

THE GENUS *FURO* (PISCES, HALECOMORPHI) FROM THE UPPER JURASSIC PLATTENKALKE OF GERMANY

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Abstract : An overview of the species assigned to the genus *Furo* found in the German lithographic limestones of the Solnhofen-area (Bavaria) and Nusplingen (Baden-Württemberg) is presented and the monophyly of the Upper Jurassic *Furo* is discussed. Six species can be recognized: '*F. latimanus*', '*F. longiserratus*', '*F. microlepidotes*', '*F. aldingeri*', '*F. angustus*' and '*F. münsteri*'. Among these '*F. angustus*' and '*F. münsteri*' form a monophyletic group, to which '*F. aldingeri*' might be related as well. '*F. longiserratus*' might be closely related to the Ophiopsidae, whereas '*F. microlepidotes*' shows similarities with the Caturidae. The position of '*F. latimanus*' remains to be determined. There are no indications of a monophyletic genus of *Furo* and the relationships of the Upper Jurassic furids with the Lower Jurassic species of *Furo* remain to be examined.

Key words: *Eugnathus*, *Furo*, *Halecomorphi*, phylogeny, *Plattenkalke*, *Tithonian*

Le genre *Furo* (Pisces, Halecomorphi) du Jurassique supérieur d'Allemagne.

Résumé : Les différentes espèces du genre *Furo* en provenance des gisements allemands à calcaires lithographiques des régions de Solnhofen (Bavière) et de Nusplingen (Bade-Württemberg) sont présentées et la monophylie du genre *Furo* du Jurassique supérieur est discutée. Six espèces peuvent être reconnues : '*F. latimanus*', '*F. longiserratus*', '*F. microlepidotes*', '*F. aldingeri*', '*F. angustus*' et '*F. münsteri*'. Parmi ces espèces, '*F. angustus*' et '*F. münsteri*' constituent un groupe monophylétique, auquel pourrait être rattaché '*F. aldingeri*'. '*F. longiserratus*' se rapprocherait des Ophiopsidae et '*F. microlepidotes*' montre des ressemblances avec les Caturidae. La position de '*F. latimanus*' reste à être déterminée. Il n'existe aucune indication sur la monophylie du genre *Furo* et les relations entre les furidés du Jurassique supérieur avec les espèces du genre *Furo* du Jurassique inférieur doivent être étudiées. (traduit par la rédaction).

Mots clés: *Eugnathus*, *Furo*, *Halecomorphi*, phylogénie, *Plattenkalke*, *Tithonien*

INTRODUCTION

The fossil fish genus *Furo* (= *Eugnathus*, this name was preoccupied by a genus of Coleoptera) is known from the Upper Triassic of Lombardia (*F. hermesi*, *F. trottii*, Alessandri, 1910), several species from the Lower Jurassic of England and France (Woodward, 1895a, b; Arambourg, 1935; Wenz, 1968) and the Upper Jurassic of Cerin, France (Saint-Seine, 1949) and southern Germany. The type species is *F. orthostomus* from the Lower Jurassic of

England. The knowledge of the genus is mainly based on original descriptions from the 19th century and Woodward's Catalog of Fossil Fishes (1895a). *F. normandica*, from the Toarcian of Normandy, described by Wenz (1968), is the best known species. The monophyly of the genus has never been tested and it is therefore unknown whether all species assigned to *Furo* belong to this genus. The oldest known representatives were originally described as belonging to the genera *Semionotus* and *Lepidotes* and referred to *Furo* by Alessandri (1910).

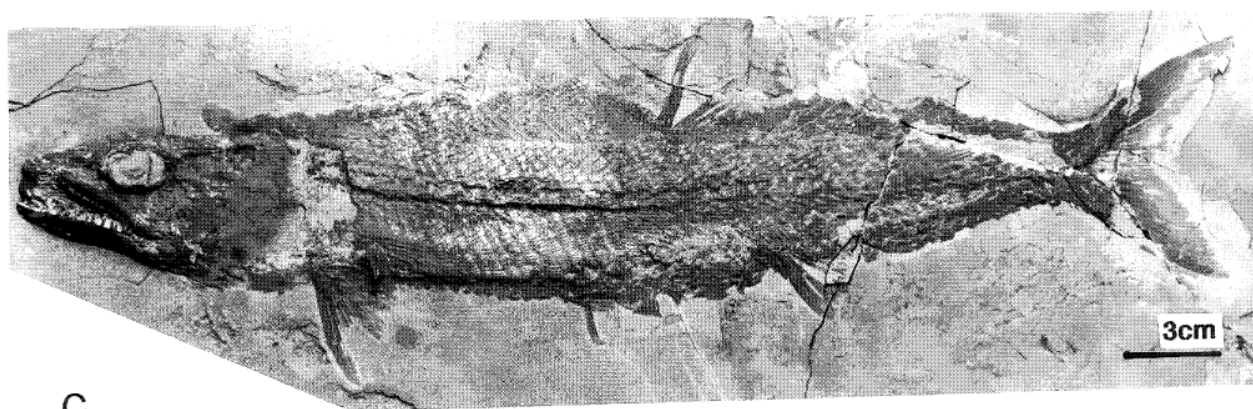
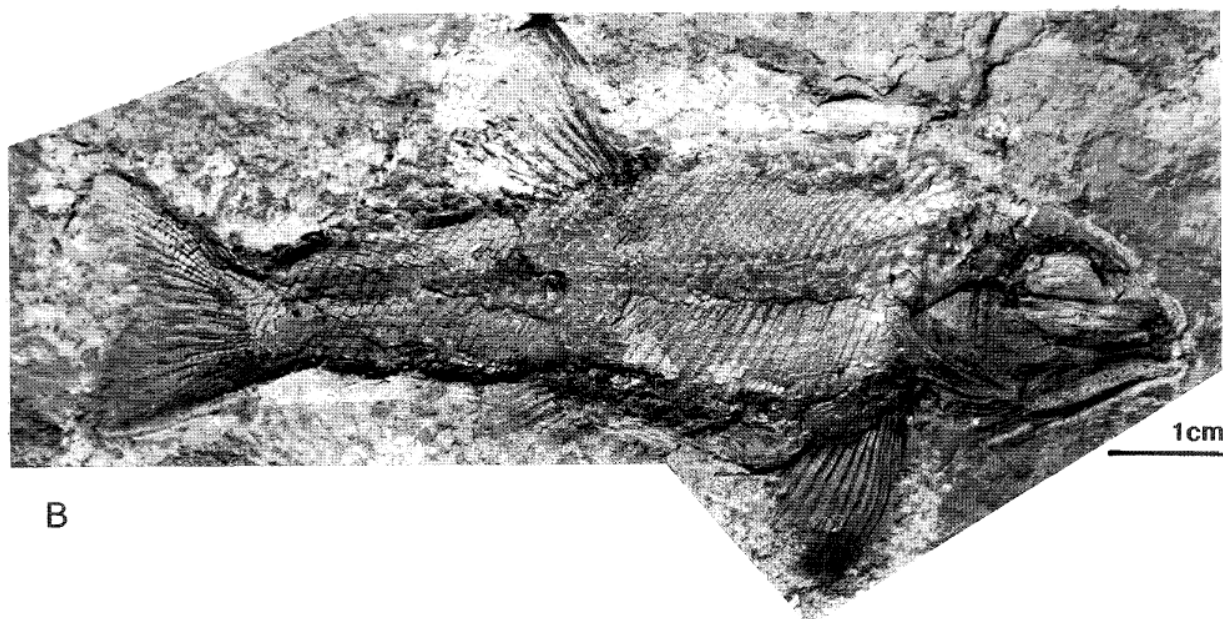
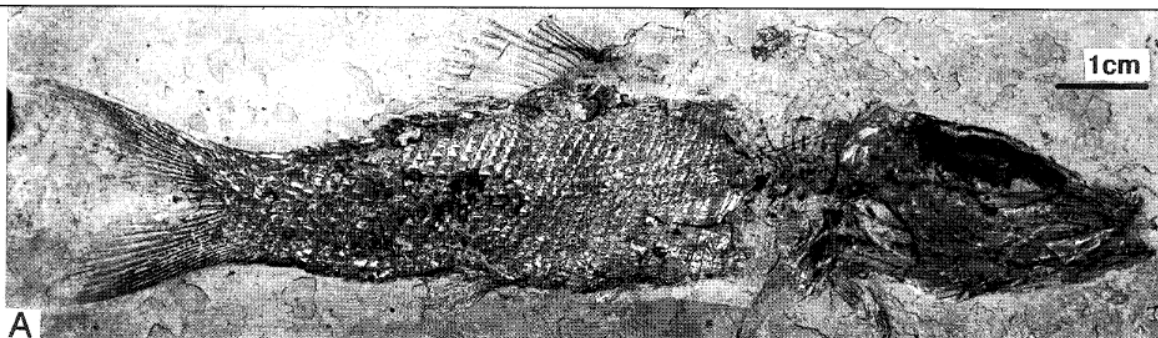


