

Toarcian fishes from the lombardian basin

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ABSTRACT — Toarcian fishes (*Leptolepis coryphaenoides*, *Pachycormus* sp. ind., *Pholidophorus* sp. ind.), are described from northern Italy for the first time. Poor preservation prevents complete anatomical description, but is sufficient for an accurate identification of the specimens. *Pachycormus* is recorded in the typical Tethyan area for the first time.

RIASSUNTO — Si descrivono numerosi esemplari di Pesci di età toarciana rinvenuti recentemente sul Monte Albenza (Bergamo). La conservazione non è ottimale, ma è stato possibile riconoscere *Leptolepis coryphaenoides*, *Pachycormus* sp. ind., *Pholidophorus* sp. ind. L'importanza del ritrovamento va al di là della descrizione anatomica forzosamente incompleta e dell'esatto inquadramento tassonomico di questi Pesci, argomenti peraltro ampiamente discussi in recenti lavori. In pratica si tratta del primo importante ritrovamento italiano di Pesci toarciani, che se da un lato conferma il cosmopolitismo di *Leptolepis* e di *Pholidophorus*, dall'altro allarga notevolmente la distribuzione areale di *Pachycormus*, finora ristretto all'Europa centrale.

KEY WORDS — Fishes, Toarcian, northern Italy.

FOREWORD

The opening of a new road from Sogno to Colle di Sogno, in the Albenza mountains (Bergamo) has exposed new outcrops of the Sogno Formation (Gaetani & Poliani, in press). South and North of q. 975 (near M. Brughetto) the road cuts twice through the base of the unit, which is usually covered by vegetation. On the southern outcrop, particularly at q. 900 m.a.s.l., abundant fishes have been found in a brown claystone. Amateurs first discovered fish remains and this was followed by more intensive sampling which yielded more than one hundred specimens.

PREVIOUS WORK

This is the first important discovery of Jurassic fishes in Italy. During this time marine sediments were deposited mostly slowly and under oxygenic bottom conditions (Jenkins, 1974). As a consequence organic matter is rarely present. However, rich ammonite-bearing beds are widely distributed (Rosso Ammonitico facies).

In other parts of western Tethys, Jurassic fishes are also rare being limited so far to Tunisia (Gaudant et Al., 1972), Greece (Kottek, 1964) and central Italy (Dufour & Wenz, 1972). However in the bo-

real province fishes are more common and have been found in France, Britain and Germany.

Data on these region were recently summarized by S. Wenz (1967) and O. Nybelin (1974).

STRATIGRAPHY

The first bed lies in the lower part of the Sogno Formation, about 14 m above the base. Ammonites belonging to the *Tenuicostatum* Zone were collected below and above the first level, allowing a precise assignment to the lowermost Toarcian.

A detailed section along the southern outcrop was measured from the base of the unit. The sequence from bottom to top is as follows:

Domaro Limestone - Grey calcilutite in beds of 20-30 cm, well subdivided by marly joints. Strongly bioturbated. In the uppermost bed of the northern outcrop the following ammonite species of Toarcian age were collected:

Dactylioceras simplex Fucini
Partschiceras anonimum (Haas)

Sogno Formation:

1. - Marls and claystones rythmically alternating in 20-30 cm beds. Colour from grey to green-brown. 1.30m

2. - As above, in more irregular beds. Bioturbated red marls, abundant white mica.
1.45m
3. - Reddish claystone with lighter spots.
0.35m
4. - Grey marls and marly limestones in ill-defined alternating beds of 30 cm. Horizontal *Condriithes*-like bioturbations.
3.60m
5. - Reddish calcareous marls, intensely bioturbated, rich in white mica and biotite.
0.75m
6. - As above, but gradually grading to rich clay and a darker brown.
1.95m
7. - Brownish and greyish claystones, fissile, poorly exposed, twisted. Black films on the laminae surfaces.
about 3.70m
8. - Grey marls, well-bedded and somewhat more compact, with plant remains and scattered small isolated bones.
0.50m
This part measures at least in total 13.60m
9. - Fish Bed. Clay and clayey marls in thin laminae, brownish with more carbonatic nuclei. Planar alignments of small pyritic crystals. Black to brown surface films. The central part of the bed, from 0.30 to 1.00 m, found to be best for fishes. Within this level the following species have been collected:
- Fishes: *Leptolepis coryphaenoides* (Bronn)
Pachycormus sp. ind.
Pholidophorus sp. ind.
- Crustaceans: *Proeryon* sp. ind.
- Cephalopods: *Cornaptychus* sp. ind.
Hildaite sp. ind.
- Pelecypoda: *Bositra buchi* (Roem.)
- Plants: *Ginkgo digitata* Brongn.
Pagiophyllum kurri Schimp.

