bed of black limestone particularly rich in bone remains. At the same outcrop and stratigraphic level the placodont *Placochelys placodonta* JAECKEL, 1902, described by ZUCCHI STOLFA (1975) and ZUCCHI STOLFA & PINNA (1979), was found. The latter consisted of a nearly complete skull exposed in palatal view (ZUCCHI STOLFA & PINNA, 1979; see fig.5 b). Some vertebrae, a rib and other bones were collected but not described; at present most of this material (including the skull) should be at the Institute of Geology and Paleontology of Trieste. This material is not available (G. Muscio, pers. comm.) and is probably lost.

ZUCCHI STOLFA (1975) referred the fossiliferous outcrop to the "raiblian marly limestones" based on data from dr. M. Cuder, at that time student of Geology at the University of Trieste. The main fossiliferous bed was considered to be the lowermost bed of the Raibl Group (M. Cuder, pers. comm.), and therefore of Carnian age (the Raibl Group represents the Middle-Upper Carnian in that area (AA.VV, 1971)). In my opinion the outcrop should placed stratigraphically between the upper part of the so called "Dolomia dello Schlern (Sciliar)", - whose thick, gray banks form the left, steep side of Tagliamento river valley from Villa Santina to Caneva near Tolmezzo (AA.VV., 1971; SELLI, 1963) - and the lower part of the Raibl Group. In fact, the outcrop is clearly located at the top of the steep left side of Tagliamento valley. The section exposes conglomerate lenses with bituminous matrix which are also present at the top of the "Dolomia dello Schlern" in localities adjacent to Fusea, above the thick banks of dolostone (AA.VV., 1971). A very similar situation is found in the Vinadia valley, less than 2 km from the Fusea outcrop (BARNABA, 1955). Therefore, the outcrop is best considered as the upper portion of the carbonate platform of the "Dolomia dello Schlern". The age of the "Dolomia dello Schlern" is generally considered Late Ladinian-Early Carnian and its thickness varies between 300 m and 800 m in the Carnic Alps (AA.VV., 1971). The dating is indirect, being based on faunas present in the overlaying Raibl Group. The thick carbonate platform deposits of Late Ladinian-Early Carnian age in the Eastern Carnic Alps (between Chiarzò torrent and Fella river) are often reported in literature under the title of Dolomia Cassiana, and are considered synonyms of "Dolomia dello Schlern (Sciliar)" (see, for example, CARULLI et al., 1987). BARNABA (1955) considered that the levels corresponding to those of Fusea and outcropping in the Vinadia valley were lowermost Carnian. A preliminary investigation of the poor microfauna found in the fossiliferous outcrop and the microfacies agrees with a Late Ladinian-Early Carnian age (S. Venturini, pers. comm.). The stratigraphy and sedimentology of the outcrop will be described in detail in another contribution.

D e s c r i p t i o n: the description of the material given here is preliminar; further abundant material excavated by the Museo Friulano di Storia Naturale of Udine from the same outcrop and belonging to the same taxon is in preparation. Future descriptions will be able to better consider the nothosaur remains.

