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COLOBODONTIDAE FROM THE UPPER TRIASSIC (CARNIAN)
OF FRIULI VENEZIA GIULIA (UDINE, NE ITALY)

*COLOBODONTIDAE DAL TRIASSICO SUPERIORE (CARNICO)
DEL FRIULI VENEZIA GIULIA (UDINE, NE ITALIA)*

Abstract - Some specimens of fossil fishes belonging to the family Colobodontidae, referable to the Carnian (Upper Triassic) and coming from a few localities in Valcanale-Canal del Ferro (Udine, NE Italy) are here described. The material, although found in the scree, can be ascribed to the Predil Limestone and the Rio del Lago Formation, based on the local geology. The examined material consists of some parts of the body and of the skull of a single specimen, a complete skull preserved in three dimensions and of isolate scales, all stored at the Museo Friulano di Storia Naturale of Udine. A body fragment covered by rows of scales is stored at the Museo Paleontologico di Monfalcone (GO). These findings are important because they are the first certain evidence of the presence of this taxon in the Upper Triassic.

Key words: Colobodontidae, Actinopterygii, Carnian, Upper Triassic, Predil Limestone, Rio del Lago Formation, Friuli.

Riassunto breve - Vengono descritti alcuni esemplari di pesci fossili appartenenti alla famiglia Colobodontidae, riferibili al Carnico (Triassico Superiore) e provenienti da diverse località della Valcanale-Canal del Ferro (provincia di Udine). I reperti sono stati rinvenuti nel Calcare del Predil e nella Formazione di Rio del Lago. Il materiale studiato è costituito da alcuni frammenti di corpo e di cranio appartenenti allo stesso esemplare, da un cranio completo conservato in tre dimensioni e da scaglie isolate, tutti depositati al Museo Friulano di Storia Naturale di Udine. Un frammento di corpo ricoperto da file di scaglie è conservato al Museo Paleontologico di Monfalcone (GO). L'importanza dei ritrovamenti è legata al fatto che sono la prima testimonianza certa della presenza di questo taxon nel Triassico Superiore.

Parole chiave: Colobodontidae, Actinopterygii, Carnico, Triassico Superiore, Calcare del Predil, Formazione di Rio del Lago, Friuli.

Geological and stratigraphical notes

The examined material was collected in a few localities of Valcanale-Canal del Ferro, 60-90 km north of Udine. The area belongs to the domain of Southern Alps and in the past had remarkable importance because of its metal-bearing depots, created time after time between Silurian and Triassic (GAETANI et al., 1981).

The specimen MFSN 19525 comes from Prasnig Creek valley, Tarvisio, MPCM 13778 from the environs of Cave del Predil, Tarvisio, MFSN 24994 from the creek close the cemetery of Dogna, MFSN 5921 from Rio Freddo valley, Tarvisio, MFSN 19955 from Dogna valley, Dogna, MFSN 21341 from the environs of Dogna.

Specimens from Prasnig Creek valley, environs of Cave del Predil and Rio Freddo valley come from the Predil Limestone, where a fossil association with fishes, crustaceans, terrestrial plants, ammonoids and other invertebrates was found (BRONN, 1858; KNER, 1866; ASSERETO et al., 1968; TINTORI, 1991). The Predil Limestone is dated to the early Carnian (Julian) on the base of the presence of the ammonoid *Trachyceras aon* and "*Clionitites*" *basileus* (*aon* Ammonoid Subzone) (ASSERETO et al., 1968). The fossiliferous beds are black, thinly-bedded and marly limestones (ibidem). The environment of deposition was an intraplateau basin with disoxic bottom conditions.

The specimens from the environs of Dogna come from the Rio del Lago Formation (PRETO et al., 2005; DALLA VECCHIA, 2006). This unit is dated to the early Carnian and is slightly younger than the Predil Limestone (*aonoides* Ammonoid Subzone) on the base of the ammonoids *Carnites floridus* and *Trachyceras* cf. *saulus*, and a rich palinoflora (PRETO et al., 2005; DALLA VECCHIA, 2006). The Rio del Lago Formation in the Dogna area is made of grey to dark grey, thinly bedded limestone, often bioturbated and rich in invertebrate fossils, intercalated with greenish to dark grey marls and clayey marls (ibidem). The depositional environment was a mixed terrigenous-carbonate ramp (PRETO et al., 2005).

