Middridge

[NZ 249 252] (Potential GCR site)

Highlights

Middridge in Durham is the relatively most productive British Permian fossil fish locality. It is the source of specimens of 13 species of fossil fishes, including 11 bony fishes, a chimaera and a coelacanth.

Introduction

Many museum specimens of fossil fish have been obtained in the past from Middridge Quarry. The flora and fauna from this quarry is the most prolific for the Marl Slate in Durham (Mills and Hull, 1976). The Late Permian Marl Slate exposed in a quarry and railway cutting 1 km SSW of Middridge, and close to East Thickley and Thickley Wood, has long been known for its rich fossil plant, invertebrate and vertebrate assemblages. There is another quarry, Old Towns Quarry [NZ 257 246], about 1 km to the south-east, and closer to Newton Aycliffe than to Middridge. However, the fish site is almost certainly the former, sometimes termed Thickley Quarry. Extensive collections were made in the 19th century, and these include many specimens of fishes, as well as the 'amphibian' *Lepidotosaurus,* and the reptiles *Protorosaurus* and *Adelosaurus* (see Benton and Spencer, 1995, p. 21).

The sections of the quarry that lie near the railway line, and in the side of the railway cutting are now rather overgrown and the Marl Slate is no longer visible. However, a new excavation in the floor of the eastern end of the old quarry exposes a good section right through the Marl Slate and gives clear access to the fossiliferous beds (Mills and Hull, 1976, pp. 137–8; Bell *et al.,* 1979).

Description

As Benton and Spencer report (1995, p. 22): 'Middridge Quarry and railway cutting expose sections in the lower portion of the Upper Permian which rests unconformably on Carboniferous sediments. Typical sections taken in the new pit at Middridge show the following sequence (Bell *et al.* 1979, p. 445):

	Thickness (m)
Lower Magnesian Limestone	4+
Marl Slate	2.58–2.76
calcareous laminated siltstones and thin silty limestones	(1.47–1.60)
laminated limestone (upper invertebrate bed)	(0.02–0.03)
calcareous laminated siltstones and thin silty limestones	(1.09–1.13)
Basal Permian Breccia	
Calcareous breccia (lower invertebrate bed) with abundant Lingula in the top 0.02–0.03 m	0.38–0.42
————unconformity————	
Lower Coal Measures	
Thin-bedded micaceous sandstones and shales	1.20

The new pit exposed the Basal Breccias (?Lower Permian) which may be equivalent to the breccias observed elsewhere in Durham, Yorkshire and North Nottinghamshire lying below the Lower Permian Yellow Sands (Smith *et al.* 1974; Smith 1989; Smith and Taylor 1992). The Yellow Sands are not seen at Middridge.

The Marl Slate is well represented, compared with the thicknesses of 0–3 m elsewhere in south Durham. It comprises a succession of rusty brown-weathering, thinly laminated calcareous siltstones and thin silty limestones rich in bituminous and other organic material. There is a thin, highly fossiliferous laminated limestone (upper invertebrate bed) just over 1 m

above the base of the Marl Slate. Pyrite, galena and spha-lerite occur as spherulitic aggregates, small veins and as a partial replacement of some fossils (Bell *et al.,* 1979).

Numerous fossils have been found in the Marl Slate at Middridge, in addition to the reptiles and amphibians [two reptile species and one amphibian?] (Pattison *et al.,* 1973; Bell *et al.,* 1979). These include 12 genera of plants (Thallophyta, Pteridophyta, Pteridospermae, Coniferales), as well as a wide selection of invertebrates (foraminifers, bryozoans, brachiopods, bivalves, nautiloids and ostracods) and fish. The fishes are represented by isolated scales and fragments, as well as by a few complete flattened specimens … Some fish remains are found in coprolites deposited by other fishes or by tetra-pod predators.'

Fauna

Osteichthyes: Sarcopterygii: Actinistia

Coelacanthus granulatus Agassiz, 1839

Osteichthyes: Actinopterygii: Palaeoniscidae

Acrolepis sedgwicki Agassiz, 1833

Reticulolepis (*Acrolepis*) *exsculpta* (Kurtze, 1839) Weston, 1934

Palaeoniscus freieslebeni Blainville, 1818 (includes *P. comptus* (Agassiz, 18 35) and *P. elegans* (Sedgwick, 1850))

P. longissimus Agassiz, 1835

P. macropthalmus Agassiz, 1835

Pygopterus humbolti Agassiz, 1833 (includes *Pygopterus mandibularis* Agassiz, 1844)

Osteichthyes: Actinopterygii: Platysomidae

Globulodus macrurus (Agassiz, 1835)

Platysomus gibbosus (Blainville, 1818) (including *Platysomus striatus* Agassiz, 1833)

Osteichthyes: Actinopterygii: Dorypteridae

Dorypterus hoffmani Germar, 1842

Osteichthyes: Actinopterygii: Semionotidae

Acentrophorus glaphyrus (Agassiz, 1835)

A. altus (Kirkby, 1862)

Chondrichthyes: Holocephali

Janassa bituminosa (Schlotheim, 1820)

Elasmobranchii

Wodnika striatula Münster, 1843

In addition to the fishes, reptiles and amphibians, invertebrates and vascular plants are numerous at Middridge (see Benton and Spencer, 1995, p. 22).