The specimens consist of three vertebrae originally imbedded in dark gray limestone slabs; they were completely freed from rocky matrix by mechanical tools and using 5% formic acid. Two vertebrae (16850 and 16851 MFSN; fig 6 A-D) were almost directly articulated. The other (16849 MFSN) was isolated at about 1.5 m from the others and on the same upper surfa-
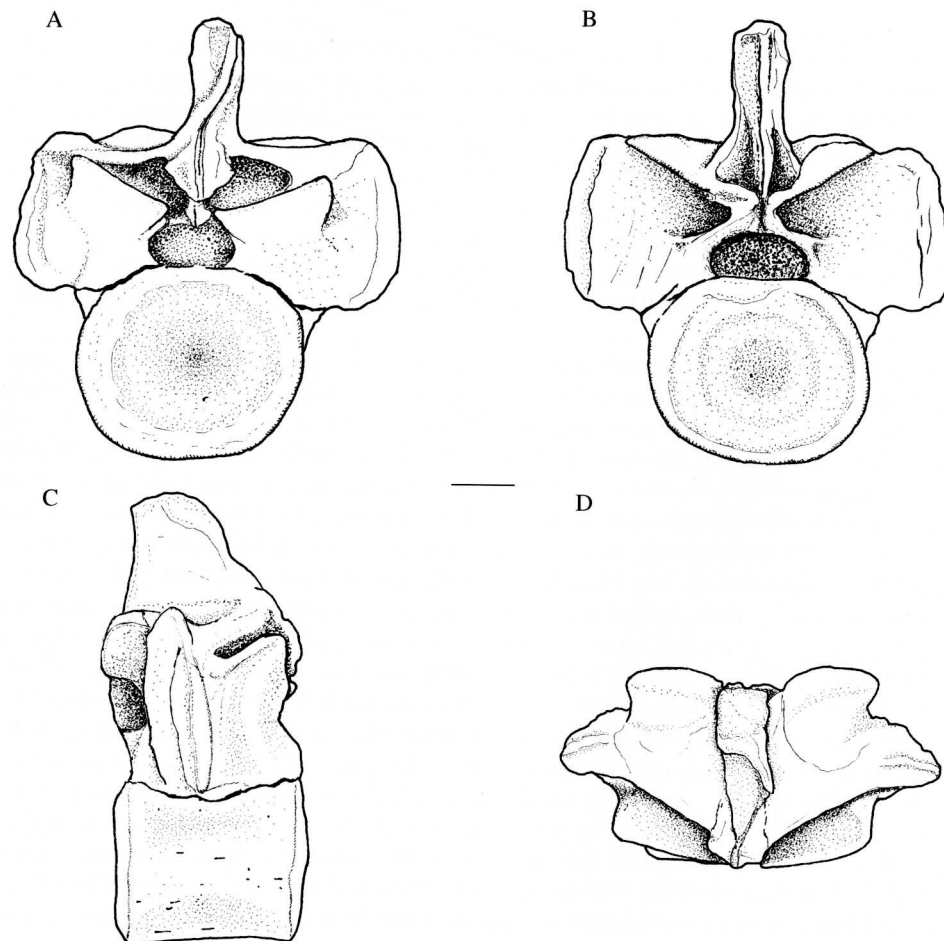

Fig. 6 - Dorsal vertebra (es. 16850 MFSN) of cf. *Paranothosaurus*. A) anterior view, B) posterior view, C) lateral view, D) dorsal view. Scale bar = 1 cm.
- *Vertebra dorsale (es. 16850 MFSN) di cf.* Paranothosaurus. *A) visione anteriore, B) visione posteriore, C) visione laterale, D) visione dorsale. Scala di riferimento = 1 cm.*

ce of the main fossiliferous bed. Vertebrae 16850-51 MFSN are identical, but 16850 MFSN is less deformed by lithostatic pressure. The centrum is platycoelous, forming a heavy cylinder with slightly depressed anterior and posterior faces. It is 33 mm long and 33.5 high, with a l/h ratio = 0.98. There is a sutural connection between the neural arch and the centrum. The neural arch is relatively broad and flat. The transverse processes are nearly as high as the neural arch; they are not large and inflated as in *Parthanosaurus* (SKUPHOS, 1893) even though the distal part of both processes is crushed. Prezygapophyses and postzygapophyses are well developed, with slightly inward tilted articular surfaces; small parts are restored. Two sockets, formed by the postzygapophyses above, and the crests bordering the upper margins of neural channel below, receive the prezygapophyses. The neural spine is low (about 20 mm), and partly crushed anteriorly.

Vertebra 16849 MFSN (fig.7 A-F) is antero-posteriorly compressed and deformed; its shape differs considerably from that of the other two. The centrum is platycoelous with only slight depressions on the anterior and posterior faces. It is 32.2/33.5 mm high and 21.35 mm long. The parapophysis is well raised from the lower part of the centrum and directed laterally and slightly downward. The shape of the articular facet is nearly circular to oval when not deformed. The diapophysis faces laterally and slightly downward and is located at the base of the neural arch. The articular facet is dorso-ventrally and slightly postero-anteriorly elongated. There is a sutural connection between the neural arch and the centrum. The neural arch is large, high (65 mm) and extends to the upper half of the lateral side of the centrum; its shape in antero-posterior view is quadrangular. The zygapophyses are nearly horizontal and project laterally as sharp wings well beyond the sides of the centrum and beyond the lateral extent of the diapophysis. The anterior part of both prezygapophyses was eroded by weathering; it articulated in a posterior socket upwardly bordered by the flat postzygapophyseal facet. The neural spine is short (20 mm).

