BEARSDEN

OS Grid Reference: NS53057325

Highlights

Bearsden in Glasgow, Strathclyde, is one of the most important fossil shark sites in the world, and many discoveries have been made there in recent years. It is the source of 14 species of fishes, including complete and superb specimens of sharks, and several unique bony fishes.

Introduction

The fish beds in shales in the Manse Burn at Bearsden were discovered in 1981 by S.P. Wood (Wood, 1982). In 1981 the NCC financed an excavation to expose these shales, and a temporary quarry, 5 × 3 m in area was worked, bed by bed, through the shales exposed there, by a team of workers from the Hunterian Museum led by Wood. Many new species were discovered, including complete fossil sharks, which are usually only known from teeth and spines because it takes unusual preservation environments to preserve the cartilaginous skeletons. The site also yielded the first complete *Deltoptychius*.

Several publications have appeared since Wood's (1982) announcement of the site. Dick *et al*. (1986) referred to the sharks, Clark (1990, 1991) has described some of the crustaceans, and Lowney (1983) and Coates (1993) have described new actinopterygians from the site.

Description

The Bearsden site exposes the Manse Burn Formation, which has been dated as Pendleian (earliest Namurian = earliest Serpukhovian), E_1 Zone, based upon spore, conodont and goniatite analysis. Clark (1989) defined the Formation as including the shales from the Top Hosie Limestone Marine Band to the base of the first thick sandstone. The Manse Burn Formation (Figure 9.27) has been divided into six members on the basis of sedimentology and fossil content: the Shrimp Member, the *Posidonia* Member, the Nodular Shale Member, the Platey Shale Member, the Betwixt Member and the *Lingula* Member. These members correspond roughly to the ‘beds' A–E described by Wood (1982).

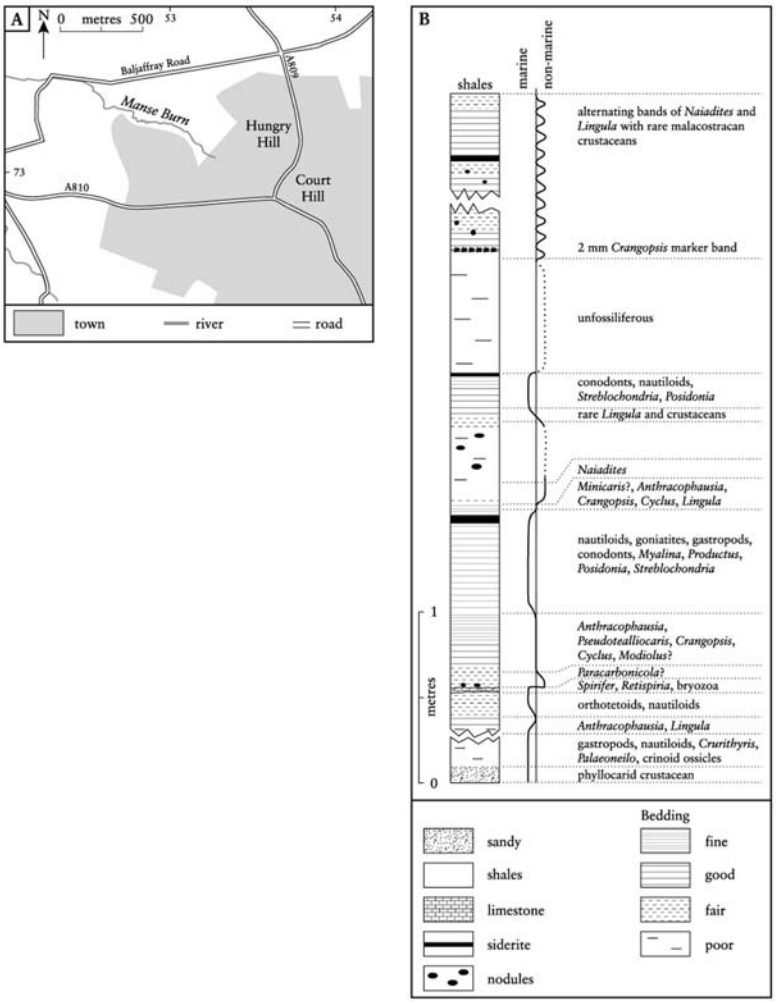


Figure 9.27: (A) Sketch map of the Bearsden area, Glasgow, with the stratigraphical section (B) found in the Manse Burn Formation (after Wood, 1982).