In addition a few unidentifiable ammonites, belemnite rostra and fragments of plants and crustaceans occur within this level.

1.75m

10. - Calcareous marls alternating with fissile marls. Greyish to pale reddish. Diffuse bioturbations. Rare ammonites:
Dactylioceras polymorphum Fucini
Hildaite sp. ind.

1.20m

11. - Marly limestones, grey, in 20 cm beds, regularly alternating with marls and claystones, monotonously continuing upwards for tens of meters.

PALAEOECOLOGY

The general lack of fossil fish in the Toarcian of the Lombardian Basin is attributed to the particular type of sedimentation.

Generally we have a very slow rate of sedimentation and also oxygenic condition. On the Albenza Mountains the sedimentation rate was about 7÷11 m for MY (Gaetani & Poliani, in press) showing a partly reducing condition at the centre of the trough.

All the fishes were twisted and broken. We also have a few levels resembling « bone beds », with many isolated bones. Therefore we infer that the water was calm, with occasional gentle currents (Bone Beds).

The poor preservation of almost all the specimens is due to the great compaction suffered by these sediments (Claystones) and subsequent orogenesis. Only very resistant bones could withstand such events (especially *Pachycormus* bones).

Euxinic bottom conditions are also indicated by the presence of plant remains and by the complete absence of benthonic fauna and bioturbation.

The organic carbon was analyzed in a single rock specimen: the organic matter constitutes 1.29% of the whole rock, and indicates a mixed origin, with marine and continental sources (Tissot et Al., 1974).

The depth of the basin is unknown, but it could have been fairly deep, assuming that the Lombardian Basin was a marginal basin with an Atlantic-type of continental margin.

GENERAL REMARKS ON THE FISHES

Over a hundred specimens were collected but they belong to few species. Over 95% of them are assigned to *Leptolepis coryphaenoides* (Bronn), while the other species are represented by very few specimens.

Although the *Leptolepis* specimens are often poorly preserved, their abundance allows accurate identification. The diagnostic features used were cheek-bones, opercular apparatus, lower jaw and the caudal skeleton. Detached bones are generally better preserved and better for study than the complete specimens. In the latter it was often difficult to recognize individual bones owing to twisting and crushing. Regarding other bones little or nothing could be made out. The circumorbital bones were

mostly undetectable. Also it has been impossible to observe details of the exoskeletal bones of the skull roof, because only one dorso-ventrally crushed specimen has been found.

The parasphenoid is clearly visible, at least in its anterior part, but detailed observations were not possible.

The other species are better preserved than *Leptolepis*, since the bones are thicker, and better able to withstand the disturbances during fossilization.

PALAEOBIOGEOGRAPHY

Leptolepis coryphaenoides is very common in Central Europe. Famous localities are Ilminster and Whitby in England, Boll and Neudingen in Germany, Le Caine, Saint-Colombe and Pic-Saint-Loup in France.

In the Mediterranean region some specimens have been found in Tunisia and Greece, and one specimen in central Italy. The new find of numerous specimens in northern Italy confirms the great areal extent of this species.

The genus *Pholidophorus* is very common in widespread localities in Europe.

Regarding *Pachycormus* this is the first record outside its typical area (the same localities as for *L. coryphaenoides* in England, Germany and France), showing its presence also in the more typical Tethyan area. (Valz and Sain-Loup, in southern-France are on the Tethys margin).

PALAEONTOLOGICAL DESCRIPTIONS

About ten fossil species (fishes, crustaceans, molluscs and plants), have been collected. Only the fishes are described here, since they represent the most interesting feature of the locality.

The following species have been identified:

Leptolepis coryphaenoides (Bronn)

Pachycormus sp. ind.

Pholidophorus sp. ind.

In addition, one specimen differing from all the above has been collected, but it is difficult to study in detail because of its very poor preservation.

LEPTOLEPIS CORYPHAENOIDES (Bronn, 1830)
(Fig. 1-4)

Synonymy. For synonymy refer to Wenz (1967) and Nybelin (1974).

Nybelin (1962, 1974) established a new species, *L. normandica*, in the *Leptolepis coryphaenoides* Auct. group.