Figure 1 a. Holotype of *Furo longiserratus*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, AS.VII.1136, Kelheim, Bavaria.
 b. Holotype of *Furo latimanus*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, AS.VII.262, Solnhofen, Bavaria.
 c. Holotype of *Furo microlepidotes*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, AS.V.11a, Eichstätt, Bavaria.

In the Upper Jurassic lithographic limestones of Bavaria and Nusplingen in Germany and Cerin, France, the following species of *Furo* have been described (following the definition of *Furo* by Woodward, 1895 a): *Furo aldingeri* (Nusplingen; Heimberg, 1949), *Furo vetteri* (Bavaria?, Nusplingen; Heineke, 1906) *Furo longimanus* (Bavaria), *Furo longiserratus* (Bavaria, Nusplingen), *Furo microlepidotus* (Bavaria, Nusplingen) and *Furo praelongus* (Cerin, see Saint-Seine, 1949). Woodward (1895a) thought that *Pholidophorus angustus*, *Pholidophorus elongatus* and *Pholidophorus münsteri* belonged to *Furo* as well. Zittel (1887) placed *Furo longiserratus*, *Furo longimanus* and *Furo münsteri* in a separate genus *Isopholis*. He also included *Pholidophorus brevivelis* described by Wagner (1863) in this genus.

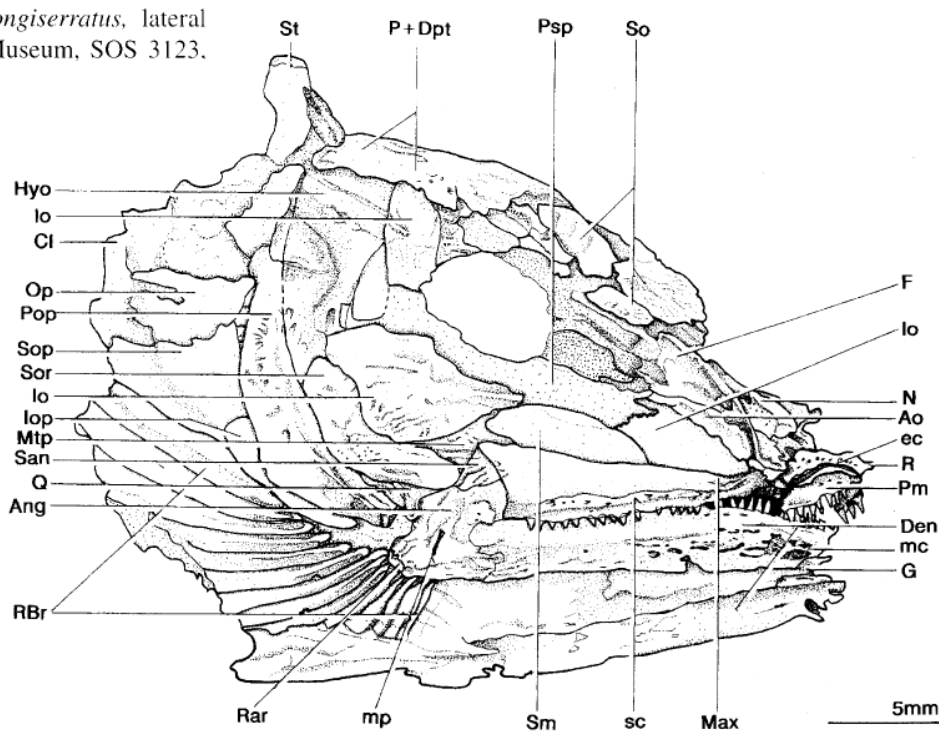
The purpose of this paper is to give a short overview of the species of *Furo* from the German Upper Jurassic localities, to discuss some salient anatomical features and their implications on the phylogeny of *Furo*. A more detailed description of the species and an elaborate phylogenetic discussion will be published in the future. As it appears that it is not possible

to group the Upper Jurassic *Furo* into a monophyletic assemblage together with the Lower Jurassic type species, all Upper Jurassic forms will be designated '*Furo*'.

'*FURO*' *LONGISERRATUS*

- '*Furo*' *longiserratus* (Agassiz) (Figs. 1a, 2)
 1843 *Pholidophorus longiserratus* Agassiz, vol. II, pt. I, p. 277, pl. 38, fig. 2 (1843) (in 1833-1843)
 1863 *Pholidophorus longiserratus*, Wagner, p. 664
 1863 *Pholidophorus brevivelis*, Wagner, p. 664
 1887 *Isopholis longiserratus*, Zittel, p. 216
 1887 *Isopholis brevivelis*, Zittel, p. 216
 1895a *Eugnathus longiserratus* (Agassiz), Woodward, p. 301
 ?1914 *Eugnathus longiserratus* (Agassiz), Eastman, p. 410, pl. LXIV, figs. 1, 2
 1949 *Eugnathus longiserratus* Agassiz, Heimberg, p. 97, pl. VIII, fig. 2
 1966 *Eugnathus longiserratus* (Agassiz), Schultze, fig. 19b
 1994 *Furo longimanus*, Frickhinger, p. 206, fig. 434

Figure 2 - Skull of *Furo longiserratus*, lateral view, specimen in the Jura-Museum, SOS 3123, Tithonian of Zandt, Bavaria.



Holotype : Specimen AS.VII.1136, Bayerische Staatssammlung für Paläontologie und historische Geologie, Kelheim, Bavaria.

'*Furo*' *longiserratus* was originally described as a pholidophorid. This species was classified with the poorly defined genus *Isopholis* by Zittel (1887).

'*Furo*' *longiserratus* is a slender, fusiform fish, with elongate head, pointed snout, high back, rather long dorsal fin placed posteriorly to halfway the body length, narrow caudal peduncle, deeply forked caudal fin, the ventral rim forming almost a straight line from the anterior trunk to the posterior end of the lower lobe of the caudal fin and a scale-cover consisting of rhombic scales with serrated posterior margins, but in the throat region the scales are circular. Most specimens measure between 10 and 15 cm standard length, but the largest specimen that probably belongs to this species has a standard length of 29 cm (specimen SOS.2178a/b in the Jura-Museum, Eichstätt).