The fossil fishes and abundant crustaceans are in finely laminated shales of the Shrimp Member, which has now been identified at several other localities nearby (Clark, 1989). Some specimens were collected from weathered exposures along Manse Burn, but most came from the temporary quarry. Of the fishes, all but *Acanthodes* are restricted to certain beds. Some actinopterygians occur only in marine phases, others are restricted to transitional beds. The sharks *Stethacanthus* and *Tristychius* are mutually exclusive. *Tristychius* probably represents the non-marine *Diplodoselache* fauna described by Dick (1981) from the Oil Shales of Edinburgh (Wood, 1982).

Fauna

Acanthodii: Acanthodiformes: Acanthodidae

Acanthodes sulcatus Agassiz, 1835

Osteichthyes: Sarcopterygii: Rhizodont scales

Osteichthyes: Sarcopterygii: Actinistia

coelacanth head

Osteichthyes: Actinopterygii

Melanecta anneiae Coates, 1966 *Woodichthys bearsdeni* Coates, 1966

Palaeophoxinus mansei Coates MS

Frederichthys musadentatus Coates, 1993

Osteichthyes: Actinopterygii: Canobiidae

Mesopoma carricki Coates, 1993

M. smithsoni Coates, 1993

M. pancheni Coates, 1993

Osteichthyes: Actinopterygii: Amphicentridae

Cheirodus crassus Traquair, 1890

Chondrichthyes: Elasmobranchii: Symmoriiformes

Stethacanthus cf. *altonensis* (St John and Worthen, 1875)