In the Sogno Formation specimens all the bones relevant to this taxonomic problem cannot be seen. However the preoperculum is clearly that of *L. coryphaenoides* sensu Nybelin, 1962. The operculum has a very varied shape, with gradations between triangular and trapezoid shape: the first is typical for *L. normandica* Nybelin, the second for *L. coryphaenoides*.

Thus I incline towards identification as *L. coryphaenoides* in accordance with the interpretation of Wenz (1967).



Fig. 1 - *Leptolepis coryphaenoides*, Specimen TS2.

Material. 91 specimen of which 6 are complete have been examined. Many other specimens have been collected by amateurs under my guidance.

ANATOMICAL DESCRIPTION

The valued standard length of the complete specimens ranges between 30 mm and 55 mm, and they are always rather twisted. The smaller specimens are more poorly preserved than the larger ones. Therefore the material seems to come from individuals at different stages of growth, with prevalence of adult individuals.

Exoskeletal skull roof (fig. 2a).

This has been observed only in one specimen, and here only in outline. The supraorbital sensory canal (soc) is visible extending backwards from the frontal (Fr) into the parietal (Pa).

The premaxilla (PMx, fig. 2b, e, f), has a boomerang-like shape and it articulated with the anterior process of the maxilla. The connection must have been tenuous because often the premaxilla is not preserved. On specimen TS68 the ventral margin of the premaxilla has an ornamentation perpendicular to the margin itself, as the anterior part of the maxilla; the teeth are not preserved, but their number must be about ten.

Dermal bones of the cheek and the opercular apparatus.

The maxilla (Mx, fig. 2b, d, e, f), consists of a small anterior part, medially directed, and a much longer part, axially directed. The concave upper margin of the bone bears the two supramaxilla. The deepest part of the maxilla is close to the anterior process. On the lateral surface there is a rounded longitudinal ridge, which diminishes backwards.

Rough longitudinal ornamentation can be detected on the surface.

The anterior supramaxilla (SMx1, fig. 2b, d, e, f), resembles an arrow-head but varies in shape somewhat from one specimen to another. In some cases the anterior supramaxilla is smaller than the posterior one; in others the two bones are similar in size.

The posterior supramaxilla (SMx2, fig. 2b, d, f), is almost oval in shape and possesses a long antero-dorsal spine over the anterior supramaxilla. It takes a slender ornamentation.

The suture between the two supramaxilla is sinuous and varies slightly from one individual to another.

The preoperculum (POp, fig. 2b, 4a, f) is composed of two limbs, a dorsal vertical one and a ventral horizontal one, which lie almost at right angles. The posterior corner is rather rounded and the ante-