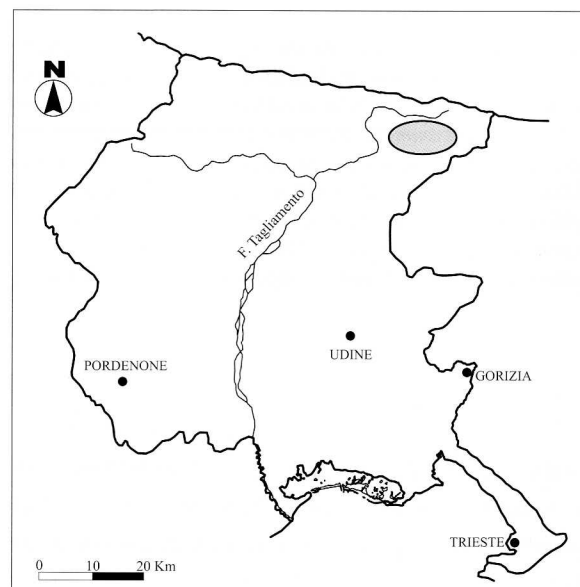


Fig. 1 - Geographic localization of the finding site.
- Localizzazione geografica dell'area di rinvenimento del materiale.

Material and methods of preparation

The material at our disposal for this work consists of four typologies: a series of isolated teeth, some body's fragments (MFSN 19525) preserved on slab, a body's fragment cover by rows of scales (MPCM 13778) and a skull (MFSN 24994), preserved in three dimensions, extremely rare event for what concerns the Italian fossil ichthyofauna.

For this latter specimen different methods were applied, both of chemical and mechanical kind. The first step consisted in cleaning the fossil's surface, obtained by immersions into a solution containing peroxide. In the next step the fossil has been immersed in formic acid 5% diluted. However, because of the find's frailty, before every cycle of immersion in acid the displayed bone parts has been consolidated by means of an ethylic methacrylate's polymer, cleanable with acetone. Once the fossil has been dried, the clayey residual has been removed mechanically with harmonic steel's points, at binocular microscope.

The remaining material consists of two-dimensional preserved specimens. After a careful evaluation it has been retained opportune to prepare just the parts to be examined (scales) through mechanical removal. After all the material at disposal was prepared, the graphic representation of the material itself, through draws made at the camera lucida, was made.

Acronyms: MFSN = Museo Friulano di Storia Naturale, Udine; MPCM = Museo Paleontologico Cittadino, Monfalcone (Gorizia).

Systematic Paleontology

Class Osteichthyes HUXLEY, 1880

Subclass Actinopterygii COPE, 1887

Order Perleidiformes BERG, 1937

Family Colobodontidae ANDERSSON, 1916

Colobodus AGASSIZ, 1844

Colobodus sp.

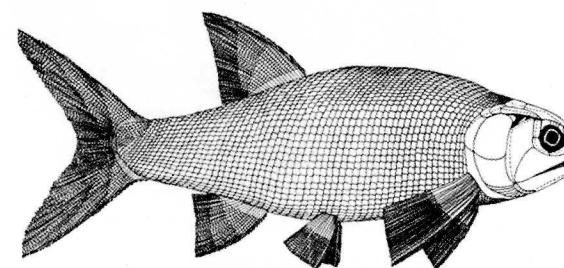


Fig. 2 - *Colobodus bassanii* (DE ALESSANDRI, 1910) (after MUTTER, 2002).
- *Colobodus bassanii* (DE ALESSANDRI, 1910) (da MUTTER, 2002).

Specimen MFSN 19525

The specimen MFSN 19525 lies on three slabs, whereof one belongs to the counterpart. Matrix is carbonatic with a light clay component (weakly marly limestone). The fossil is very disarticulated and poor preserved; few bones are undamaged and they all are randomly arranged on the surface of the slabs. It is possible to identify only the two maxillas, the mandibles, the supracleithrum and the ectopterygoid. There are fragments of dermal bones with dense ornamentation and parts of the fins impossible to describe.

A portion of the scales covering has been preserved partially articulated.

S k u l l - M a x i l l a: The large maxilla has a posteriorly expanded dorsal margin and a slightly convex oral one. Teeth are visible in its anterior parts until about half of the length of the bone. The strong, long and conical teeth are arranged in a single row and they show some stripes just on their upper parts. On the tip of the better preserved teeth is possible to notice an acrodine cap. The maxilla is completely covered by an ornamentation that consists in ganoine's tubercles, that gives a grained look to the surface.