The skull anatomy is of the general halecomorph type, with large first infraorbital, a single infraorbital behind the orbit, a broad, plate-like maxilla, with straight dentigerous border and which is expanded dorsally in its posterior part with the dorsal margin directed obliquely ventro-dorsally. The posterior

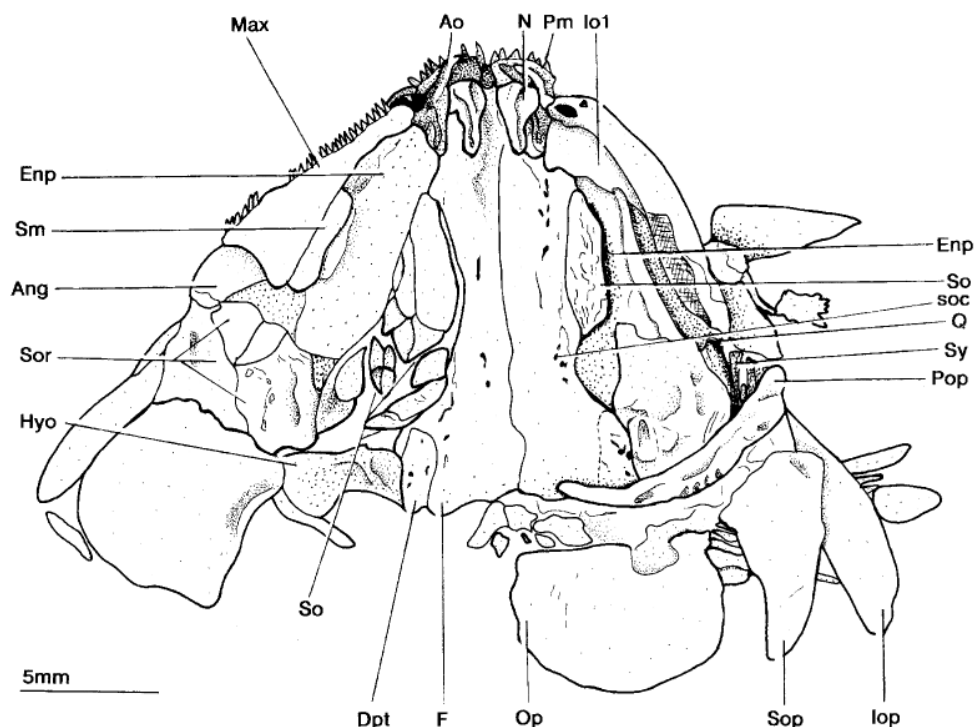
margin is embayed or only slightly notched, with a small posterior process ventrally. The shape of the maxilla is similar to that of primitive halecomorphs such as *Brachyichthys* (Woodward, 1895a), *Conodus* (pers. obs., a.o. specimen P.3645 in the NHM, London), *Heterolepidotes* (pers. obs., a.o. specimen P.2008 in the NHM, London), *Ionoscopus* (pers. obs., a.o. specimen 1903.I.64 in the Bayerische Staatssammlung für Paläontologie und historische Geologie), *Ophiopsis* (Bartram, 1975), *Teoichthys* (Applegate, 1988), *Macrepistius* (Schaeffer, 1960) and Lower Jurassic *Furo* (Woodward, 1895a; Wenz, 1968). Most conspicuous is the presence of a sensory canal that runs through the maxilla. This is so far only known in the ophiopsids *Ophiopsis* and *Teoichthys* (Bartram, 1975; Applegate, 1988). The supramaxilla is half-oval. There are at least 14 branchiostegal rays.

'FURO' LATIMANUS

'*Furo*' *latimanus* (Agassiz) (Figs. 1b, 3)

1838-1843 *Pholidophorus latimanus* Agassiz, vol. II, pt I, 280 (1843), pl. 43 (1838), (in 1833-1843)
1863 *Pholidophorus latimanus*, Wagner, p. 665

Figure 3
Skull of *Furo latimanus*,
dorsal view, specimen in the
Jura-Museum, SOS 2814,
Tithonian of Dollnstein,
Bavaria.



- 1881 *Pholidophorus latimanus*, Vetter, p. 58
 1887 *Pholidophorus latimanus*, Zittel, p. 216
 1895a *Eugnathus latimanus*, Agassiz, Woodward, p. 302
 1966 *Eugnathus latimanus* (Agassiz), Schultze, fig. 26
 1994 *Furo vetteri*, Frickhinger, p. 206, fig. 435

Holotype: Specimen AS.VII.262, Bayerische Staatssammlung für Paläontologie und historische Geologie. Solnhofen, Bavaria.

'*Furo*' *latimanus* was originally described as a pholidophorid. It is a small (standard length up to 10 cm) fish, with a round dorsal profile, a short skull with a rounded or blunt snout, a triangular dorsal fin situated posteriorly to halfway the body-length, broad pectoral fin and a short, only weekly forked caudal fin. No specimens that clearly show the skull anatomy in lateral view are available. Nevertheless, from examined specimens it appears that the maxilla is of similar shape as that of '*F.*' *longiserratus*, but it does not contain a sensory canal. The dorsal border of the supramaxilla is slightly concave. The operculum is roughly quadrangular. There is one large supraorbital ventral and posterior to which many smaller supraorbitals are present. The broad pectoral fin and

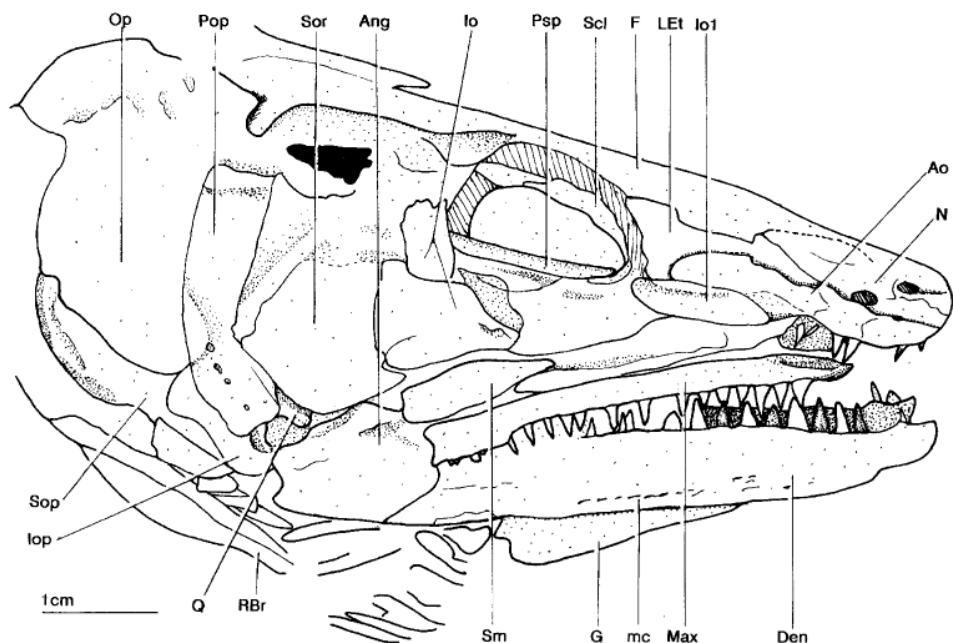
the short, weekly forked caudal fin are unique for this form.

'*FURO*' *MICROLEPIDOTES*

- '*Furo*' *microlepidotes* (Agassiz) (Figs. 1c, 4, 5)
 1833 *Uraeus microlepidotes*, Agassiz, vol. II, pt. I, p. 12 (in 1833-1843)
 1839-1843 *Eugnathus microlepidotes*, Agassiz, vol. IV, p. 118 (1839), vol. II, pt. II, p. 104, (1843), (in 1833-1843)
 1863 *Eugnathus microlepidotes*, Wagner, p. 673
 1895a *Eugnathus microlepidotes*, Agassiz, Woodward, p. 300
 1906 *Eugnathus microlepidotes* Ag., Heineke, p. 27, fig. 7, pl. V, figs. 5-7; pl. VII, fig. 5
 1966 *Eugnathus microlepidotes* Agassiz, Schultze, figs. 13, 25
 1994 *Eugnathus microlepidotes*, Frickhinger, p. 433
Holotype: Specimen AS.V.11a/b, Bayerische Staatssammlung für Paläontologie und historische Geologie. Eichstätt, Bavaria.

Agassiz originally described this species as *Uraeus*, a genus in which he also put species that were later referred to Pholidophoridae and Caturidae.

Figure 4
 Skull of *Furo microlepidotes*, lateral view, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, 1964.XXIII.554, Schernfeld, Bavaria.



'*Furo*' *microlepidotes* is an elongate fish, of rather large size (standard length up to 35 cm), with an elongate skull with a blunt snout in which the dorsal and ventral border of the skull are more or less parallel. As in other halecomorphs there is one infraorbital posterior to the orbit. Conspicuous in the skull is the slender, bar-like maxilla, which lacks the dorsal expansion posteriorly but that is slightly deepened downwards instead, with a clear notch in its posterior border and widely spaced, laterally compressed teeth.