The fossil assemblage from the Marl Slate consists of diapsid reptiles and palaeoniscid fishes; the inarticulate brachiopod *Lingula* also occurs. The fishes are mainly fusiform palaeoniscids, such as *Palaeoniscus* and *Acrolepis,* and some deep-bodied palaeoniscids, such as *Platysomus.* Most palaeoniscids were small, with thick rhomboidal scales, and triangular dorsal and anal fins. The suborder appeared in the Devonian, became more numerous in the Carboniferous and extended into the Mesozoic.

The majority of Marl Slate 'palaeoniscid' early actinopterygians belong to the family Palaeoniscidae, which is known from the Devonian to the Permian. *Acrolepis* occurs in the Carboniferous of Scotland and the Permian of Durham, the Kupferschiefer of Germany and the Permian of Russia (Aldinger, 1937). *Acrolepis* is included in the '*Pteronisculus*'group of stem-group actinopterygians by Gardiner and Schaeffer (1989). *Acrolepis sedgwickii* is a well-preserved example of the genus (Gardiner and Schaeffer, 1989, fig. 3B) and A. *exsculpta* is distinguished by ornamented lepi-dotrichia, and was made a separate genus, *Reticulolepis,* by Westoll (1934).

Palaeoniscus is widespread in the Permian. It occurs in the Marl Slate, the Kupferschiefer, and the Permian of Russia and Greenland (Aldinger, 1937). The '*Palaeoniscum*'group of Gardiner and Schaeffer (1989) includes *Palaeoniscum* (sic) and some species of *Elonichthys* and *Cosmolepis* from the Carboniferous, and is probably paraphyletic. *Palaeoniscus freieslebeni* (Figure 10.5) is known from the Marl Slate and Kupferschiefer, plus the Permian of Russia and Greenland, and the Eotrias of Spitsbergen and Karroo of South Africa (Piveteau, 1966). In Germany it comprises about 90% of all fish finds in the Kupferschiefer (Schaumberg, 1978)

Platysomids include deep-bodied and laterally compressed forms. In modern fishes this shape is associated with life in quiet waters. The genus *Globulodus* is restricted to the Marl Slate and the Kupferschiefer. The proportions of its body are similar to *Mesolepis* from the Carboniferous. Its dentition indicates a diet mainly of shellfish. *Platysomus* is also known from the Carboniferous. The *Platysomus* group of Gardiner and Schaeffer (1989) includes several genera besides *Platysomus,* e.g. *Cheirodopsis* and *Ampbicentrum.*

Dorypterus was a deep-bodied, laterally compressed fish and is known from the Upper Permian of Germany and Durham. The body is naked with a very long dorsal fin behind the head. The fins are similar to platysomids, but the skull is reduced and most of the scales and teeth are lost. It is the only known representative of the Order Dorypterida, whose affinities have not been determined (Schaeffer, 1973) and is known from a single species *D. hoffmani* that occurs in the Kupferschiefer and the Marl Slate. *Dorypterus boffmani* was first described and named by Germar (1842) from a specimen from the Kupferschiefer of the Eisleben district, Germany. The first English examples were described by Hancock and Howse (1870a) from four specimens collected by J. Duff from the Marl Slate of Middridge in the 1860s and 1870s (Figure 10.6). These were redescribed by Gill (1925) and Westoll (1941).

Many families of Mesozoic fishes have neopterygian features, including the ancestral features of the teleosts. The earliest known neopterygian is *Acentrophorus,* which is distinguished from 'chondrosteans' by the presence of an interopercular and the separation of the maxilla from the opercular series (Schaeffer, 1973; (Figure 10.7)). *Acentrophorus* is classified among the Semionotidae, which includes many other genera from the Mesozoic, *Semionotus* from the Triassic and *Lepidotes* from the Upper Triassic and Lower Cretaceous. *Acentrophorus* (Figure 10.7) is small (about 7 cm long), and covered with overlapping cycloid ganoid scales. The tail is heterocercal, but the axial lobe is reduced to a single row of scales. (In later neopterygians it became reduced to a homocercal tail.) The jaw suspension is upright and teeth are present only at the front.

Chondrichthyans from the Marl Slate include holocephalians. The petalodontids are an extensive group of chondrichthyans that appear in the Lower Carboniferous and continue into the Permian. Very little is known of the body form of these soft-bodied fishes, but rare specimens of *Janassa* show that this petalodont had a dorso-ventrally compressed body and large pectoral fins like a small modern-day ray (Hancock and Howse, 1870b). *Janassa bituminosa* (Figure 10.8) has a large rostral cartilage in the head, and some cartilages in the pectoral and pelvic fins are preserved. It has no fin spines. The tail tapers to a point, with a large epichordal lobe. This fish was stenophagous (i.e. feeding upon a limited or single type of food) and its stomach contents include broken brachiopod shells, crinoids, foraminifera and fragments of large crabs.