D i s c u s s i o n: the shape of vertebrae 16850-51 MFSN indicates that they are nothosaur dorsal vertebrae (see CARROL, 1988; ROMER, 1956). 16849 MFSN is clearly a distal cervical vertebra ("pectoral vertebra" of Romer, 1956, p. 131) of a nothosaur. The vertebrae belong to a large individual; a gross estimation of its length should be about 3-3.5 m.

Dr. R. Wild (pers. comm.) pointed out the similarity of 16850 MFSN with the dorsal vertebrae of *Paranothosaurus*. *Paranothosaurus* is a large nothosaur genus (it reaches a length of 4 m) typical of the European Middle Triassic. The type species (by monotypy), *Paranothosaurus amsleri* PEYER, 1939, was found in the Anisian/Ladinian Grenzbitumenzone ("Scisti ittiolitici di Besano" of Italian Authors) of Mt. San Giorgio (Kanton Tessin, Switzerland); several *Paranothosaurus* specimens were collected from the German Muschelkalk (Anisian-Ladinian) (R. Wild, pers. comm.), in particular the Lower Muschelkalk of Thuringia (PEYER, 1939). The features that permit comparison with the dorsal vertebrae of the genus *Paranothosaurus* are the short length of the centrum in comparison with its height and the low neural spine (Wild, pers. comm.; PEYER, 1939). However, the Anisian/Ladinian genus *Ceresiosaurus* also has relatively low neural spines
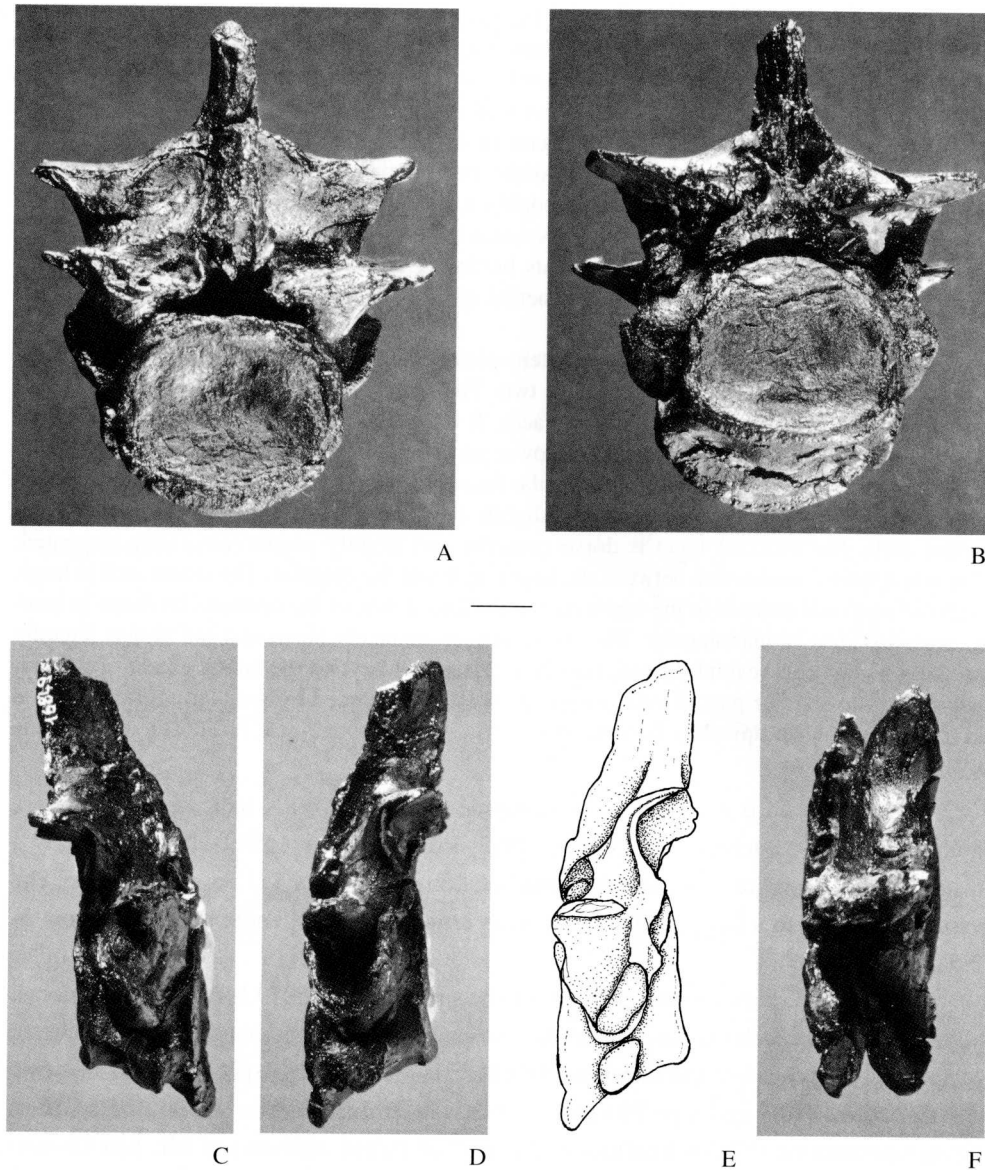
Fig. 7 - Cervical vertebra (es. 16849 MFSN) of cf. *Paranothosaurus*. A) anterior view, B) posterior view, C) right lateral view; D-E) left lateral view, F) dorsal view. Scale bar = 1 cm.
 - *Vertebra cervicale (es. 16849 MFSN) di cf.* Paranothosaurus. *A) visione anteriore, B) visione posteriore, C) visione laterale destra, D-E) visione laterale sinistra F) visione dorsale. Scala di riferimento = 1 cm.*