The shape of the maxilla is very different from all other species of *Furo* and is in fact only known in the caturid genera *Caturus* and *Amblysemius* (Lambers, 1992, 1995). The supramaxilla is sharply pointed anteriorly. The parietals are unequal in size with irregular, sinuous outlines. Parietals with irregular, sinuous outlines are known in several halecomorphs, but the big size difference is only known in *Caturus* (Lambers, 1992, 1994) and *Osteorachis* (Gardiner, 1960). The squamation consists of narrow rhombic scales, at the ventral rim measuring not more than 1mm.

The triangular dorsal fin is placed posteriorly to halfway the body, the caudal fin is deeply forked and symmetrical, very similar to the one of *Caturus*.

**'FURO' ANGUSTUS, 'FURO' MÜNSTERI
AND 'FURO' ALDINGERI**

'*Furo*' *angustus* (Münster) (Figs. 6a, b, c, 7)

1842 *Pholidophorus angustus*, Münster, p. 43

1848 *Pholidophorus Muensteri*, Giebel, p. 208

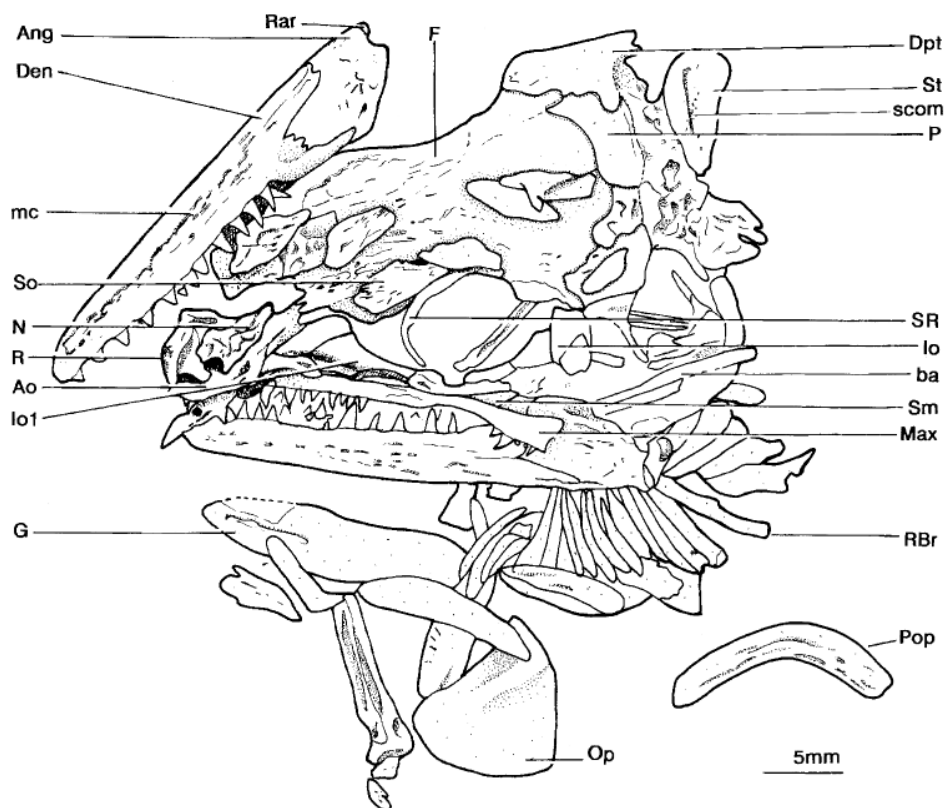
1863 *Pholidophorus elongatus*, Wagner, p. 664

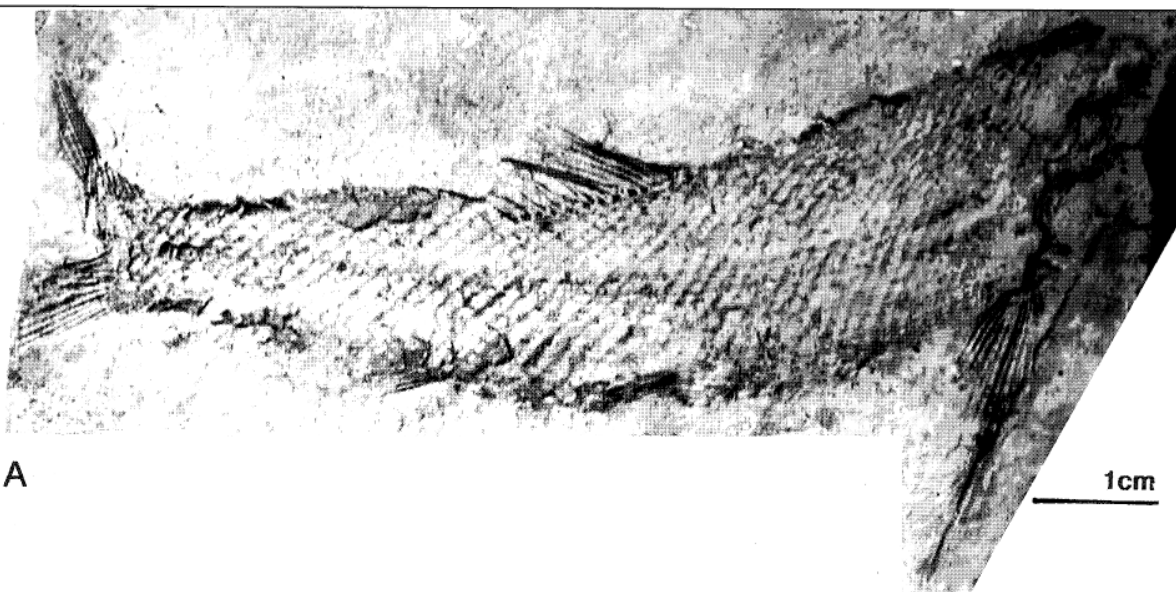
1895a *Pholidophorus elongatus*, Woodward, p. 304

1895a *Pholidophorus angustus*, Woodward, p. 477

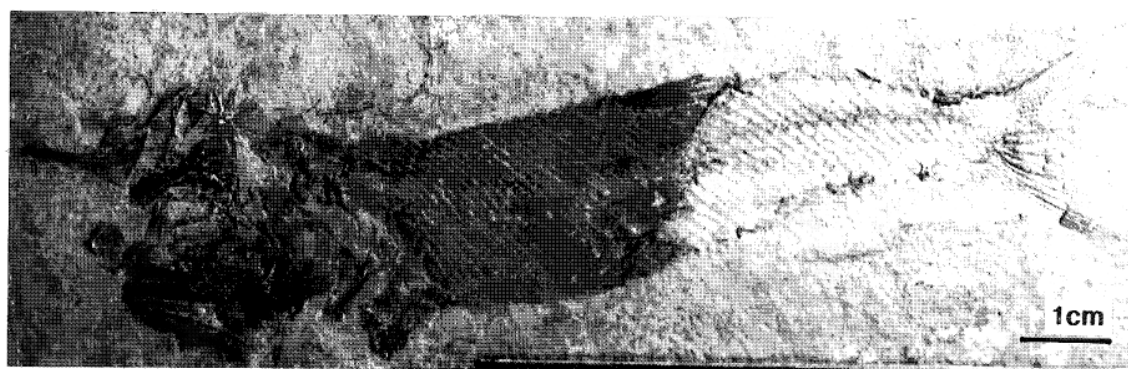
Holotype: Specimen AS.VII.1137, Bayerische Staatssammlung für Paläontologie und historische Geologie. Mörnsheim, Bavaria.

Figure 5
Skull of *Furo*
microlepidotes,
lateral view,
skull roof in
dorsal view,
specimen
Jura-Museum,
SOS 3054,
Tithonian of
Zandt,
Bavaria.