The coelacanth *Coelacanthus granulatus* (Figure 10.9) is the type species of this genus, and described by Schaumberg (1978) based only on German specimens. It was a small- to medium-sized fish, slender and with a narrow head, big eyes and deeply opening lower jaw There were two dorsal fins, only the posterior of which was lobed, and the lepidotrichia of the anterior dorsal fin articulates directly with the internal element. The tail was typical for coelacanths and was three-lobed. The swim bladder was calcified.

Interpretation

The Marl Slate is interpreted as a shallow-water marine deposit. It is generally reckoned to be the oldest unit in the British Late Permian, and is treated as a correlatable stratigraphical marker that stretches from north Nottinghamshire, through central and east Yorkshire, south Durham, the Durham coast and into the North Sea (Smith *et al.,* 1974; Smith, 1989; Smith and Taylor, 1992). It is correlated with the Kupferschiefer of north-west Europe (Lower Zechstein), and is regarded as marking a series of anoxic events prior to the main flooding of the Zechstein Basin in the first of five cycles.

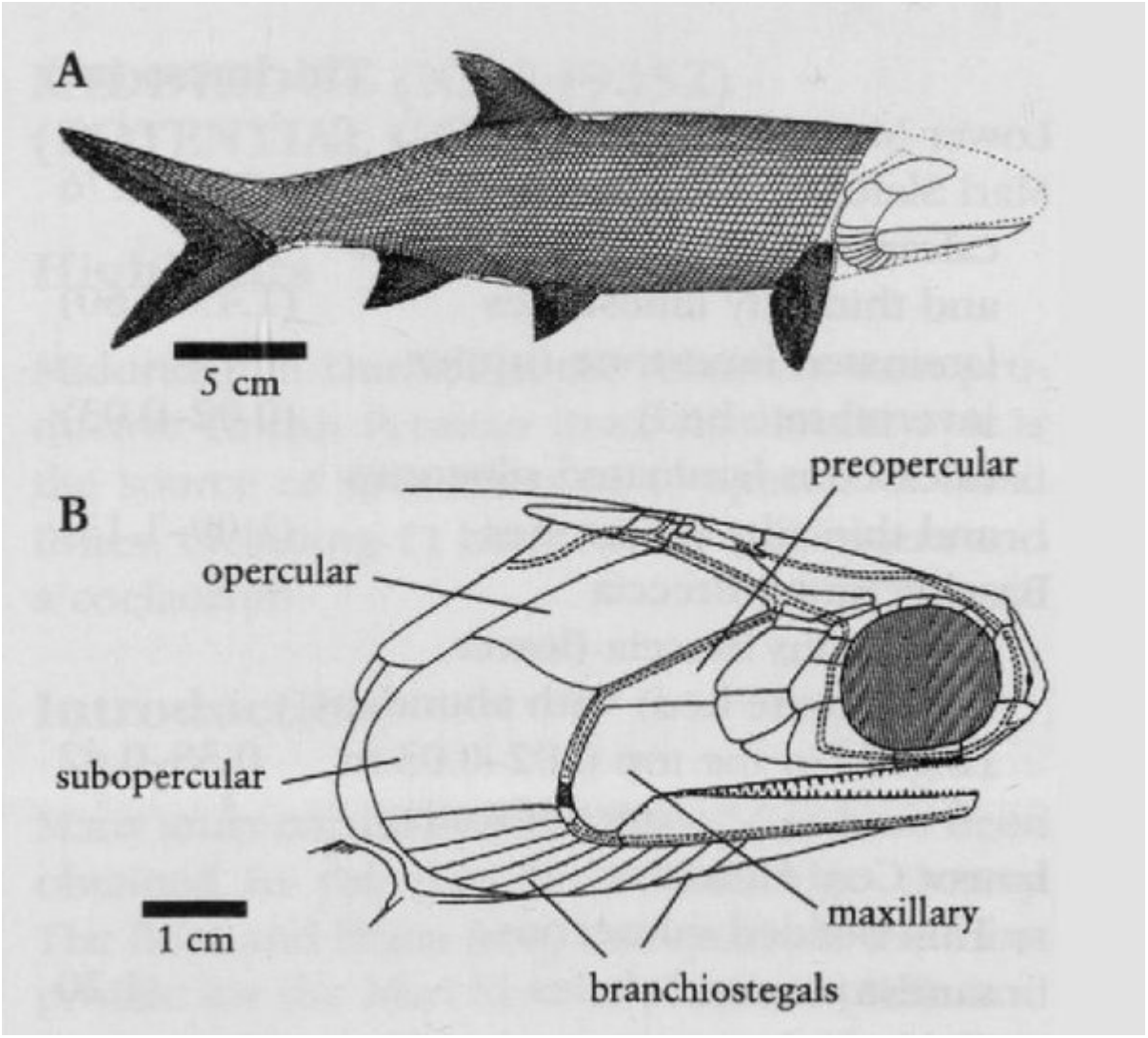
Fossil fishes have been found elsewhere in the Marl Slate of Durham, namely at Eppleton Quarry or High Downs Quarry [NZ 360 483] near Hetton-le-Hole, and Quarrington Quarry [NZ 329 378]. Outside Britain, the most closely comparable fish-bearing formation to the Marl Slate is the Kupferschiefer of Germany. This is a similar fine-grained, flaggy rock in which specimens are well preserved, flattened on individual laminae. The Kupferschiefer has produced identical species of fishes, invertebrates, plants and reptiles (see Haubold *et al.,* 1985). The Middridge Marl Slate fish appear to have been a nearshore assemblage feeding on soft aquatic vegetation (*Dorypterus*)or on shellfish (*Platysomus*). Westoll (1934) suggested that the fish inhabited water with dense masses of vegetation that offered shelter for predators. The larger predators were relatively few; *Coelacanthus* had a very wide gape to the jaw and could have seized palaeoniscid prey easily. *Pygopterus* was relatively big (i.e. 50 cm long; see (Figure 10.11)) and was a powerful predator. The chondrichthyans were not especially large. *Wodinka* (Figure 10.10) probably fed upon arthropods, while *Janassa* was a benthonic durophagous petalodont (Malzahn, 1986).