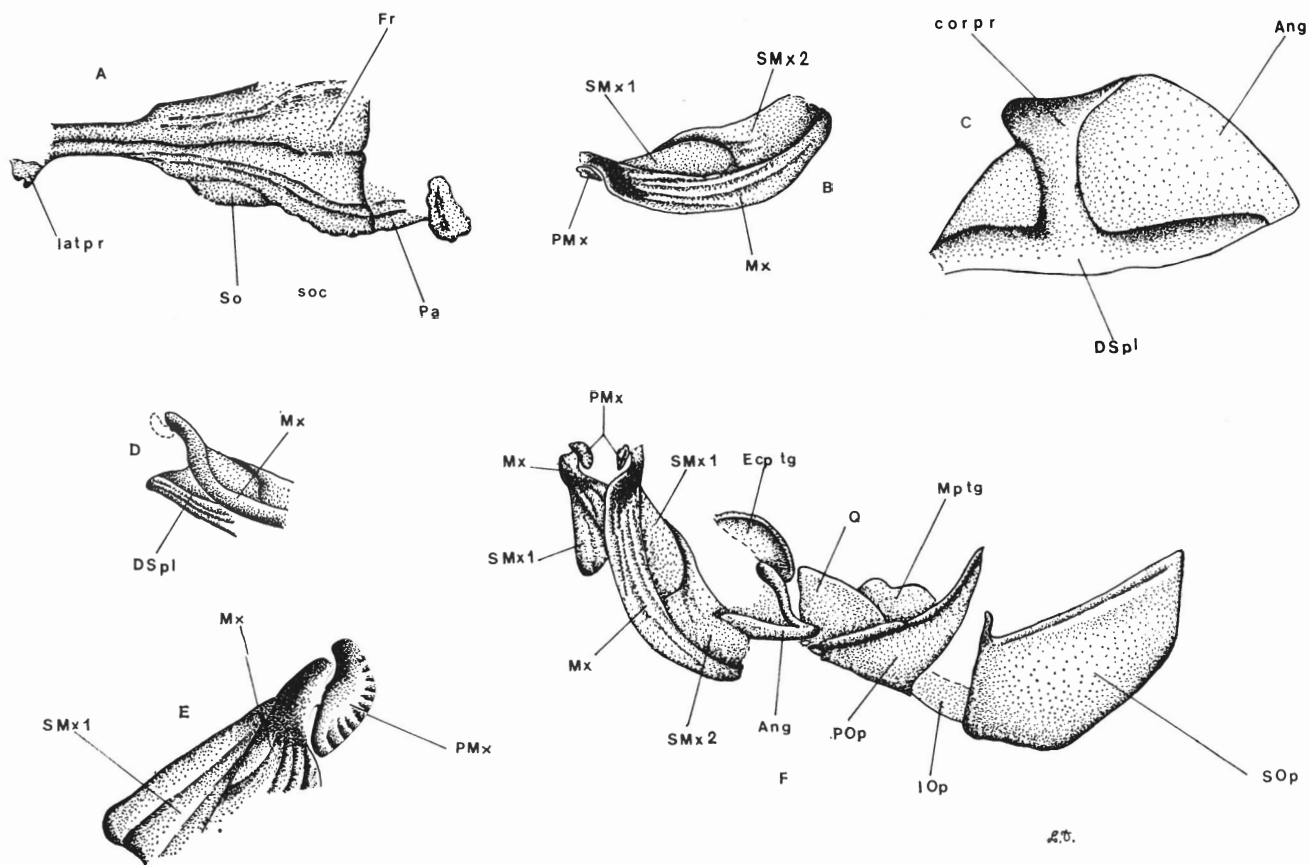


Fig. 2 - *Leptolepis coryphaenoides*.

A. Specimen TS 3, x 7, dorsal view; B-F. Specimen TS68, x 3.5; C. Specimen TS33, x 7; D. Specimen TS60, x 3.5; E. Specimen TS68, x 7.

Ang, angular; DSpl, dentalsplenial; Ecp tg, ectopterygoid; Fr, frontal; IOp, interoperculum; Mx, maxillary; Mptg, metapterygoid; Op, operculum; Pa, parietal; PMx, premaxillary; POp, preoperculum; Q, quadrate; SMx1-SMx2, anterior and posterior supramaxillaries; So, supraorbital; SOp, suboperculum; latpr, lateral process; corpr, coronoid process; soc, supraorbital sensory canal.

rior concavity is occupied by a thin lamella (« low broadly rounded process » of Nybelin, 1974). However the general shape of this bone is not very important. Much more interesting is the preopercular sensory canal (poc) which is situated along the anterior margin of this bone. The number and the shape of the tubules in lower and the posterior part of the bone seems to have a great taxonomic importance (Nybelin, 1974). The tubules could not be counted with any accuracy in the specimens described here, but without doubt they exceed 10 in number, on both limbs of the bone. Some tubules are branched. This type of preopercular sensory canal is characteristic of *L. coryphaenoides*.

Many detached and well preserved opercula (Op, fig. 4b, e, g), were examined: their outline varies between triangular and trapezoid, with several intermediate shape. The dorsal corner is rounded, while the antero-ventral one is rather sharp. The bone is rather convex and provided with fine growth striations dorsally. Along the anterior margin there is a ridge which decreases gradually upwards.

The suboperculum (SOp, fig. 2f, 4d, e, g) is a little smaller than the operculum. The general shape is semicircular; the dorsal margin is straight, but has a well marked antero-dorsal process. This process is situated just in front of the antero-ventral corner of the operculum.

The interoperculum (IOp, fig. 2b, 4c, f, g), is a trapezoid bone, often only partly visible because it is covered by the ventral limb of the preoperculum. A few detached specimens show the whole outline of this bone. Its surface generally has some strong growth lines.

Lower jaw.

The lower jaw is composed of two bones: the dentalosplenic and the angular.

The dentalosplenic (DSpl, 2c, d) is very complicated and characteristic, with a very high coronoid process (corpr) at the top of a thickened middle part, as in all other leptolepids. Anterior to this there is a thin triangular lamella, but (owing to poor preservation?) the notch described by Nybelin (1974) could not be seen. The horizontal part is thick rounded, and when broken shows the tube for the mandibular sensory canal.

The angular (Ang, fig. 2c, d) is much simpler: roughly triangular, rather thin, without ornamentation. The anterior outline is not well defined, while the posterior one carries the articulation for the quadrate.

Palate bones.