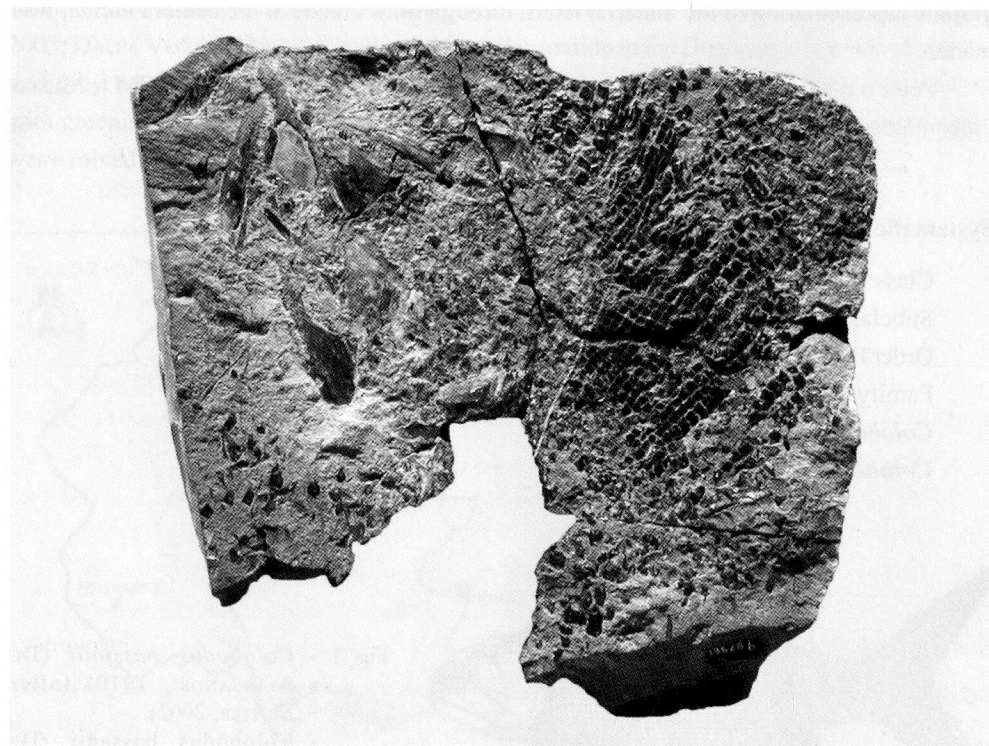


Fig. 3 - *Colobodus* sp.: specimen MFSN 19525.
- *Colobodus* sp.: esemplare MFSN 19525.

M a n d i b l e: Both ramii of the lower jaw are preserved. This powerful bone shows a slightly bent ventral margin and straight oral margin. The teeth, approximately twenty, are arranged on a single row and they are inserted in the anterior half of the bone; they are similar in shape to the teeth on the maxilla. The teeth have different size, with smaller elements alternating to bigger ones. The ornamentation, as in the case of maxilla, is homogenous on all the bone and is made of tubercles.

S u p r a c l e i t h r u m: Trapezium-shaped bone, that was originally placed behind the post-temporal; posteriorly is in contact with the first vertical row of scales. The ornamentation of this bone is particular as in the anterior part consists of ganoine stripes parallel to the longest margin of the element, for all his length. Posteriorly to the stripes, the surface of the element is covered by tubercles that become enlarged, approaching the posterior margin of the bone, perpendicular to this and parallel to the scale's ornamentation.

E c t o p t e r i g o i d: Sigmoid-shaped, has an oral margin with nine teeth on the convex part of the margin. It is possible to observe (in section) only a row of small hemispheric teeth.

G i l l r a k e r s: Two isolate fragments has been preserved; they are disc-shaped structures on that insert from six to eight spiny processes. Their shape is typical of the Colobodontidae.

S c a l e s c o v e r i n g: The anterior region of the trunk, partially articulated, shows at least thirty-three transversal rows of thick scales. On the slab there are also other disarticulated scales randomly arranged around the main remain. They show the articular process on the dorsal margin that inserts in the socket of the ventral one of the overtopping scale. Generally the scales have rhombic shape, as high as long; some smaller scales, broader than deep, probably belong to the posterior part of the body. The scales are covered for about one-third of their surface by the scales of the precedent row. The free surface has a marked ornamentation, consisting of a series of ganoine longitudinal irregular ridges, some of which end on the posterior margin of the scale forming the denticulation. The ridges can branch posteriorly or merge in the anterior region of the scale, forming a uniform ganoine cover. Some scales show shortest ridges, drop-shaped: they can be interpreted as the starting point of a new ridge.

It is possible to recognize, proceeding from the anterior region to the posterior one, three different areas of ornamentation. The first includes rhombic-shape scales, wherein the number of the ridges changes from 15 to 20; generally the ridges cover all the lenght of the exposed part of the scale. The ridges have comparable size and they are generally arranged parallel to the longitudinal axis. The second area includes the dorsal scales. Their surfaces show ridges larger than those present on the scales of the lateral part of the trunk. The number of ridges varies from 2 to 4 and they diverge from the longitudinal axis of the scale. There are also small ornamental elements drop-shaped. The scales of the ventral part of the trunk are comparable, for shape and ornamentation, to that of the dorsal region. The third type of scales is represented by those covering the posterior part of the body; they are broader than deep.