Schaumberg (1978) has made a study of the fossil fish assemblages of the German Kupferschiefer and estimated the percentages of the different genera present (Figure 10.11). It is likely that the figures for the fossil fish genera present in the British site would be similar, with the larger actinopterygians and the coelacanth at the apex of the trophic pyramid.

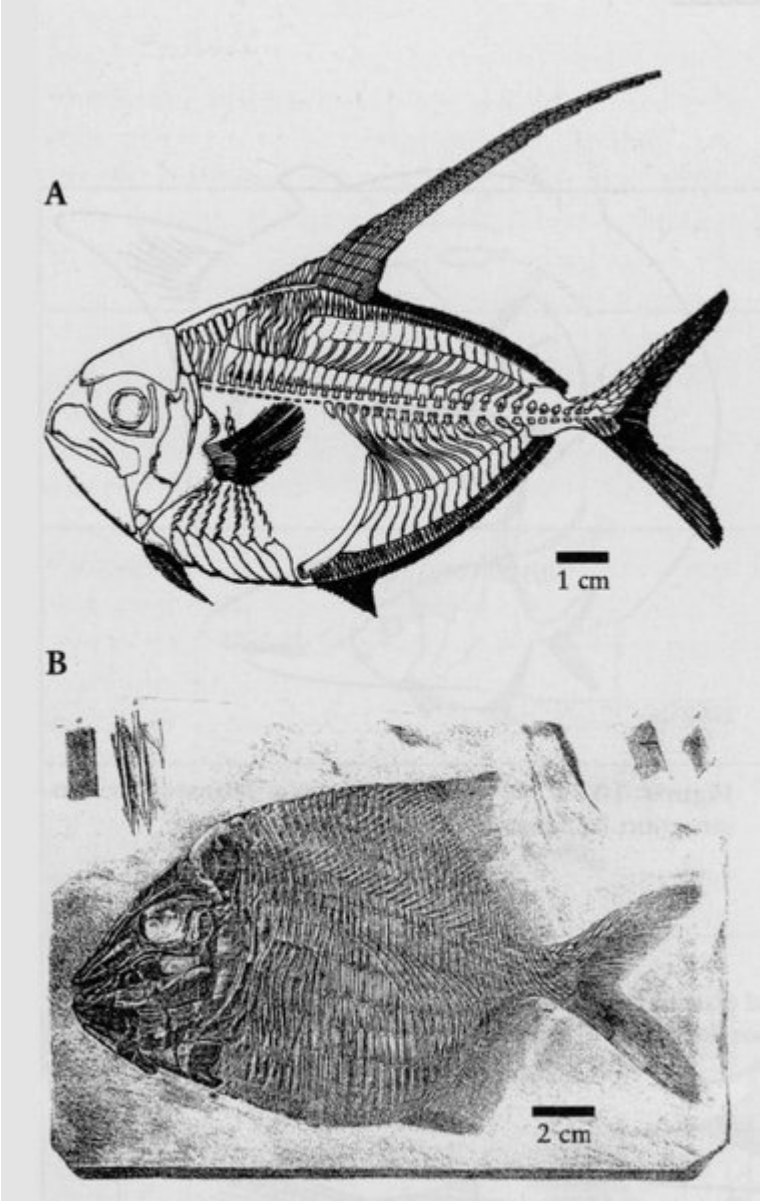
Conclusion

The fossil fishes from the Marl Slate at Middridge are diverse and reasonably abundant. Its conservation value arises from it being the most productive of British Permian fish sites. Although the site is rather overgrown now, recent excavations produced a number of fossils (Bell *et al.,* 1979, p. 452), and there is a good chance of further discoveries.