The quadrate (Q, fig. 2b, 4h) is subtriangular, with a well developed posterior spine, bordering the dorsal margin of the ventral limb of the preoperculum. In the antero-ventral corner there is a notch behind the articulation with the angular, not completely visible in Sogno specimens.

The metapterygoid (Mptg, fig. 2f, 4h) is visible only in specimen TS68, where it is rather well preserved. The bone is made up of two parts: a posterior one and a smaller anterior one. Between the two parts there is a well marked notch to allow the passage of the trigeminal nerve. The bone is probably incomplete.



Fig. 3 - *Leptolepis coryphaenoides*, Specimen TS68; referred to Fig. 2E for the explanation of this specimen.

The ectopterygoid (Ecptg, fig. 2f, 4h), also exposed only in specimen TS68, is a triangular bone, lying in front of the quadrate. There is a low ridge along the upper and posterior margins, while the remaining part of the bone is lamellar.

Hyoid arch.

Only one specimen showing the two ceratohyals (anterior and posterior) was available, and no details could be observed. The general shape agrees with previous descriptions (Rayner, 1937).

The branchiostegal rays are likely to be more numerous than ten. However, no specimen shows all the rays and their number has to be inferred.

Exoskeletal shoulder-girdle.

The cleithrum is the only bone of this region that was observable in the Sogno specimens. The cleithrum is a strong bone and therefore well-preserved even when broken or warped. It has a sinuous shape

with a complex relief. It bears an S-shaped ridge, broader and weaker ventrally than dorsally. In some specimens the ridge bifurcates in the middle region, and then isolates a small, vertical elongate depression. The whole surface of the cleithrum is covered with fine curved striations like those described by previous authors.

Axial skeleton (fig. 4m).

The exact number of vertebrae could not be stated precisely, but it must exceed the 40 that are usually visible behind the cleithrum. Since the vertebral centre are always very warped, the typical constricted shape is indistinctly visible. The last 5 pre-ural vertebrae have larger haemal and neural spines (fig. 4n, NrS, HaS) than the preceding ones.

The fins position agrees with previous works (Wenz, 1967).

Paired fins.

The endoskeletal shoulder-girdle is not visible in any of the specimens. The number of pectoral lepidotrichia seems to be greater than that given by Nybelin (1974). About 20 lepidotrichia were visible, but they were not clear enough to describe in any detail.

More interesting are the pelvic fins (fig. 4i l), with the pelvic girdle visible in at least 3 specimens (TS 4-19-70). The pelvic girdle consist of two elongate plates with a very complex relief, as described by Wenz (1967) and Rayner (1937).

The lepidotrichia are 12 to 13 in number and they articulate directly with the pelvic plates (PP).

Unpaired fins.

The dorsal fin (DF, fig. 4m) seems to have fewer elements than those indicated by Nybelin (1974). The number of radials and lepidotrichia seems to be about equal. The first 2-3 radials are united in a large, thin plate that support the first, longest, lepidotrichium and the two preceding fulcra. Behind the first, the lepidotrichia decrease gradually in length because of shortening of the unbranched part.

The anal fin (AF, fig. 4m) begins uppersite the end of the dorsal fin and has about 10 lepidotrichia and radials.

The caudal fin is forked, with equal lobes.

The dorsal margin has some basal fulcra and few fringing fulcra, whereas the ventral one has only basal fulcra.

The caudal skeleton (fig. 4n) is typically of *Leptolepis*. A well preserved specimen without lepidotrichia (TS89) permits a rather detailed description.

Nine hypurals (Hy1-9) are clearly visible: the first two are much larger than the others, and are carried by the first ural centrum (U1), which is well ossified, but crushed. Hypurals 6-9 resemble small rods.

Three uroneurals (Un) are visible. The first one reaches the first preural centrum. The others are less clearly visible and posteriorly seem to overlap the last hypural.

The number of epurals is not certain, but it seems to be about 3.

PACHYCORMUS sp. ind.

Only 3 fragmentary specimens attributable to the genus *Pachycormus* have been found, and one of these is dubious. Observable features are only sufficient to reach a generic determination.

Specimen TS115R shows some well preserved, skull bones while specimen TS106R is only a fragment of body with a good dorsal fin; the third specimen, TS82R, shows some fragments of skull bones.

ANATOMICAL DESCRIPTION

Dermal bones of cheek and opercular apparatus.

The inner and outer faces of the maxilla (Mx, fig. 5b) are visible and show many features.