Chondrichthyes: Elasmobranchii: Ctenacanthiformes

Tristychius arcuatus Agassiz, 1837

Onychoselache traquairi Dick, 1978

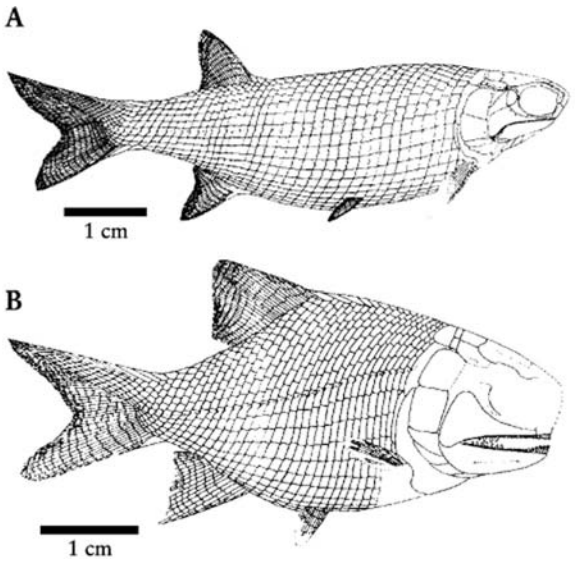
Chondrichthyes: Holocephali

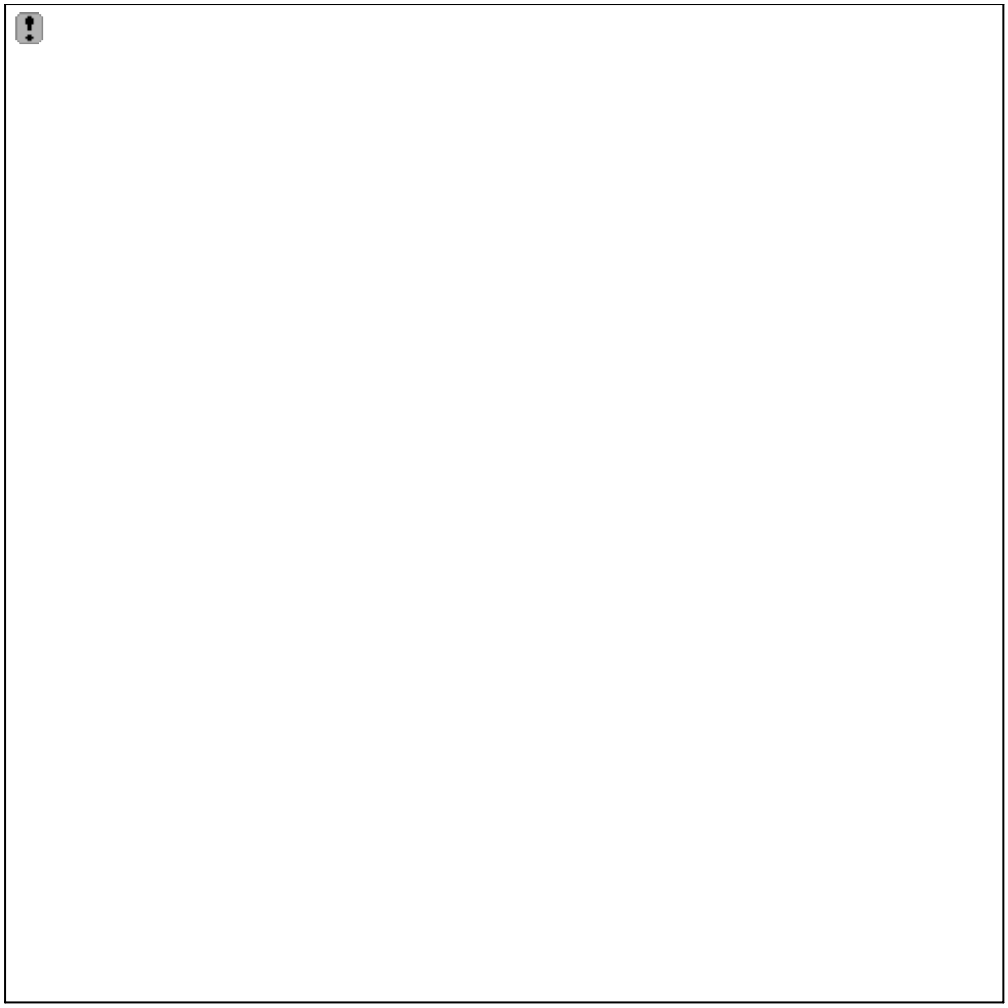
Deltoptychius sp.