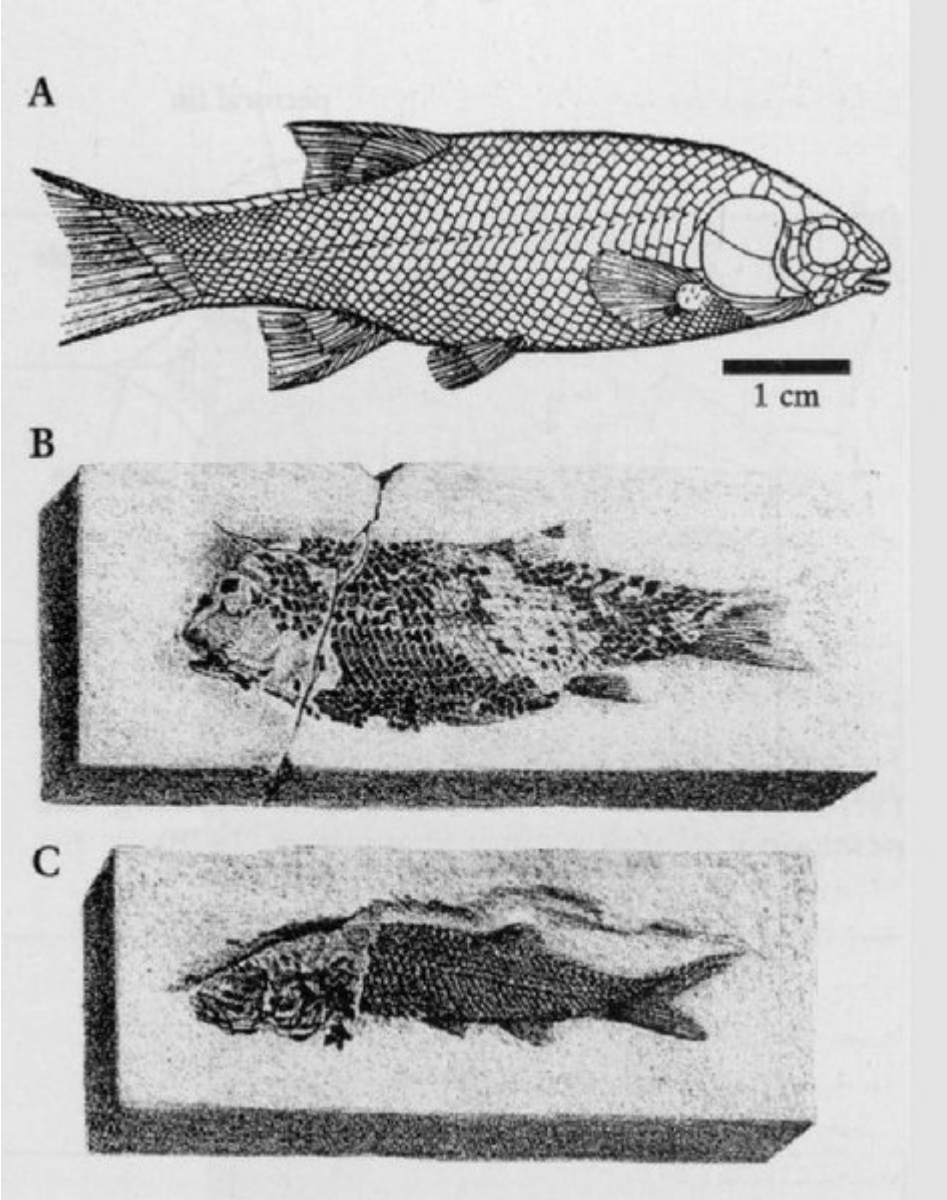
References



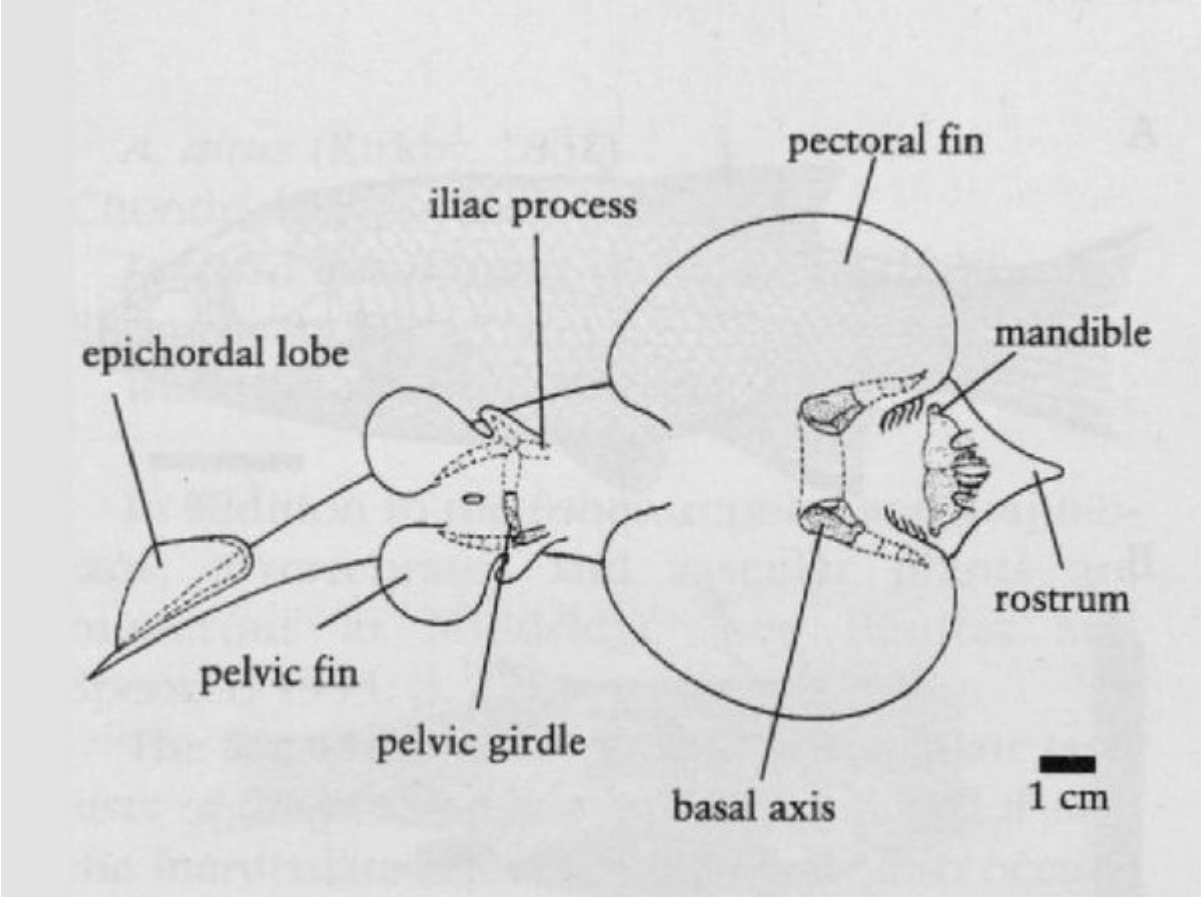
(Figure 10.5) The palaeoniscid Palaeoniscus freieslebeni Blainville: (A) restored lateral view (after Aldinger, 1937); (B) reconstruction