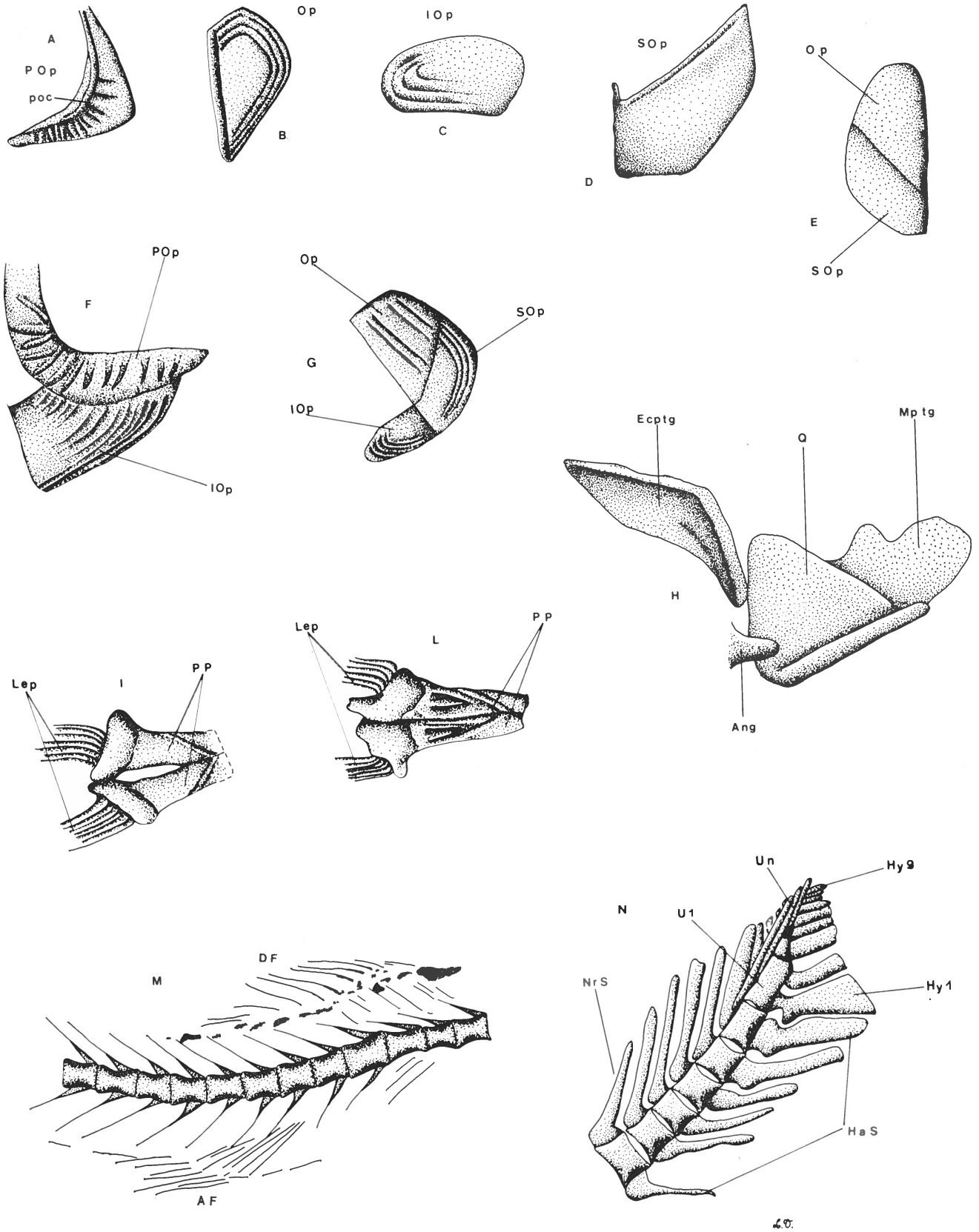
In shape the maxilla is an elongate triangle, with a notch for the missing supramaxilla at the postero-dorsal corner.

The external surface shows two regions with different ornamentation: the oral part with small tubercles and the dorsal one with longitudinal fur-

Fig. 4 - *Leptolepis coryphaenoides*.

A. Specimen TS77, x 3.5; B. Specimen TS93, x 3.5; C. Specimen TS55, x 7; D. Specimen TS68, x 3.5; E. Specimen TS57, x 3.5; F. Specimen TS46, x 7; G. Specimen TS73, x 3.5; H. Specimen TS68, x 7; I. Specimen TS70, x 7; L. Specimen TS19, x 5; M. Specimen TS90, x 7; N. Specimen TS89, x 7.