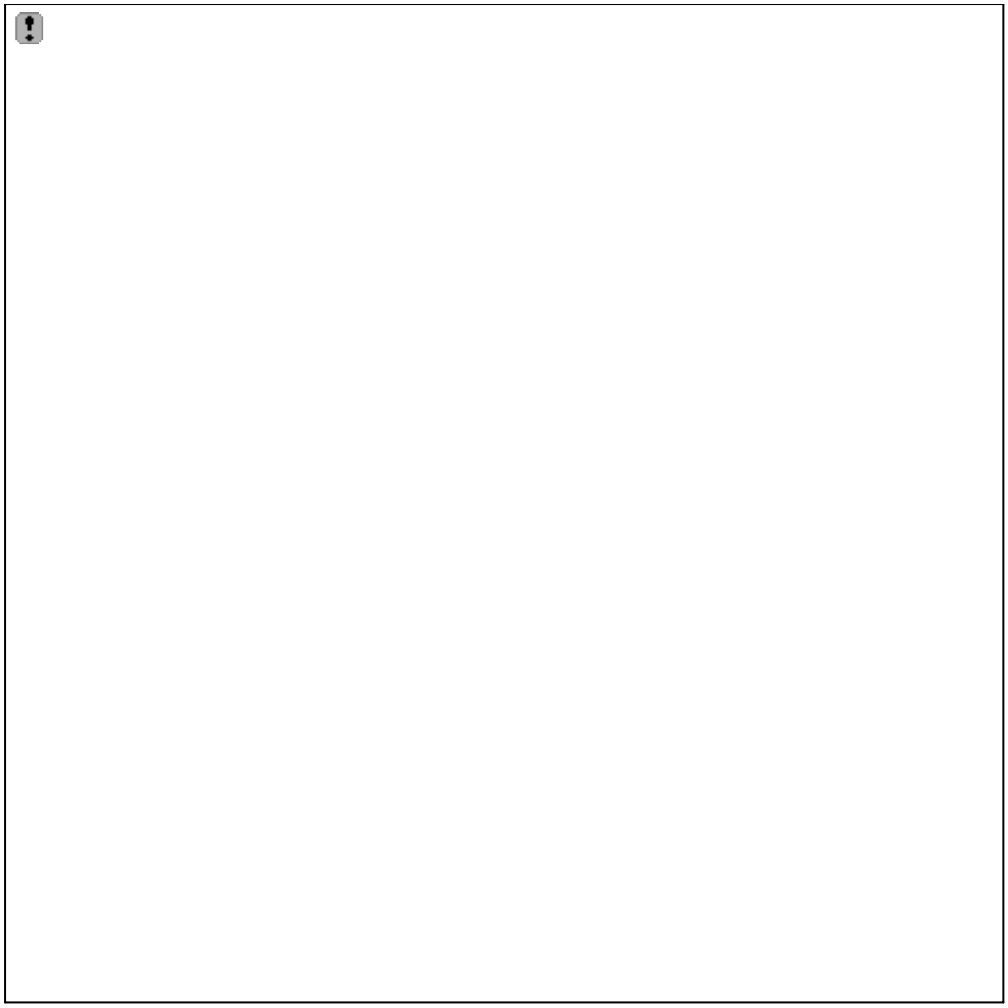
menaspid holocephalian

Acanthodes sulcatus occurs throughout the Bearsden section, and is not restricted to marine or brackish sediments. One specimen collected in 1981 contained the first known specimen of a Carboniferous acanthodian braincase (Wood, 1982). Dipnoans are absent, and there is a single isolated coelacanth head in the collection (Wood, 1982).

The marine actinopterygian fauna from Bearsden is unique (Figure 9.28), and bears no relationship to the marine palaeoniscids from Glencartholm (q.v.) or from South Africa (Wood, 1982). There are as many as eight species (Coates, 1988), of which Coates (1993) described three new species of *Mesopoma*, a genus already widely known from the Early Carboniferous of Scotland, and a new species of the new genus *Frederichthys*, a platysomid (Figure 9.28B). Several fine specimens of *Cheirodus crassus* Traquair, 1890 have also been discovered at Bearsden. They show for the first time that pelvic fins were present in this species.