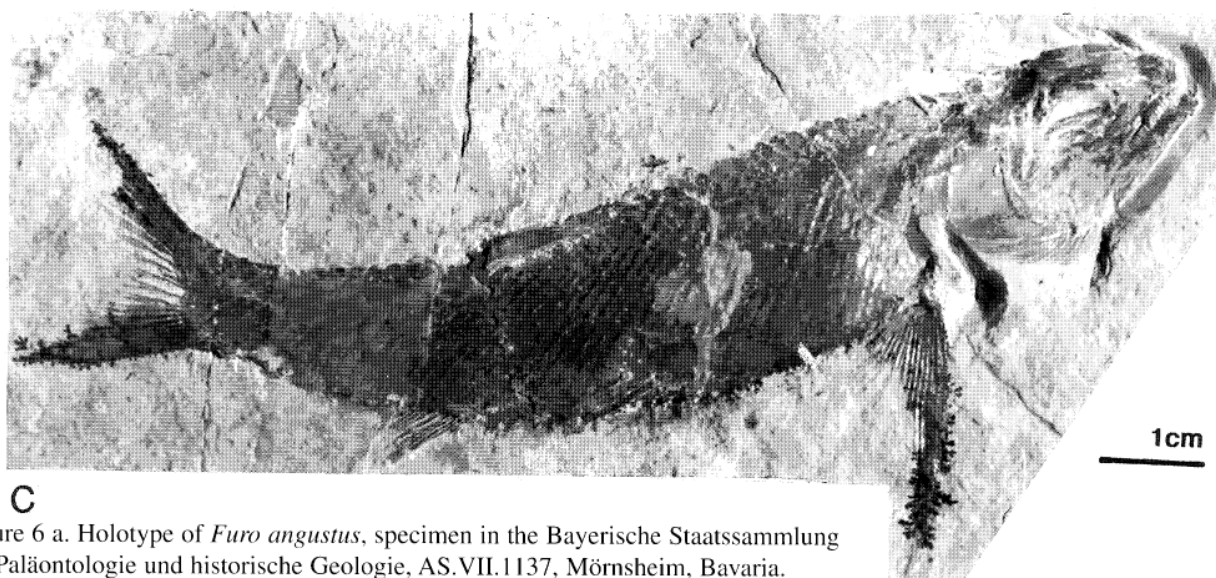




A



B



C

Figure 6 a. Holotype of *Furo angustus*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, AS.VII.1137, Mönsheim, Bavaria.

b. Holotype of *Furo elongatus*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, AS.VI.502a. - c. Specimen of *Furo angustus*, specimen in the collection Kümpel, Wuppertal.

Münster (1842) described a small and slender fish with a long and slender pectoral fin as *Pholidophorus angustus* (Fig. 6a). Giebel (1848) briefly redescribed the species as *Ph. münsteri*, as Agassiz had already described a *Ph. angustus* from the Jurassic of Poland. Wagner (1863) described a similar form as *Ph. elongatus* (Fig. 6b). He mentioned the similarity between these two species. The holotype of *Ph. angustus* Münster however, is an impression in the matrix only, lacking any trace of the skull and the holotype of *Ph. elongatus* shows a disarticulated skull but has only part of the pectoral fin preserved. Probably for this reason he did not synonymize both species. The holotypes of the above mentioned species, together with recently discovered material from other collections, allows a rather detailed description of the species '*Furo*' *angustus*. This fish is an elongate, slender, small fish, that tapers gently towards the caudal fin, with a small skull with rounded snout. Conspicuous is the extremely long and slender pectoral fin and the short and slightly bifurcated caudal fin which counts 19-20 rays only, in contrast to the caudal fin of the other furids which contains about 30 rays.

Characteristics in the skull are the presence of five supratemporals and the posterior/ventral border of the supratemporals, operculum, suboperculum and

the first branchiostegal rays which are deeply serrated. The serrations are directed postero-ventrally in the opercular bones. There are about nine branchiostegal rays. The supraorbitals consist of numerous small and irregular shaped bones.

'*Furo*' *münsteri* (Agassiz) (Fig. 8)

1834 *Ophiopsis münsteri*, Agassiz, p. 385

1843 *Ophiopsis münsteri*, Agassiz, vol. II, pt. I, p. 292, pt. II, p. 289 (in 1833-1843)

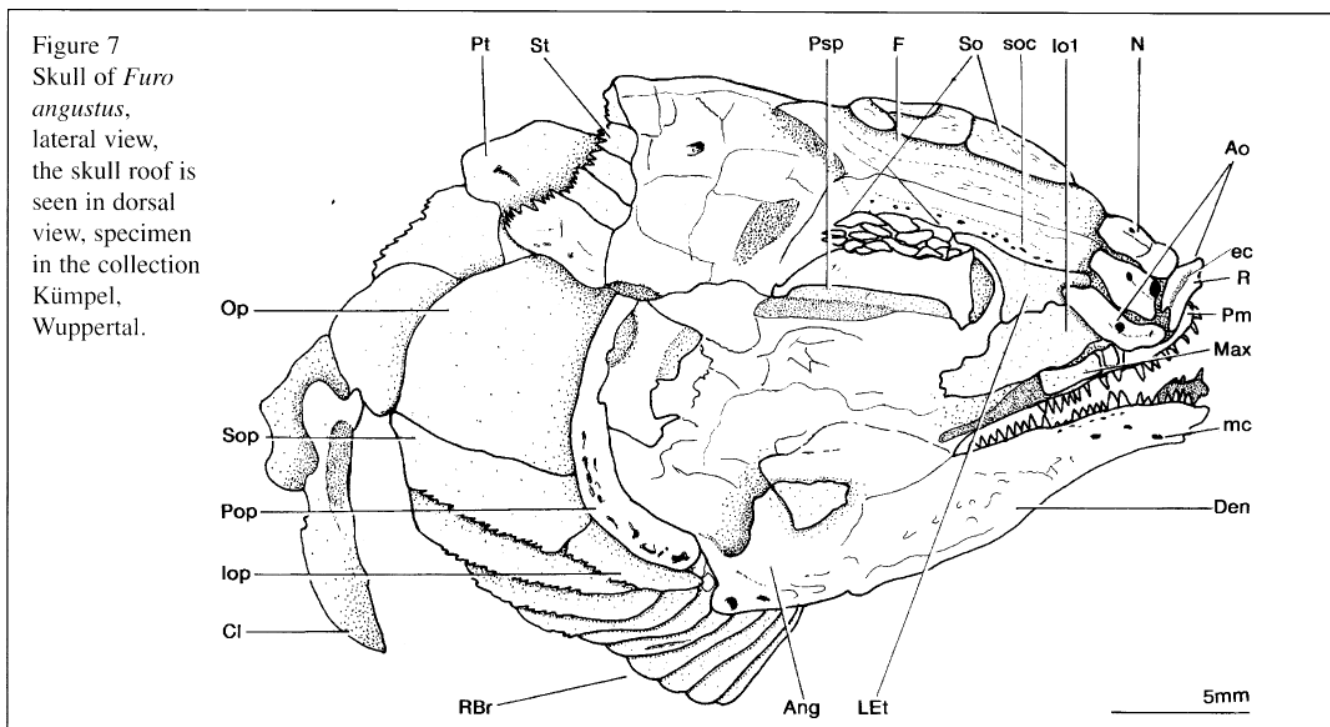
1851 *Ophiopsis Münsteri* Ag., Wagner, p. 60

1887 *Isopholis Münsteri* Ag., Zittel, p. 216, fig. 230

1895a *Ophiopsis münsteri*, Woodward, p. 173

Holotype : Specimen AS.VII.1135, Bayerische Staatssammlung für Paläontologie und historische Geologie. Kehlheim, Bavaria. Figured is specimen 1870.IV.2 (Bayerische Staatssammlung) from Wellenburg, near Kelheim, Bavaria, which has better preserved skull and pectoral fin.

Agassiz (1834) erected a species, *Ophiopsis münsteri*, based on the description of scales only. Wagner (1851) provided a more detailed description of the holotype. Zittel (1887) referred the species to the genus *Isopholis* and presented a schematic drawing of the skull.