of the head (after Westoll, 1941).



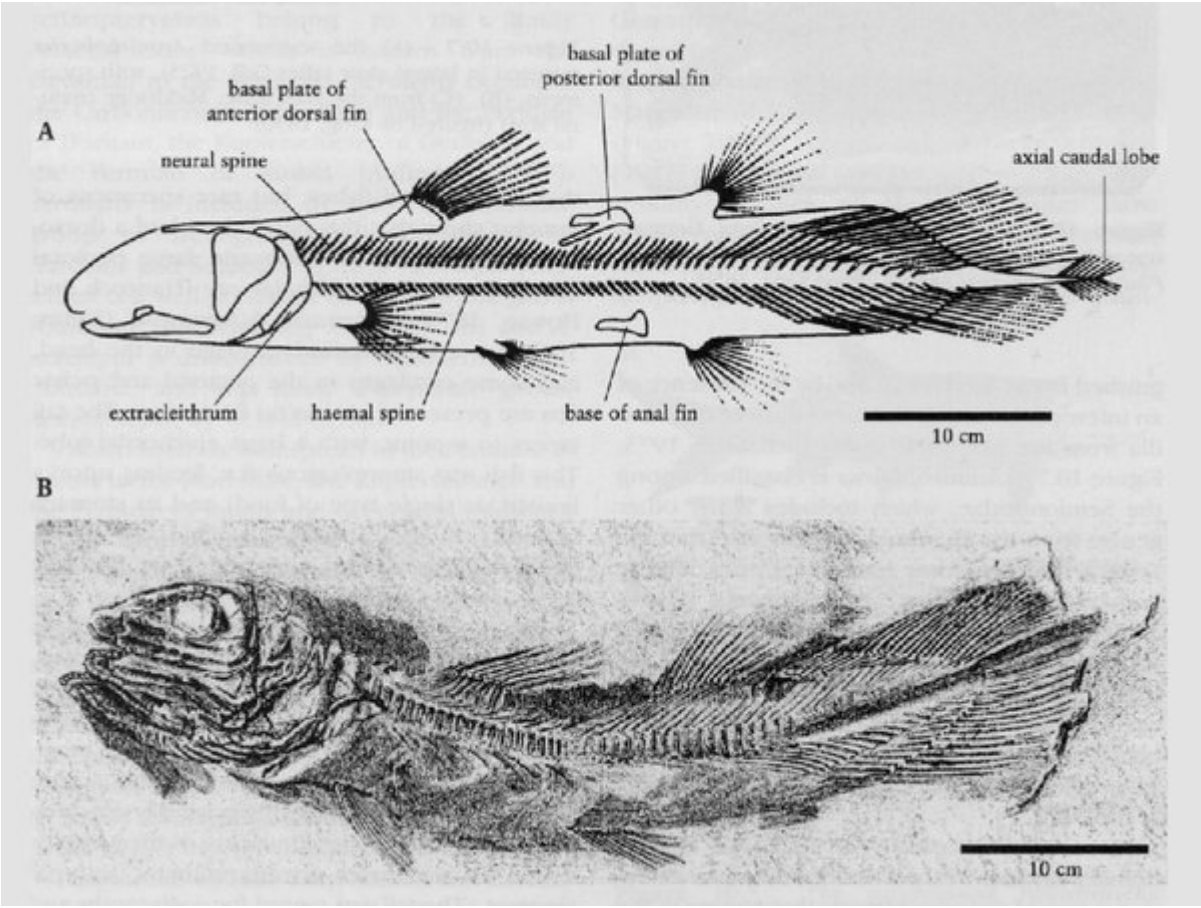
(Figure 10.6) (A) Dorypterus hoffmanni Germar, restoration in lateral view (after Westoll, 1941); (B) Platysomus striatus Agassiz (from King, 1850).