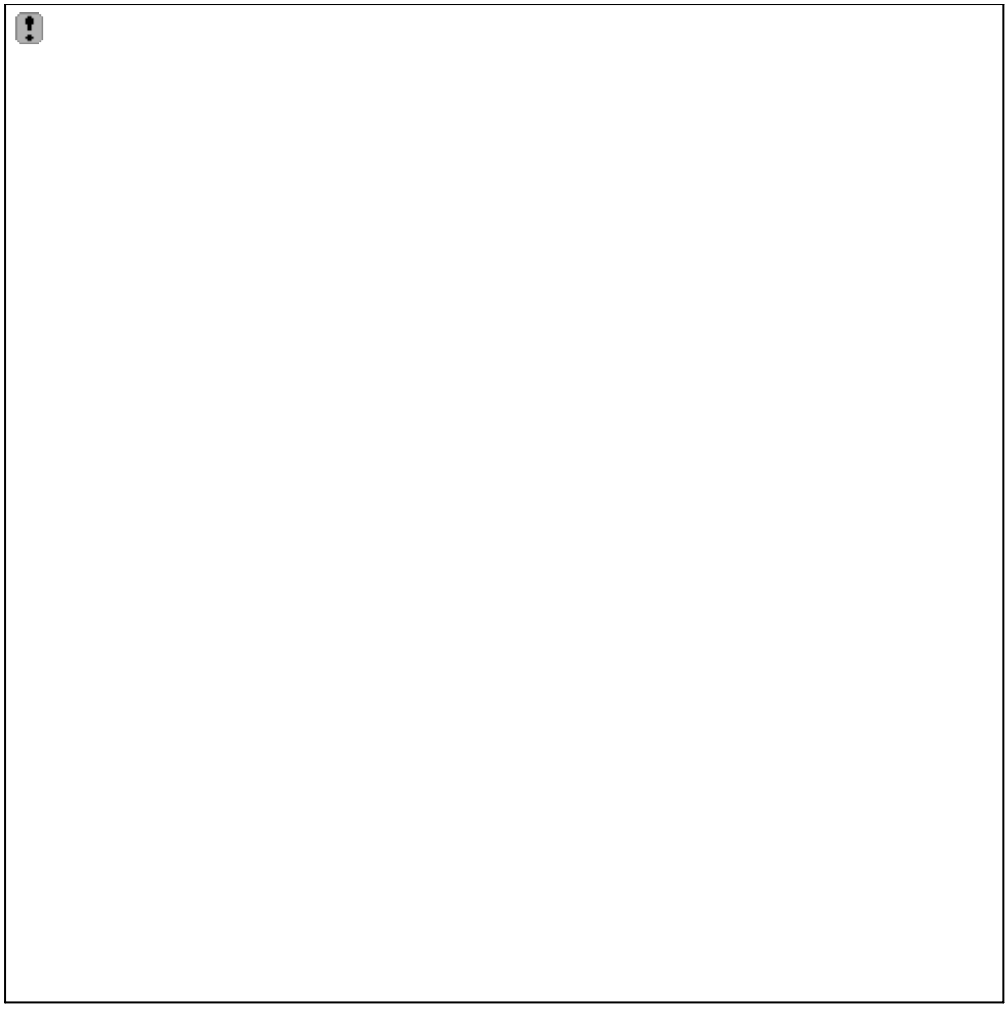


Figure 9.28: Bearsden actinopterygians: (A) Mesopoma carricki Coates in lateral restoration (after Coates, 1993); (B) Frederichthys musadentatus Coates, a composite restoration after the holotype GLAHM V 8286 (from Coates, 1993). Bearsden actinopterygians: (C) Melanecta annaea, GLAHM V 8255, × 2, photographed in UV light; (D) Mesopoma carricki, GLAHM V 8254, × 1.5, photographed in toluene; (E) Cheirodus sp., GLAHM, × 1.25 (Photos: courtesy of Hunterian Museum,, Glasgow).

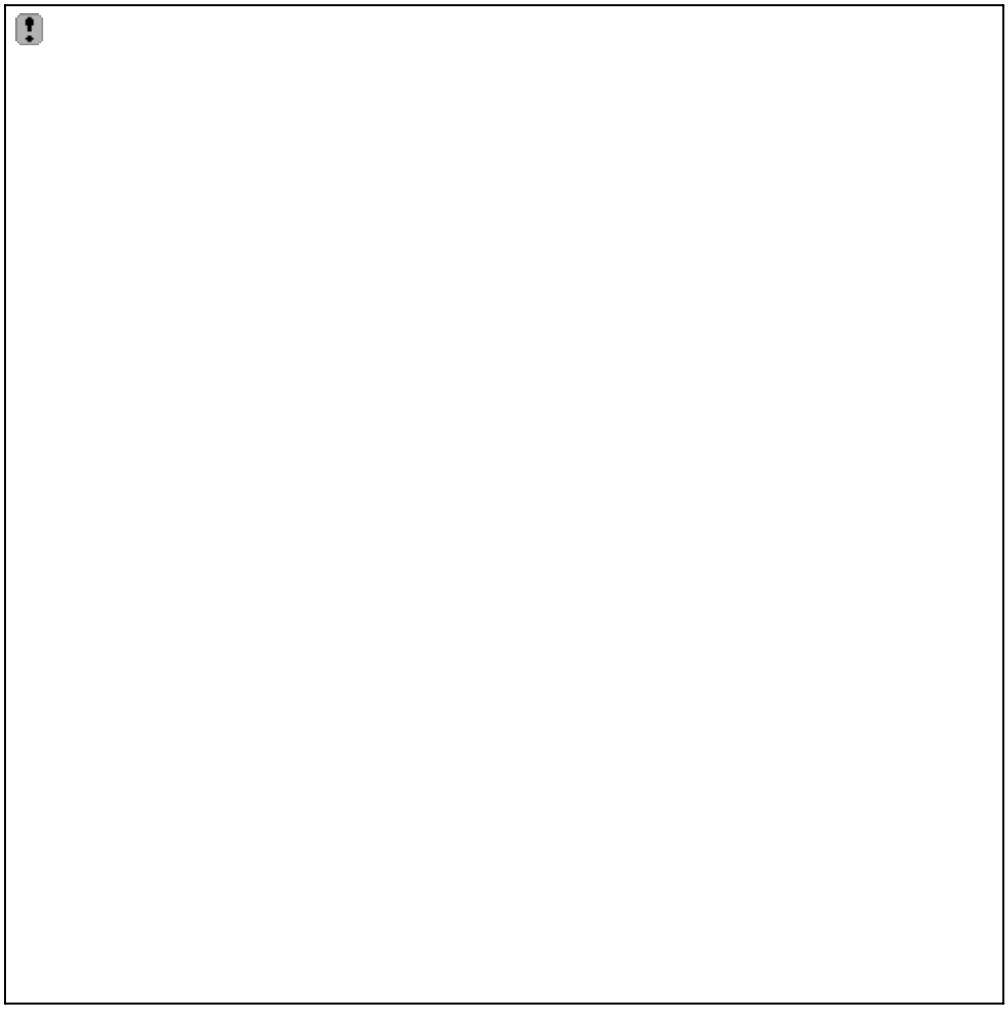
Outside North America, complete Carboniferous marine sharks are known only from Glencartholm (q.v.) and the Edinburgh area, and non-marine sharks are known exclusively from the Edinburgh area (Dick, 1978, 1981; Dick and Maisey, 1980; Wood, 1982). None of the marine sharks discovered at Bearsden occur at the Edinburgh or Glencartholm sites. The non-marine shark *Tristychius arcuatus* is present at Bearsden and in the Edinburgh area, but is absent at Glencartholm.