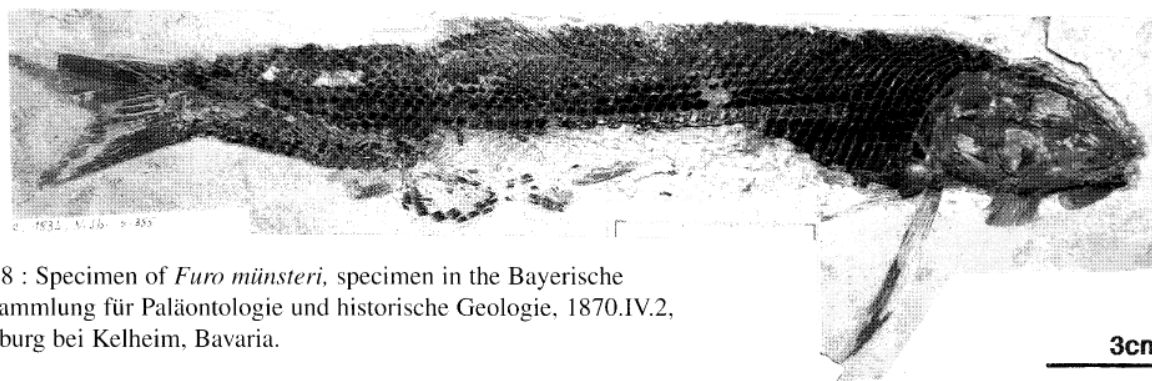


Figure 8 : Specimen of *Furo münsteri*, specimen in the Bayerische Staatssammlung für Paläontologie und historische Geologie, 1870.IV.2, Wellenburg bei Kelheim, Bavaria.

The species '*Furo*' *münsteri* is similar in shape to '*F.*' *angustus*, but with a standard length of about 32 cm much larger in size. As in the latter it has a very long and slender pectoral fin and a small caudal fin. In specimen 1870.IV.2 (Bayerische Staatssammlung für Paläontologie und historische Geologie) serrations on the posterior border of the operculum are visible. The vertebrae are well ossified ringcentra, unlike those of '*F.*' *angustus*, which are composed of dorsal and ventral hemicentra. The caudal fin is asymmetrical in shape, as the upper lobe is longer than the lower lobe, whereas in '*F.*' *angustus* both lobes are equal in size. The serrated posterior margin of the posttemporals and the opercular bones in '*Furo*' *münsteri* and '*F.*' *angustus* is unique among halecomorphs. Some species of *Ophiopsis* have a denticulated posterior border of the supratemporals (Bartram, 1975). The long and slender pectoral fin and the small caudal fin are unique among halecomorphs as well. These characters unite '*F.*' *angustus* and '*F.*' *münsteri* in a monophyletic genus. Five supratemporals is a derived condition, the number of supratemporals of '*F.*' *münsteri* is unknown. The asymmetric shape of the caudal fin is unique for '*F.*' *münsteri*.

'*Furo*' *aldingeri* (Heimberg) (Fig. 9a, b, c, 10)

1949 *Eugnathus aldingeri*, Heimberg, p. 95, pl. VIII, fig. 1, fig. 10

1966 *Eugnathus aldingeri* Heimberg, Schultze, fig. 56

Holotype: Specimen PV.19495a/b, Geologisches und Paläontologisches Institut of the university of Tübingen. Nusplingen, Baden-Württemberg.

Heimberg described '*Furo*' *aldingeri* after a single specimen in part and counterpart from the lithographic

limestone of Nusplingen, lacking the anterior part of the skull. Additional material (PU.80440/12 from Nusplingen, Baden Württemberg, Staatliches Museum für Naturkunde; fig. 10), displaying isolated skull bones allows a detailed description of the species.

'*Furo*' *aldingeri* is a very slender and elongate fish, about 10 horizontal scale-rows broad, with conspicuously broad pectoral, dorsal, pelvic and anal fins. The plate-like maxilla is widened dorsally, as in e.g. '*F.*' *longiserratus*, but also has a rather rounded ventral deepening in its posterior third. The posterior margin of the maxilla is deeply concave. The teeth on dentary and maxilla are slender and sharply pointed. The interoperculum has a posterior serrated margin, with more or less ventrally directed and widely spaced serrations. There are several small and irregular supraorbital. The parietals are rectangular and equal in size. The small scales behind the skull are serrated posteriorly, but halfway the body the scales lack serrations, and the posterior margin is arrow-shaped. The lateral line scales are deeply notched, showing two posterior projections. The extremely slender body shape, and broad fins are unique for '*F.*' *aldingeri*. The shape of the maxilla and its posterior margin is different from the maxillae in other halecomorphs (see above). The type of lateral line scales and the overall squamation is not seen in any other halecomorph. The lateral line scales are usually not very conspicuous and the rhombic scales of halecomorphs usually have a serrated posterior margin. The serrated posterior margin of the interoperculum is slightly different from the situation in '*F.*' *angustus*, as the serrations are less deep and the 'teeth' are more widely spaced and not directed postero-ventrally. However, this difference might well be a preservational effect.

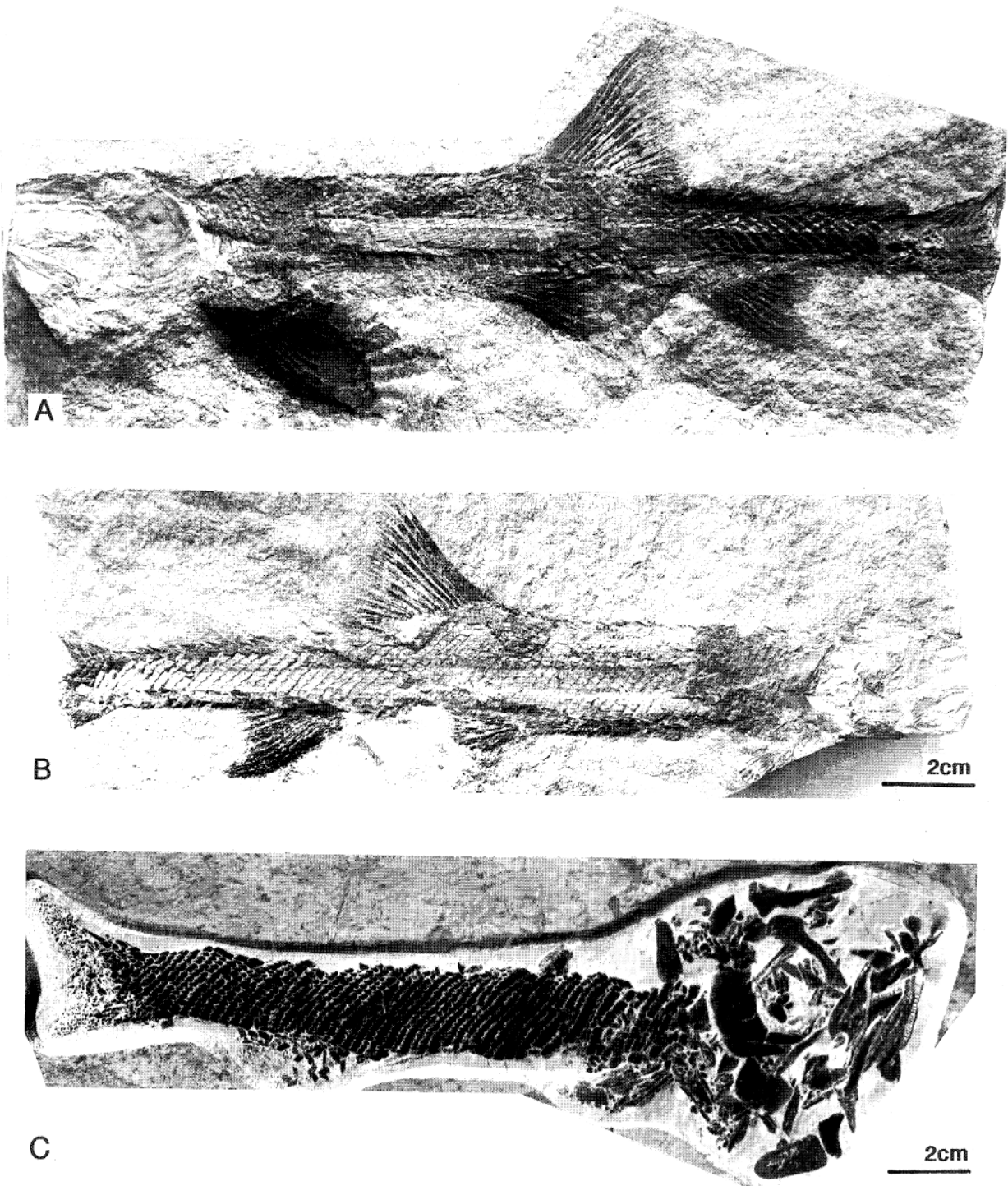


Figure 9

a/b. Holotype of *Furo aldingeri*, specimen in the Geologisches und Paläontologisches Institut of the university of Tübingen, PV.19495a/b, Nusplingen, Baden-Württemberg.