(PEYER, 1931). Both *Paranothosaurus amsleri* PEYER, 1939 and *Ceresiosaurus calcagnii* PEYER, 1931 come from the same formation (Grenzbitumenzone = "Scisti ittiolitici di Besano"). They are preserved with bones crushed on slabs and the vertebrae were not isolated from rock and accurately described. Thus comparisons via the literature are difficult but with the original specimens the same problems are met.

Dorsal vertebrae of *Pistosaurus*, another large genus from the Middle Triassic of Germany, have narrower zygapophyses with nearly horizontal articular facets, and elongated, slender transverse processes.

The more common genus *Nothosaurus* (Middle-LateTriassic of Europe and Middle Triassic of Southwestern Asia; CARROL, 1988), which reached large sizes and was coeval with the nothosaur of Fusea, has relatively more elongated centra and very high neural spines in comparison to *Paranothosaurus* and 16850-16851 MFSN. The different shape of the neural arches and neural spines are linked to the different swimming mode in the two genera (CARROL, 1988): *Paranothosaurus* swam by sigmoid, lateral undulations of the body (helped by the orientation of pre-postzygaphophyses articulation permitting relative lateral movement between vertebrae), as modern crocodiles, while *Nothosaurus* used the forelimbs for propulsion.

The cervical vertebra differs from those of *Nothosaurus* figured by ROMER (1956), mainly in the shape and position of the dia- and parapophyses; the neural spine has nearly the same height. I consider it as belonging to the same taxon of the adjacent vertebrae on the bed surface and very probably to the same individual. Cervical vertebrae of *Paranothosaurus* are not well known and described (PEYER, 1939).

Nothosaurs were apparently poorly diversified during the Late Triassic (Keuper of Western Europe). Our specimens could indicate that the stratigraphic and geographic distribution of *Paranothosaurus* was wider than previously supposed (CARROL, 1988). This is the first report of a large nothosaur other than *Nothosaurus* in the Upper Triassic and is probably the largest nothosaur ever found in Italy.

Order   Thalattosauria MERRIAM, 1904
?Thalattosauria
(fig. 8)

L o c a l i t y   a n d   a g e: the "scisti ittiolitici di Raibl" ("Raibler Schichten" of German and Austrian Authors) are famous for their ichthyofauna, studied since the last century (BRONN, 1858; KNER, 1866; TINTORI, 1990). They constitute the lower part of the Predil Limestone Formation (ASSERETO et al., 1968). They outcrop near the small mining town of Cave del Predil (known in the past, when the zone was under Austro-Hungarian government, as Raibl), located in the Julian Alps, close to the Austro-Italo-Slovenian border.