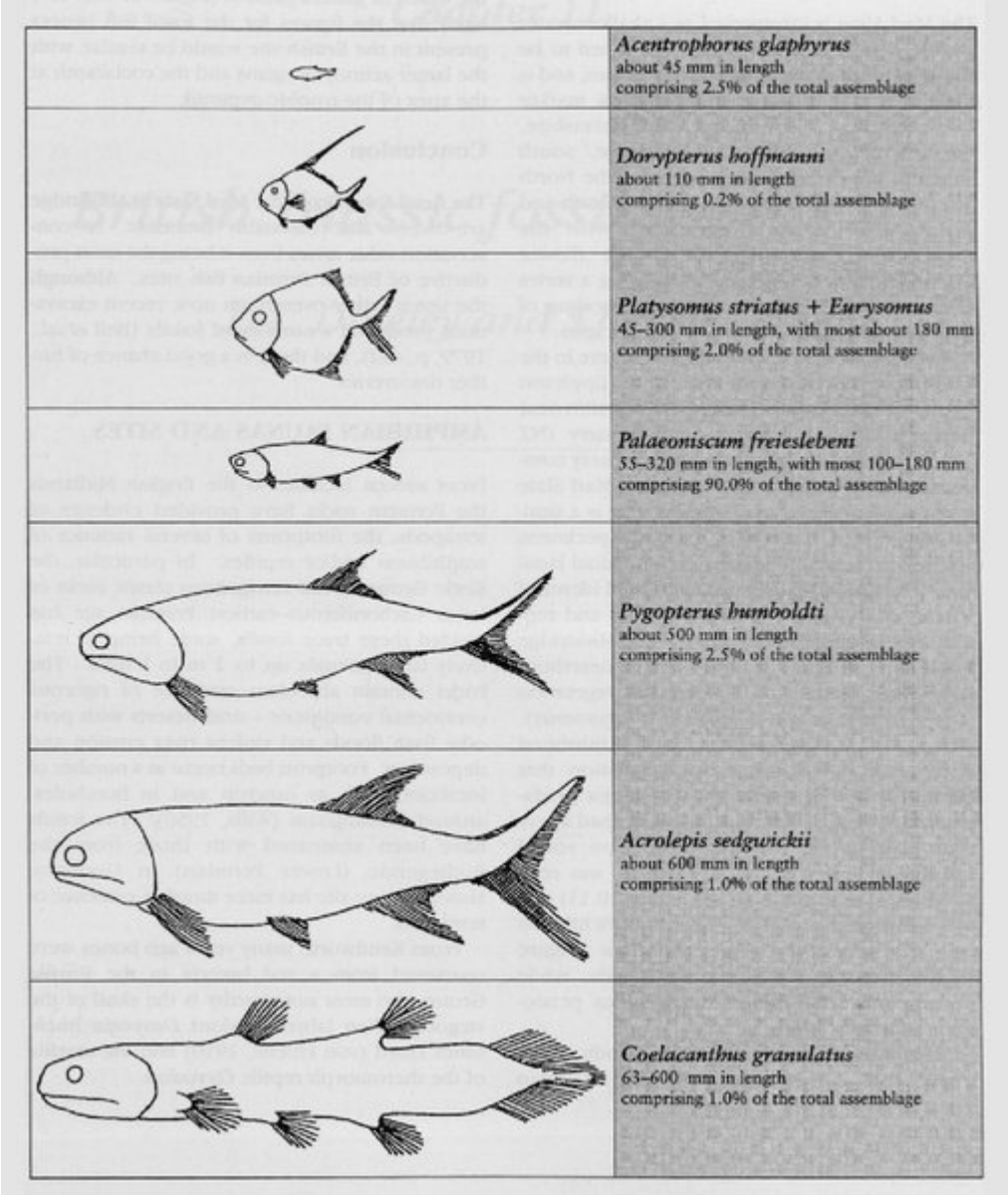
(Figure 10.7) (A) the semionotid Acentrophorus restored in lateral view (after Gill, 1925), with specimens, (B), (C) from the Marl Slate, Middridge (natural size) (figured by King, 1850).