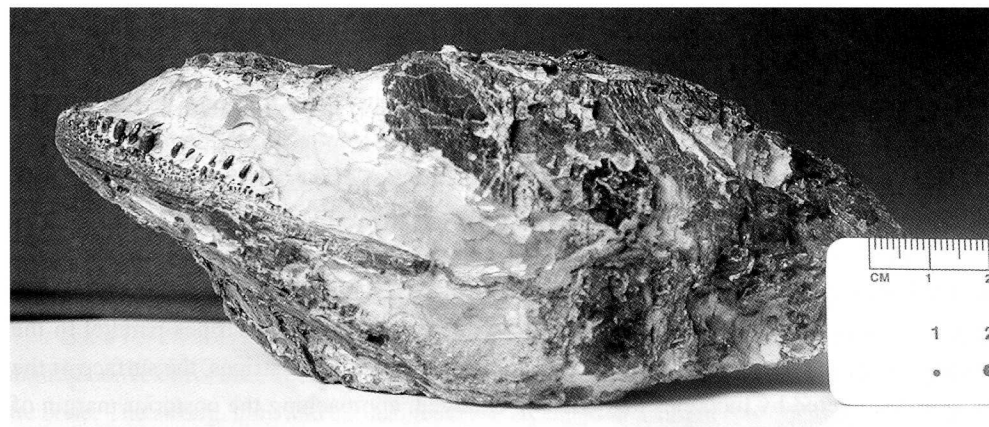


Fig. 4 - *Colobodus* sp.: specimen MFSN 24994.
- *Colobodus* sp.: *esemplare* MFSN 24994.

The ornamentation consists of large ridges similar to that described for the previous areas, but in this case their number changes from 1 to 4. Posteriorly, the ridges tend to reduce so that the surface of the scale covering the caudal pedicle is smooth.

Specimen MFSN 24994

The specimen consists of a portion of skull preserved in three dimensions. The bones are partially articulated, but are poor preserved: the margins of almost all the bones are in fact broken. Only few elements are recognizable: the parietals, the post-parietals, the dermopterotic, the infraorbital, the preoperculum, the maxilla, the mandible and the ectopterygoid.

P a r i e t a l s: In the region of the skull roof two fragments are visible, one rectangular and the other trapezoidal, in mutual contact on their median margin; the fragment of the right side of the skull anteriorly overlaps the sphenotic and posteriorly touches the post-parietal. The other element looks displaced respect to its original position, so that it is partially covered by the right parietal. The marked ornamentation is made of ridges of ganoine and it covers the bones in their entirety.

P o s t p a r i e t a l: These elements are both visible and they are quadrangular in shape. The element of the right side of the skull is anteriorly in contact with the parietals; the median margin reaches the left post-parietal while distally contacts the dermopterotic. The ornamentation consists of ridges of ganoine. The posterior margin shows an area lacking the ornamentation and that probably represents the overlapping zone of the extra-scapulars.

D e r m o p t e r o t i c: It has an irregular antero-posteriorly elongated shape; dorsally it contacts the post-parietal with a sigmoid suture. The bone is almost entirely covered by ridges and tubercles of ganoine, randomly arranged; only part of the dorsal region is smooth.

I n f r a o r b i t a l: A single element of the infraorbital's series is recognizable; it has a