Lithologically they are characterized by thin and well bedded black limestones and marls. The associated fauna includes fishes, crustaceans, ammonites and also land plants are present. Deposition took place in a small anoxic basin bounded by a shallow carbonate platform on which the shallow water Dolomia Cassiana was deposited. The Predil Limestone Formation is well dated, thanks to the presence of ammonoids: *Trachyceras aon* and *Trachyceras basileus* indicate Early Carnian age (TINTORI, 1990).

In spite of the abundance of fossils and the favourable environment for the fossilization, no reptile remains have been described to date from the "scisti ittiolitici di Raibl". The first reptilian remain recently discovered at the Rio Freddo outcrop by mr. L. Cassutti is therefore described here.

D e s c r i p t i o n: originally the specimen (13228 MFSN) was nearly completely enclosed in matrix and was prepared on both sides under a Wild3 binocular microscope using insect needles and a dental drill.

Three articulated caudal vertebrae are preserved, although none of them is entire; a fourth vertebra, the anteriormost, is indicated only by a fragment of the neural spine. The vertebrae are referred to numerically here from the anteriormost preserved one (1) to the posteriormost (4). Vertebra (2) lacks the middle-anterior part of the centrum and the respective chevron is shifted caudally. The next vertebra (3) lacks the middle-upper part of the neural spine and more than the distal half of the chevron. Only the anterior half of vertebra (4) is preserved.

The centra are amphiplatyan, elongate (18 -19 mm) and low (8.5 mm at the anterior articular extremity). They are slightly bent with the concavity facing downward. The lateral side of the centrum is longitudinally excavated and has an elongated spool shape in dorsal-ventral view.
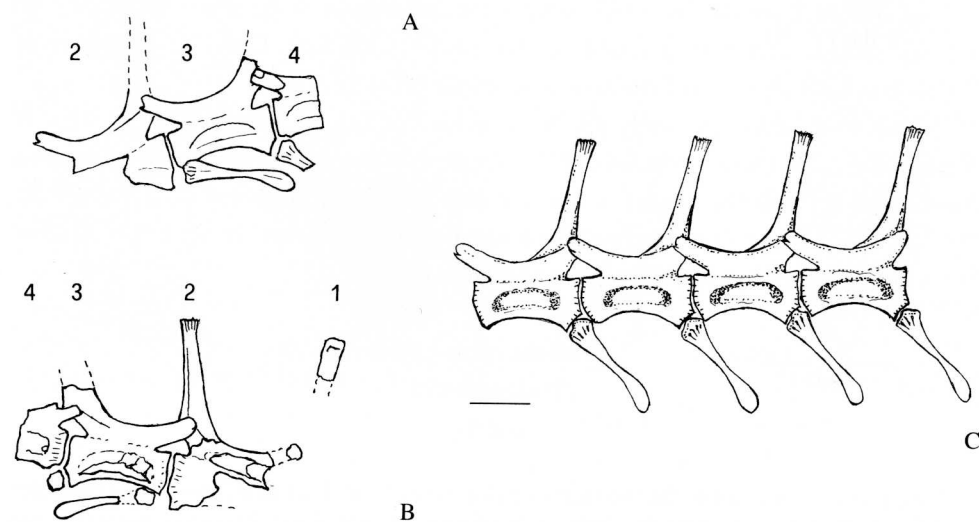

Fig. 8 - Drawing of the specimen 13228 MFSN from the left (A) and right (B) side. C) Reconstruction of the tail segment represented by this specimen. Scale bar = 1 cm.
  - *Disegno dell'esemplare 13228 MFSN dal lato sinistro (A) e destro (B). C) Ricostruzione del segmento caudale rappresentato da questo esemplare. Scala di riferimento = 1 cm.*

In lateral view the posterior end of the centrum is deeper than the anterior end. The articular facets for the haemal arch is located at the posterior end, backward and downward.

The part of the centrum bearing these facets is clearly distinct from the upper intercentral articular part. The haemal arches may also articulate with a smaller ventral facet at the anterior extremity of the succeeding centrum. The pleurapophyses are completely reduced. The deep crushing of the right side of centra (3) and (4) suggests that they were hollow.

The neural arch is a well developed, dorsally curved structure and is fused with the centrum. The prezygapophyses are elongate, rod-like and V-shaped in dorsal view with slightly medially arched branches. They terminate beyond the anterior limit of the centrum. The postzygapophysis is reduced to a shallow rise at the base of the neural spine. The articular facets of the zygapophyses are nearly vertical.