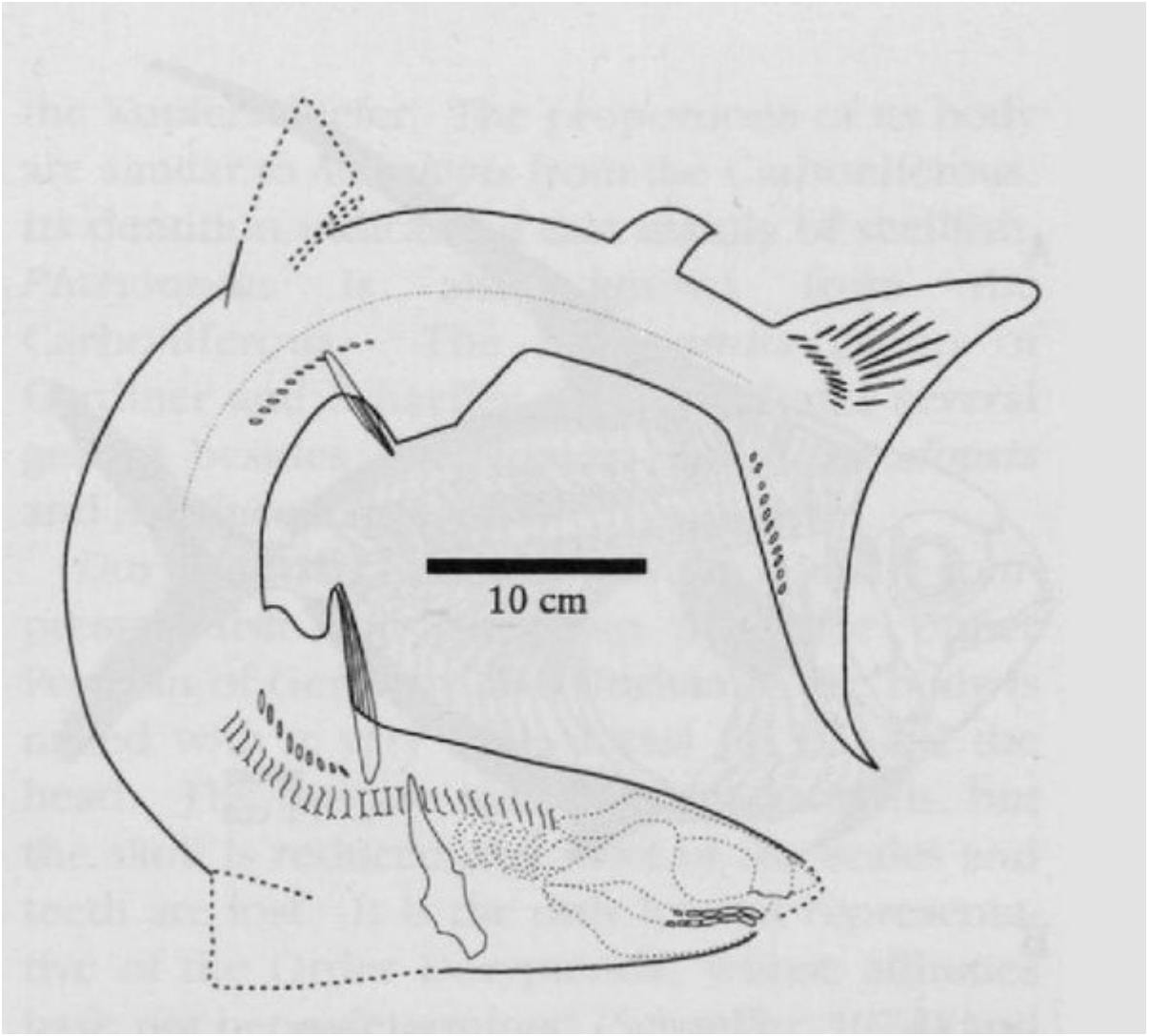
(Figure 10.8) The holocephalian janassa bituminosa (Schlotheim) in ventral view, and showing the petalodont dentition (after Shaumberg, 1978).



(Figure 10.9) (A) Coelacanthus granulatus Agassiz, a restoration in lateral view (after Moy-Thomas and Westoll, 1935); (B) specimen from the Marl Slate, Middridge, figured by King (1850).



(Figure 10.11) Components of the fossil fish fauna from the German Kupferschiefer, probably closely comparable to that at Middridge. Palaeoniscids make up more than 90% of the assemblage, while the larger actinoptery-glans and the coelacanth constitute less than 5% at the top of the trophic pyramid (after Schaumberg, 1978).



(Figure 10.10) Wodnika striatula Munster, reconstruction by Schaumberg (1978).