c. Specimen of *Furo aldingeri*, specimen in the Staatliches Museum für Naturkunde Stuttgart, PU.80440/12, Nusplingen, Baden-Württemberg.

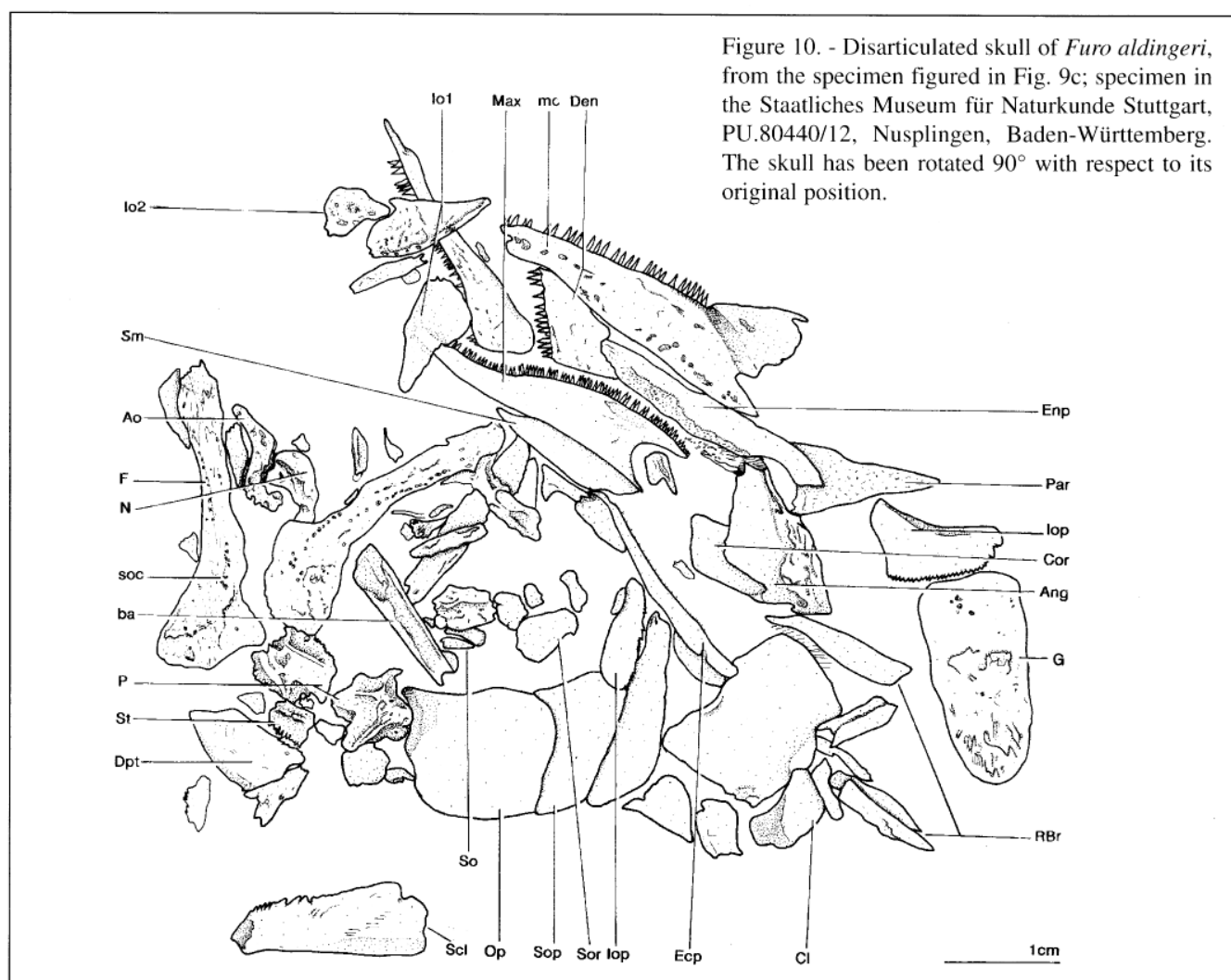


Figure 10. - Disarticulated skull of *Furo aldingeri*, from the specimen figured in Fig. 9c; specimen in the Staatliches Museum für Naturkunde Stuttgart, PU.80440/12, Nusplingen, Baden-Württemberg. The skull has been rotated 90° with respect to its original position.

DISCUSSION

Up till now 10 fossil fish species from the Upper Jurassic of Germany were assigned to the genus *Furo*. On which grounds the assignment to this genus was based is, however, unclear. The genus *Furo* is in fact a Liassic form and the knowledge of the Liassic representatives is very incomplete. Apparently elongate, fusiform Jurassic fishes with rhombic scales with serrated margin and rather heavy dentition were all placed within this genus. In publications authors often refer to the genus *Furo* (e.g. Schultze 1966, 1996; Lambers, 1995) without taking into account that the genus, as presently known, is not monophyletic, probably a polyphyletic assemblage and as such has no phylogenetic value. From my brief overview of the Upper Jurassic forms from Germany the anatomical diversity of the species is apparent and is as

big as between separate genera. Clear differences between all species are shown in overall body-form, skull shape, squamation, position, shape and size of the fins. A few characters deserve mentioning. '*F.* latimanus', '*F.* münsteri' and '*F.* aldingeri' have large two to three large supraorbitals, accompanied by numerous small infraorbitals. Numerous small supraorbitals are known from several halecomorphs, e.g. *Caturus* (Lambers, 1992) and the amiiform *Calamopleurus* (Maisey, 1991). This character is therefore no useful indicator of phylogenetic relationship. '*F.* longiserratus' has a sensory canal running through the maxilla, a condition that is only known in Ophiopsidae. However, this species lacks the deep infraorbitals and the sensory line continuing into the caudal fin, known in Ophiopsidae (Bartram, 1975), nor does the maxilla have a posteriorly directed ventral hook anterior on the maxilla, as known in

Ophiopsis (pers. observ. on several specimens, e.g. 1938.58 in the Geological Museum, Copenhagen, see also reconstructions in Bartram, 1975). '*F.* *longimanus*' is, in skull anatomy, similar to the general primitive halecomorph pattern, but in body-form and shape of the fins the species is different from all other species. '*F.* *microlepidotes*' has a bar-like maxilla that is similar to the one in Caturidae and the irregular parietals are as in Caturidae rather than in other furid species. The very narrow scales make this species easily distinguishable from the other species. Its vertebral column remains unknown, it is not known whether it has the broad haemal spines typical for caturids (Lambers, 1995). '*F.* *angustus*' and '*F.* *münsteri*' share an unusually long and slender pectoral fin, a relatively small and blunt-snouted head, serrated posterior margins of suboperculum, interoperculum and branchiostegal rays and a small caudal fin. The five supratemporals of '*F.* *angustus*' are unique among halecomorphs. The supratemporals of '*F.* *münsteri*' are unknown. The upper lobe of the caudal fin of this form is much longer than in any other *Furo*. These two species probably belong to the same genus. '*F.* *aldireri*' is easily distinguishable by its extremely slender body-shape, very large pectoral, dorsal, pelvic and anal fins, the shape of the scales and the lateral line scales, and the shape of the maxilla with its very deep notch and round downward expansion posteriorly. The serrated posterior margin of the suboperculum might indicate a relationship with '*F.* *angustus*'/'*F.* *münsteri*'. Apparently the Upper Jurassic species of '*Furo*' do not belong to a monophyletic assemblage. They represent several distinct genera. It is not known whether any of the Upper Jurassic '*Furo*' belongs to genus *Furo* as characterized by the Lower Jurassic type species. Their relationship to the Lower Jurassic *Furo* remains to be determined.