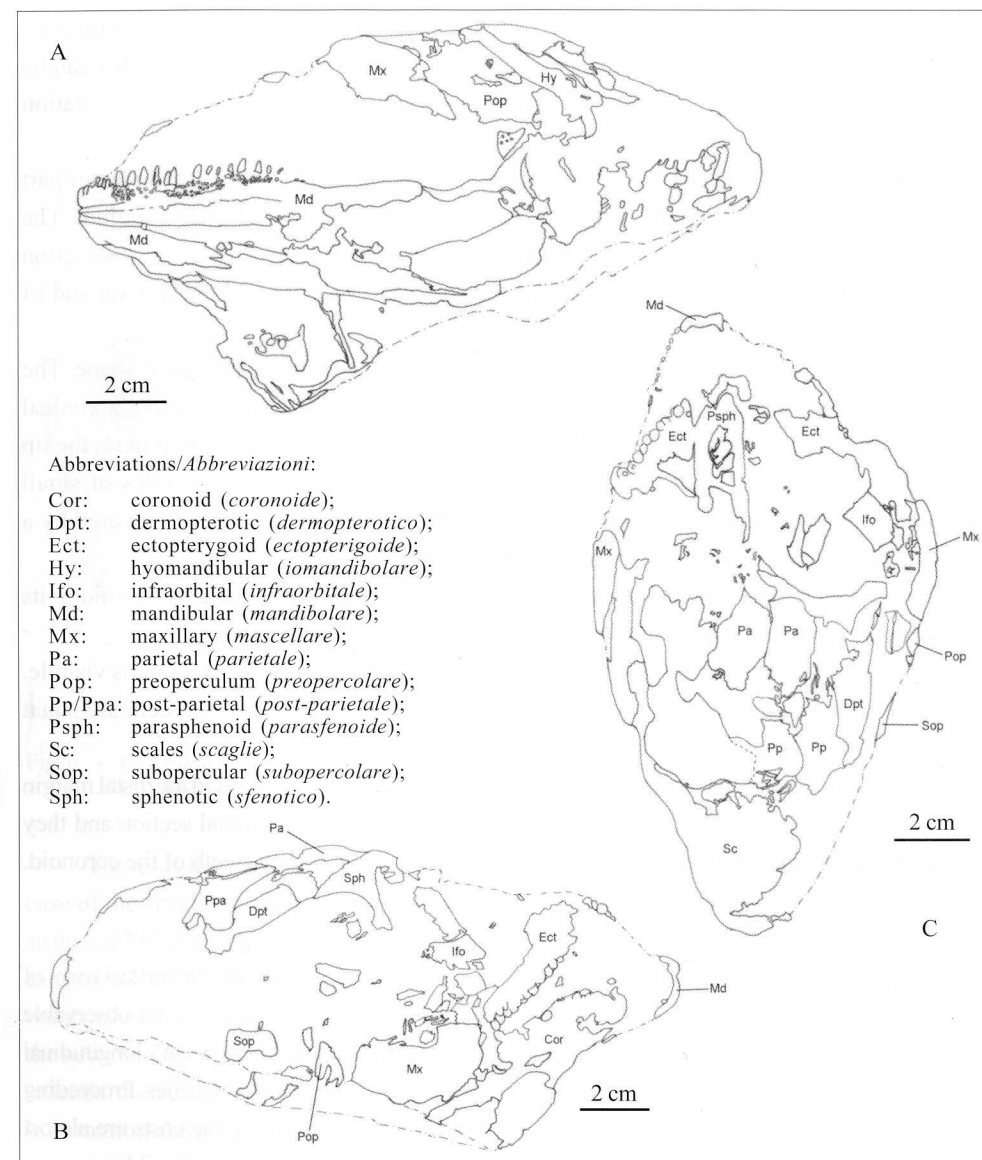


Fig. 5 - *Colobodus* sp.: drawings of specimen MFSN 24994 in A: left lateral; B: right lateral; C: dorsal view.
- *Colobodus* sp.: *disegni dell'esemplare* MFSN 24994 in vista A: laterale sinistra; B: laterale destra; C: dorsale.

trapezoidal shape and it is placed dorsally to the maxilla. Only the concave dorsal margin is undamaged. In section the groove corresponding to the passage of the infraorbital canal is visible. The bone is covered by a heavy ornamentation, formed by a series of tubercles and

ridges irregularly arranged. The ridges can merge with the contiguous or bifurcate.

P r e o p e r c u l u m: On both sides of the specimen are visible fragments that can be interpreted, because of their position, as remains of the preoperculum. The ornamentation consists of tubercles.

R i g h t M a x i l l a: It consists of a fragment with an irregular shape; in the upper part it is in contact with the infraorbital and posteriorly with fragments of the preoperculum. The ornamentation (not present on all the surface of the element because of the bad conservation of the fossil) consists mainly of sub-parallel ridges of ganoine in the ventral region and of tubercles in the postero-dorsal region of the bone.

L e f t M a n d i b l e: It is an elongated and very strong element, of triangular shape. The oral margin shows, till the half of his length, a single row of teeth; these have a conical appearance and are partly furrowed by longitudinal ridges, beginning from their base; the tip is covered by a thick layer of acrodine. The ornamentation consists of a series of small emispherical teeth, arranged on several rows near the oral margin; each one is covered by a series of grooves radiating from the tip, where it is possible to see a tubercle.

C o r o n o i d: The right coronoid is partially visible, with emispherical teeth along its dorsal margin, arranged at least on two rows.

R i g h t E c t o p t e r i g o i d: A fragment belonging to the right ectopterygoid is visible. On the oral margin it is possible to detect three rows of crushing teeth. The teeth are squat with the apex somewhat round and smooth.

L e f t E c t o p t e r i g o i d: It is poorly preserved and it is visible dorsally. On the distal margin there are at least three rows of teeth; some of these are visible in longitudinal section and they show the pulpar cavity. The teeth are comparable for shape and size to the teeth of the coronoid.

Specimen MPCM 13778

The specimen consist of a body's fragment about 20 cm long, covered by 28 vertical rows of scales, from rectangular to rhomboidal shape. The posterior margin of the scales is not observable because of the material conservation. The ornamentation consists of a series of ganoine's longitudinal costs that can merge or remain separates. Several costs can split in two or three branches. Proceeding from anterior to posterior part, it is possible to see that near the anterior part, the costs are almost equal and just rarely are divided by larger elements, while near the posterior part prevail large costs. In the last rows, the larger elements are not always placed longitudinally to the scale, but diverge from the axis; these costs have a tendency to curve and split, and are anteriorly more larges.