AF, anal fin; Ang, angular; DF, dorsal fin; Ecptg, ectopterygoid; HaS, haemal spine; Hy1-Hy9, hypurals; IOp, interoperculum; Lep, lepidotrichia; Mptg, metapterygoid; NrS, neural spine; Op, operculum; POp, preoperculum; PP, pelvic plates; Q, quadrate; SOp, suboperculum; U, ural centrum; Un, uroneural; poc, preopercular sensory canal.



rows. The internal surface has a longitudinal ridge which decreases slowly in height backwards, as described by Wenz (1967, pg. 118). A few teeth are also visible.

The operculum (Op, fig. 5c) is very large, but its exact shape is not clear. It resembles like a right-angled triangle, with the right angle placed ventrally.

The suboperculum (SOp, fig. 5c) is a little smaller than the operculum and is rectangular, with the posterior margin and the postero-ventral corner rounded. At the antero-dorsal corner there is a well developed process. The internal surface of the bone has a weak, irregular ornamentation, like all the other bones.

Lower jaw.

The dentalosplenic (DSp, fig. 5a) is the only bone clearly visible in the lower jaw. It is as long as the maxilla, but much deeper, especially in the posterior part. The oral margin is thickened and carries many teeth, of which only the bases are visible.

On the internal side of the oral margin a coronoid (Cor) appears to have been attached. In this specimen it lies on the internal surface of the dentalosplenic, right along its length.

The angular and the surangular are covered by the fragments of an anterior ceratohyal (Ch2).