The neural spine is extremely elongated (24 mm in vertebra (2)); it is only slightly angled posteriorly while in (3) it seems to be a little more angled. In the latter, however, only the basal half is preserved. On the posterior side a sharp carina is tapering toward the tip, but terminating before reaching it. The distal part is flattened, slightly expanded and ornamented by short furrows.

The haemal arch is elongate (21 mm in the vertebra (2)), Y-shaped, with the distal segment flattened, spatulate and slightly bent anteriorly. The proximal articular parts are nail-shaped, expanded and thick, perhaps with two articular facets or condyles, one for the anterior and the other for the posterior centrum.

D i s c u s s i o n: the elongation of centrum, complete reduction of transverse processes and presence of haemal arches indicates that the vertebrae originate from the tail.

Generally, elongated centra and the complete reduction of the pleurapophysis are typical of the middle-posterior caudals of most reptiles. There, however, neural spines and chevrons are somewhat lower and decidedly angled posteriorly. Our reptile has in every case an unusually deep tail. The size of the vertebrae shows that the complete skeleton must have attained a relatively large size, probably a length in excess of 1.5 m.

A deep tail is generally considered an adaptation for propulsion in order to improve acquatic locomotion. Elongated neural spines and haemal arches are present in the laterally compressed tail of many marine reptiles, for example in the Agialosaurids (CARROL & DEBRAGA, 1992). The caudals in this group show the same reduction of the postzygapophyses, similar prezygapophyseal shape and angle of articulation, and the absence of pleurapophyses in the posterior half of the tail. The different age (Agialosaurids are essentially Early Cretaceous) make the attribution of our specimen to this group unlikely. A deep tail is common in other mesozoic reptile groups (for example the pleurosaurs), due mainly but not necessarily to an aquatic mode of life. Some dinosaurs (WEISHAMPEL et al., 1990) and also the small arboreal *Megalancosaurus* (S. Renesto, pers. comm.) have a deep tail.

If we exclude ichthyosaurs, nothosaurs and placodonts (all present in the Middle-Upper Triassic of the Carnic region), to which our vertebrae very probably do not belong, few other Triassic groups of marine reptiles remain for comparison.

Drepanosauridae (*Drepanosaurus unguicaudatus, Dolabrosaurus aquatilis* and a nameless small reptile from Lockatong Formation of Connecticut and New Jersey; BERMAN & REISZ, 1992), a family of Triassic reptiles only recently identified, have an extremely deep tail. Drepanosaurids are of Carnian and Norian age and have in common with 13228 MFSN tall and slender neural spines, long and slender prezygapophyses extending beyond the anterior rim of the centrum and long haemal arches. Several important diagnostic features of the Drepanosauridae are not present in 13228 MFSN, such as the neural spine anterioposteriorly expanded distally, haemal arches exceeding neural spines in length, haemal arches fused to the centra (in the posterior caudals they are fused anteriorly while anterior caudals are fused posteriorly) (BERMAN & REISZ, 1992).

The described specimen could belong to a thalattosaur. Thalattosaurs are a relatively poorly studied group of Middle Triassic reptiles (CARROL, 1988). The tail does not seem so deep posteriorly in the Late Triassic *Thalattosaurus* (HOFFSTETTER, 1955). In the Middle Triassic genera *Clarazia, Escheleria* and to a lesser extent in *Askeptosaurus*, however, the tail is laterally compressed as a propulsive organ (HOFFSTETTER, 1955; PEYER & KUHN-SCHNYDER, 1955b).

Affinities with the Norian marine reptile *Endennasaurus acutirostris* (RENESTO, 1984; 1992), which shows close relationships with thalattosaurs, is possible. This taxon shows:

1) elongated caudal centra,

2) tall neural spines, which are slightly enlarged at the top, ornamented by furrows, and not very angled posteriorly in the anterior caudals, where the pleurapophyses are already completely reduced.

3) quite long, spatulate, Y - shaped haemal arches.

If this was the case, our specimen comes from the anterior section (but not anteriormost) of the tail (see RENESTO, 1992, figg. 3, 13).

However there are some differences between the two:

1) centra seem to be amphicoelous

2) centra are not so elongated and not probably hollow

3) the articulation of the haemal arches with centra are very different

Our material is too limited for satisfactory comparison; we must wait for more complete material to identify the reptile represented by the described vertebrae.

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