Isolated scales

Some remains relative to isolate scales (catalogued as MFSN 5921, MFSN 19955 and MFSN 21341) have been examined.

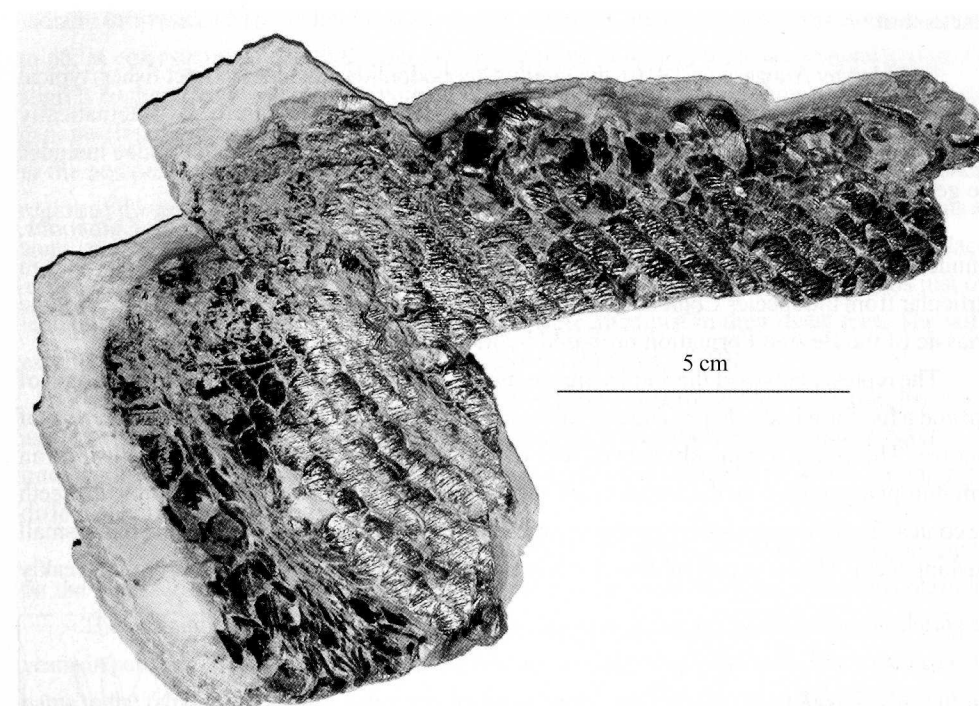


Fig. 6 - *Colobodus* sp.: specimen MPCM 13778.
- *Colobodus* sp.: *esemplare* MPCM 13778.

These scales are considerably larger compared to the other specimens. For example in the case of the specimen MFSN 21341, the lenght of the free surface of the scale is 15 mm, while scales of MFSN 19525 have a maximum length of 5 mm. The scale is larger also than those examined by MUTTER (2002). This fact allows to presume that the maximum size reachable by the colobodontids could be bigger to the 70 cm indicated by Mutter, at least in the Carnic. Owing to the new material, it is possible to suppose a length larger than 1 m. So the Friuli material not only extends the stratigraphic distribution of the colobodontids to the Carnian, but it gives new information about the maximum size reachable by the representatives of this family.

A cross section of scattered scales of specimen MFSN 5921 was made in order to compare the examined material with different sections of scales belonging to different genus of colobodontids (MUTTER, 2002). This kind of investigation is useful to distinguish colobodontids from the more primitive paleonisciformes, in case of fragmentary material; in fact, even if the two groups show scales with similar morphology and ornamentation, the scales have a distinctly different structure, visibile only in section. At the same time, the comparison has pointed out that this methodology is not useful in distinguishing the different genera within the family Colobodontidae.

Discussion

Founded by ANDERSSON (1916), the family Colobodontidae includes extinct fishes, typical of the Middle Triassic, belonging to the order Perleidiformes. The family is systematically placed in the group of advanced basal actinopterygians. The family Colobodontidae includes the genus *Colobodus* and *Crenilepis* (MUTTER, 2002).

The characters of the family are inferred mainly from the best known genus, *Colobodus*, founded by AGASSIZ (1844) on several dental plates from the French Muschelkalk, and in particular from the species *Colobodus bassanii* (DE ALESSANDRI, 1910), known from the Middle Triassic of the Besano Formation proposed by MUTTER (2002) as type species.