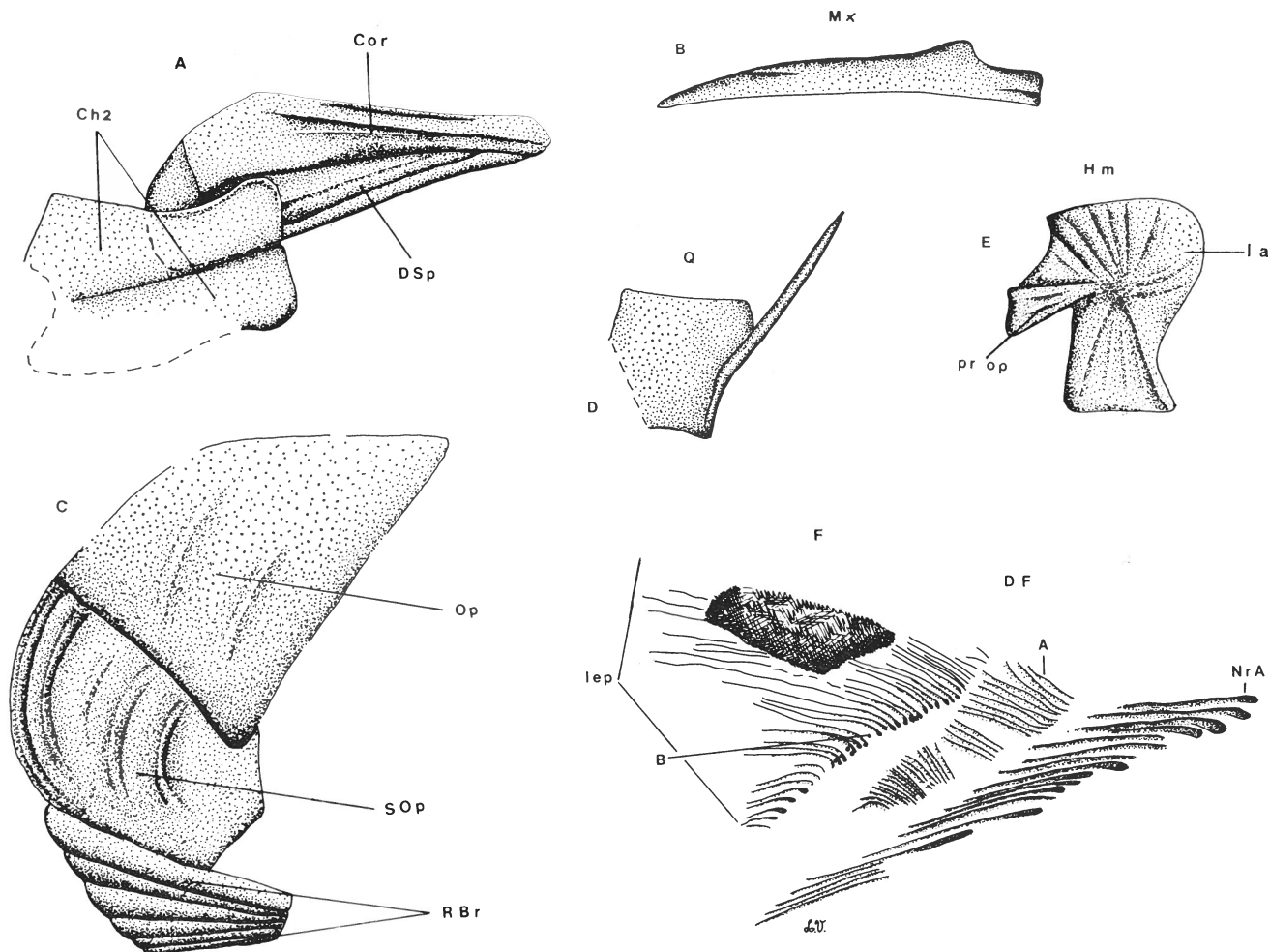


Fig. 5 - *Pachycormus* sp. ind.

A-E. Specimen TS115R, x 1; F. Specimen TS106R, x 2.

A, axonostia; B, basals; Ch2, anterior ceratohyal; Cor, coronoid; DSp, dentalosplenic; DF, dorsal fin; Hm, hyomandibular; Mx, maxillary; NrA, neural arches; Op, operculum; Q, quadrate; RBr, radii branchiostegi; SOp, suboperculum; Ia, lamella; lep, lepidotrichia; oppr, opercular process.

Palate bones.

The quadrate (Q, fig. 5d) is a large bone, incompletely preserved, with a long thick spine, the quadrato-jugal process, extending beyond the dorsal margin of the body of the quadrate for about half its length.

Hyoid arch.

The hyomandibular (fig. 5e) is a very characteristic bone, rather complex and with a very strong opercular process. The bone agrees closely with Wenz's (1967).

Axial skeleton.

The vertebral centra are not ossified and therefore only neural and haemal arches remain with their spines. Their preservation is poor and it is not possible to give a detailed description.

Paired fins.

The pectoral fins have large typical lepidotrichia with a peculiar mode of branching. Each lepidotrichium is divided into two unequal parts, a larger posterior one and a smaller anterior one. Only the posterior part continues branching further on. There are about 25 pectoral lepidotrichia of which the first two are very small and the third is the longest.

Unpaired fins (DF, fig. 5f).

The dorsal fin and its endoskeleton are well preserved, in one specimen. The agreement with Wenz's description (Wenz, 1967) supports the generic attribution. In the Sogno specimen there are 32 axonosts (A); the anterior ones are long and similar, whereas the posterior ones decrease in size and the last few are comma-shaped.

At the bases of the median lepidotrichia are certain little elements known as the basals (B).

There are about 35 lepidotrichia. The first two are very small, the following ones increase rapidly in size up to about the tenth, and thereafter the length decreases gradually to about 1/5 of the longest one. The lepidotrichia beyond this point are similar in size.

PHOLIDOPHORUS sp. ind.

Three fragmentary specimens of fishes of medium size are ascribed to the genus *Pholidophorus* Auct., but no more exact identification is possible, especially since no recent revision of the Pholidophoridae of the upper Lias is available. However a concise description of the bones is given below.

The maxilla becomes higher posteriorly. The oral margin is slightly convex and it is provided with long slender teeth. The posterior end of the bone has a well developed notch.

Above the maxilla there are two supramaxilla: the posterior one has a well developed anterior spine, whereas the anterior one is not clearly identifiable.

The dentalosplenial is elongate, and deeper posteriorly.

The preoperculum is an important bone in the taxonomy of the Pholidophoridae but unfortunately in these specimens it is not clearly visible.

Only the upper part of a hyomandibular is observable, with a strong opercular process.

The operculum is large and trapezoid in shape.

The suboperculum is smaller than the operculum.

Some branchiostegal rays and small gular plate are also visible.

One specimen also has some small scales with peg-and-socket articulations.

CONCLUSIONS

This find is interesting because it extends the geographical range of these Toarcian fishes.

The areal extent of *Pachycormus*, which had previously only been found in central Europe, is much extended.

Leptolepis and *Pholidophorus* are already known to have had a wide range, and their discovery in northern Italy is not a surprise.

The find is also interesting because of the general lack of vertebrate remains in the Toarcian rocks of the Lombardian Basin. Our find in a small area of the Albenza mountains, also provides further palaeontological support to the palaeogeographical model put forward by Gaetani (1975).

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