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ABBREVIATIONS

Ang: Angular
 Ao: Antorbital
 ba: branchial arches
 Cl: Cleithrum
 Cor: Coronoid
 Den: Dentary
 Dpt: Dermopterotic
 ec: ethmoid commissure
 Ecp: Ectopterygoid
 Enp: Entopterygoid
 F: Frontal
 G: Gular
 Hyo: Hyomandibular
 Io/Io1/Io2: Infraorbital
 Iop: Interoperculum
 LEt: Lateral ethmoid
 Max: Maxilla
 mc: mandibular canal
 mp: mandibular pit-line
 Mtp: Metapterygoid
 N: Nasal
 Op: Operculum
 P: Parietal
 Par: Prearticular
 Pm: Premaxilla
 Pop: Preoperculum
 Psp: Parasphenoid
 Pt: Posttemporal
 Q: Quadrate
 R: Rostral
 Rar: Retroarticular
 RBr: Branchiostegal rays
 San: Surangular
 sc: sensory canal
 Scl: Supracleithrum
 Scl: Sclerotic ring
 scom: supratemporal commissure
 Sm: Supramaxilla
 So: Supraorbital

soc: supraorbital canal
 Sop: Suboperculum
 Sor: Suborbital
 SR: Sclerotic ring
 St: Supratemporal
 Sy: Symplectic

REFERENCES

- AGASSIZ, L., 1833-1843. *Recherches sur les poissons fossiles*. Band 1-5. Neuchâtel.
- 1834. Abgerissene Bemerkungen über fossile Fische. *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, **4** : 379-390.
- ALLESSANDRI, G. de, 1910. Studi sui pesci Triasici della Lombardia. *Memorie Società Italiana di Scienze Naturali e Museo Civico di Storia Naturale di Milano*, **7** : 1-145.
- APPLEGATE, S.P., 1988. A new species of a holostean belonging to the family Ophiopsidae, *Teioichthys kallistos*, from the Cretaceous, near Tepexi de Rodriguez, Puebla. *Revista Universidad Nacional Autónoma México, Instituto Geología* **2** : 200-205.
- ARAMBOURG, C., 1935. Contribution à l'étude des poissons du Lias supérieur. *Annales de Paléontologie*, **24** : 1-32.
- BARTRAM, A.W.H., 1975. The holostean fish genus *Ophiopsis* Agassiz. *Zoological Journal of the Linnean Society*, **56** : 183-205.
- EASTMAN, C.R., 1914. Catalog of the fossil fishes in the Carnegie Museum, Part 4, Descriptive Catalog of the fossil fishes from the lithographic stone of Solnhofen, Bavaria. *Memoires of the Carnegie Museum*, **6**, 7: 389-423.
- FRICKHINGER, K.A., 1994. *Die Fossilien von Solnhofen*. Goldschneck-Verlag Weidert, Kolb : 1-336.
- GARDINER, B.G., 1960. A revision of certain actinopterygian and coelacanth fishes, chiefly from the Lower Lias. *Bulletin British Museum (Natural History), Geology*, **4** : 239-384.
- GIEBEL, C.G., 1848. Fauna der Vorwelt mit steter Berücksichtigung der lebenden Thiere. Band 1, Abtheilung 3. XII+461 pp. Brockhaus, Leipzig.
- HEIMBERG, G., 1949. Neue Fischfunde aus dem Weissen Jura z von Württemberg. *Palaeontographica*, **97-A** : 75-98.
- HEINEKE, E., 1906. Die Ganoiden und Teleostier des lithographischen Schiefers von Nusplingen. *Geologische und Paläontologische Abhandlungen, Neue Folge*, **8** : 159-214.
- LEHMAN, J.P., 1966. Actinopterygii; pp. 1-242. In PIVETEAU, J. (ed.) *Traité de Paleontologie*, 4, 3. Masson, Paris.
- LAMBERS, P.H., 1992. *On the ichthyofauna of the Solnhofen Lithographic Limestone (Upper Jurassic, Germany)*. Doctoral thesis, University of Groningen. X + 336 p.
- LAMBERS, P.H., 1994. The halecomorph fishes *Caturus* and *Amblysemitus* in the Lithographic Limestone of Solnhofen (Tithonian), Bavaria. *Geobios Mémoire Spécial*, n°. 16 : 91-99.
- 1995. The monophyly of the Caturidae (Pisces, Actinopterygii) and the phylogeny of the Halecomorphi; pp. 201-203. In LELIEVRE, H.; WENZ, S., BLIECK, A. & CLOUTIER, R. (eds.): *Premiers Vertébrés et Vertébrés Inférieurs. Geobios, M. S.* **19**.
- MAISEY, J.G., 1991. *Calamopleurus* Agassiz, 1841 ; pp. 139-155. In MAISEY, J.G. (ed.) *Santana fossils, an illustrated atlas*. T.F.H. Publications, Neptune City.
- MÜNSTER, G. zu., 1842. Beitrag zur Kenntniss einiger neuen seltenen Versteinerungen aus den lithographischen Schiefen in Baiern. *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 35-46.
- SAINT-SEINE, P. de, 1949. Les poissons des calcaires lithographiques de Cerin (Ain). *Nouvelles Archives du Muséum d'Histoire Naturelle de Lyon*, **2** : 1-357.
- SCHAEFFER, B., 1960. The Cretaceous holostean fish *Macrepistius*. *American Museum Novitates*, 2011: 18 pp..
- SCHULTZE, H.-P., 1966. Morphologische und histologische Untersuchungen an Schuppen mesozoischer Actinopterygier (Übergang von Ganoid- zu Rundschuppen). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **126** : 232-314.
- 1996. The scales of Mesozoic actinopterygians; pp. 83-95. In ARRATIA, G. & VIOHL, G. (eds) *Mesozoic Fishes - Systematics and Paleoecology*. Verlag Dr. Friedrich Pfeil, München.
- VETTER, B., 1881. Die Fische aus dem lithographischen Schiefer im Dresdener Museum. *Mitteilungen aus dem königlichen Mineralogisch-Geologischen und Praehistorischen Museum in Dresden*, **4** : 1-118.
- WAGNER, A., 1851. Beiträge zur Kenntnis der in den lithographischen Schiefen abgelagerten urweltlichen Fische. *Abhandlungen der Mathematisch-Physikalischen Classe der königlich Bayerischen Akademie der Wissenschaften*, **6** (1) : 1-80.
- 1863. Monographie der fossilen Fische aus den lithographischen Schief-ern Bayerns. Zweite Abtheilung. *Abhandlungen der Bayerische Akademie von Wissenschaften*, 2. Klasse, **9** (3) : 611-748.
- WENZ, S., 1968. Compléments à l'étude des poissons Actinopterygiens du Jurassique français. *Cahiers de Paléontologie*, CNRS, Paris : 1-276.
- WOODWARD, A.S., 1895a. *Catalogue of the fossil fishes in the British Museum (Natural History)*, 3, xlii + 544 pp. British Museum (Natural History), London.
- 1895b. On the fossil fishes of the Upper Lias of Whitby. Part 1. *Proceedings of the Yorkshire Geological and Polytechnic Society*, **13** : 25-42.
- ZITTEL, K.A., 1887. *Handbuch der Palaeontologie. Palaeozoologie*. III. Band. R. Oldenbourg, München und Leipzig : 1-900.

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