The representatives of this family are medium-large sized fishes with a maximum length of 1 m and a fusiform body shape. The dermal bones of the skull present a strong ornamentation of ganoine. The snout is typically convex and obtuse. The dentition is eterodont, typical of an hemidurophagous diet: on the anterior part of the oral margin of maxilla and mandible the teeth are conical, becoming posteriorly stronger and blunt-ended. The palatal bones bring many small crushing teeth. The most part of these teeth has an acrodine's cap on the tip of a crown weakly

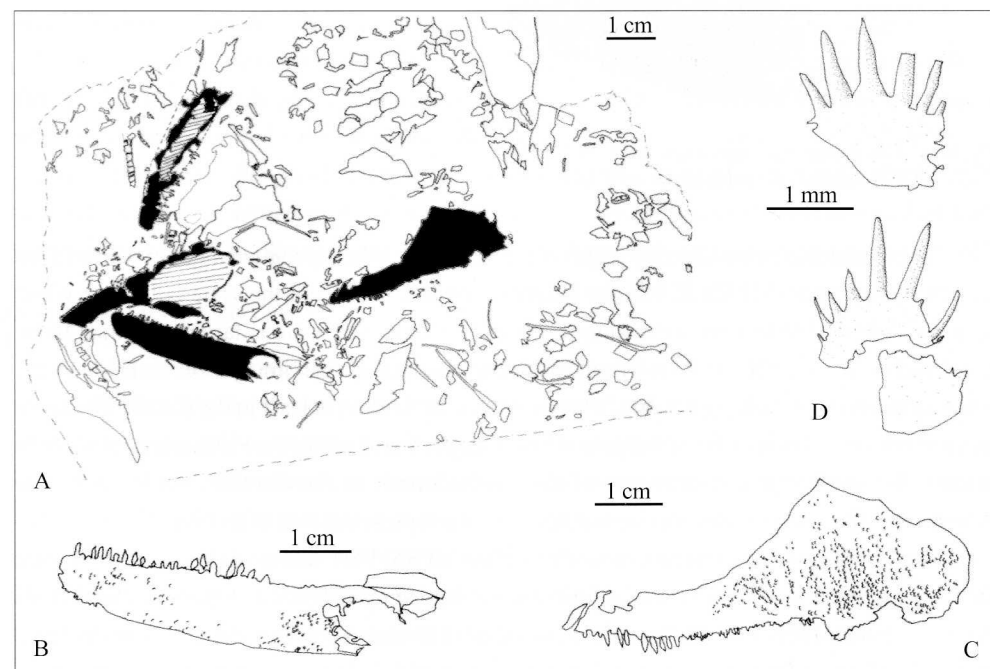


Fig. 7 - *Colobodus* sp.: drawings of specimen MFSN 19525; A: the slab (in black are evidenced the elements of the upper and lower jaws); B-C: left mandible and maxilla; D: gill rakers.
- *Colobodus* sp.: disegni dell'esemplare MFSN 19525; A: la lastra (in nero sono evidenziati entrambi i rami di mascelle e mandibole); B-C: mandibola e mascella sinistre; D: branchiospine.

radially furrowed. The notochord is sustained by a series of arcualias variable in number from 55 to 65, in correspondence with the number of the rows of scales; these are generally rhombic, slightly higher than broad on the antero-lateral region of the trunk, and show ornamentations of ganoine (longitudinal ridges) on their free surface. The kind of ornamentation changes in relation to the position of the scale on the body, with numerous and thin ridges on the middle-lateral region of the trunk, becoming fewer but thicker posteriorly. Pectoral fins are wide; pelvic fins are small and inserted about at the half of the body length. The anal and the dorsal fins are placed at the level of the thirtieth transversal row of scales; in these fins each radial sustains just one lepidotrichium. The lepidotrichia of the fins are segmented just in their distal part. The tail is exteriorly almost symmetrical and shows epaxial rays (MUTTER, 2002).

Very important for the systematics of colobodontids is the scales covering; the scales are strong, thick and extremely ornamentated, mainly with ganoine ridges and tubercles. An interesting detail is that the ornamentation of the scales is different in scales belonging to different regions of the body.

A typical feature of the family is represented by the gill rakers, thorny processes placed on the inner side of the gill arches, interpreted as structures to retain the nutritious particles.

The definition of the family Colobodontidae has been resumed again and again during the years; in particular there is a great taxonomic confusion concerning quite the genus which gave the name to the family, *Colobodus*: many species have been established in the past on the base of few fragments (teeth or scales). On the contrary, others, previously attributed to *Colobodus*, have been afterward assigned to different taxa, sometimes even to different orders, because of new findings and studies: for example *Colobodus ornatus* and *Colobodus altolepis*, represent actually a semionotiform (*Paralepidotus ornatus*) (TINTORI, 1996) and a perleidiform (*Perleidis altolepis*) (DEECKE, 1889).

Conclusions

It has been possible to attribute the examined material, even if fragmentary, to the family Colobodontidae. The general pattern of the skull and of dentition (particularly the maxilla of specimen MFSN 19525) shows a remarkable morphological affinity with that of *Colobodus* and *Crenilepis*, coming from the Besano Formation. Also the different patterns of ornamentation, found on specimens MFSN 19525 and MFSN 24994, seem to be compatibles with the previous findings of colobodontids. The gill rakers found on specimen MFSN 19525 have been a very useful element for the determination: these elements have the same morphology seen in literature, with a sub circular base surrounded by a series of spiny processes. Their pattern is constant in the group.

Concerning scale covering, well visible mainly on specimen MFSN 19525, it has been possible to distinguish three different regions of the body with different kind of ornamentation:

the first belongs to the antero-lateral part of the trunk, with numerous ridges arranged in parallel and similar in size; the second, corresponding to the dorsal part of the body, is characterized by fewer and larger elements; the third covers the caudal region of the body and the ornamentation is characterized by a very scarce number of elements. Similar ornamental patterns are typical of the colobodontids.

The family Colobodontidae has been reported in Europe and in Middle East in anisian and ladinian levels, with descriptions made on more or less complete specimens. Isolated teeth and scales findings could extend the distribution from the Lower Triassic to Carnian. Other material points to the Rhetian and enlarges the geographic distribution to Thailand (MARTIN, 1984), Somalia (D'ERASMO, 1932) and United States (LUCAS & HUNT, 1989 and RIEPPEL et al., 1996), but these findings are of very uncertain attribution.

Other fragmentary findings, attributed to the family Colobodontidae, have been reported in different part of the world. In particular, many remains of teeth and scales (teeth above all) have been found in the United States, in well known formations, especially in the south-western area, in levels referable to the Carnian.

In any case, the attribution of isolated crushing teeth (typical of a lot of durophagous fishes) to the family Colobodontidae is somewhat daring. The study of the Friuli specimens and the comparison with others works on colobodontids, stressed how only isolated teeth do

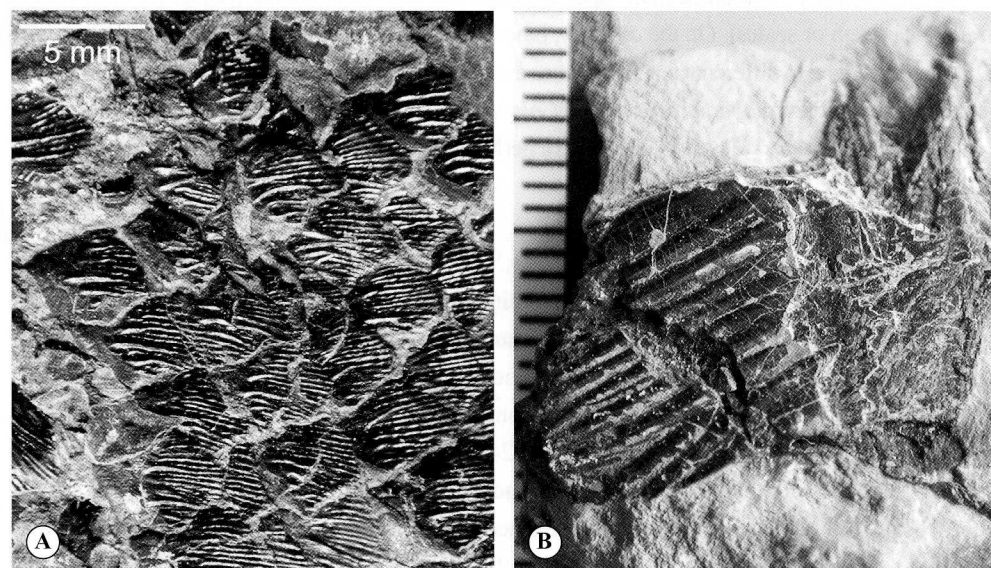


Fig. 8 - *Colobodus* sp.: A: detail of squamation of specimen MFSN 19525; B: specimen MFSN 21341: isolated scale.
- *Colobodus* sp.: A: dettaglio della copertura di scaglie dell'esemplare MFSN 19525; B: esemplare MFSN 21341: scaglia isolata.

not allow to identify unequivocally the family at issue (not even if analyzed in thin section): the only way to be really sure of the belonging of a specimen to this family is to possess the skull bones, that in the north-american specimens do not seem to be present.

So the American findings in the Carnian are to be considered extremely uncertain.

In the light of these analysis, while it has been possible to attribute the examined material to the family Colobodontidae (possibly to the genus *Colobodus*), the scarcity of the diagnostic elements made difficult to give a specific determination. Anyway, the Friuli specimens are at moment the only certain reports of colobodontids after the Ladinian. Moreover, as the last certain report of *Colobodus* comes from the upper part of the Besano Formation (Lower Ladinian), and owing to the time span between this unit and Predil Limestone-Rio del Lago Formation, it is reasonable to presume that the specimens described in this work can constitute a new species, even considering the low variability of the group. Anyway, the institution of a new species is subdue to the hope of new Carnian findings, more complete of those examined in this work.

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