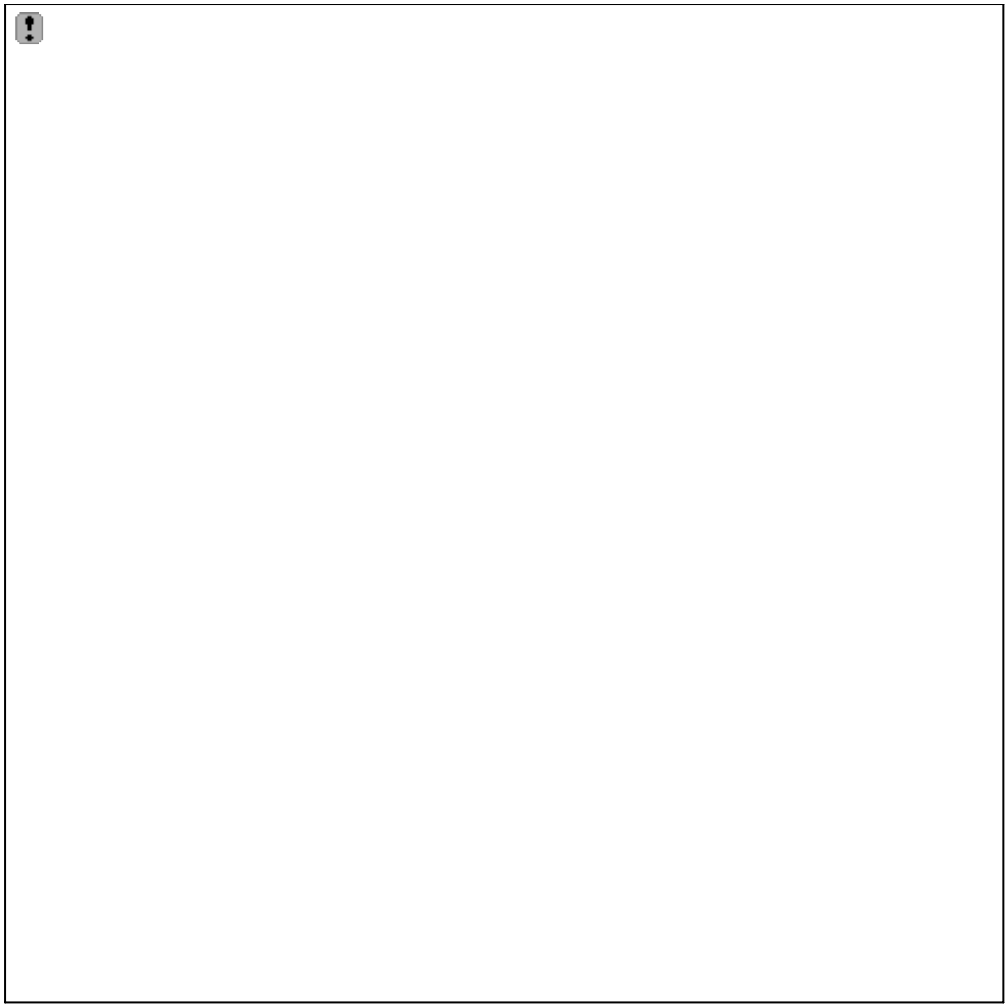
Stethacanthus is a shark from Bearsden which has a peculiar large toothed triangular ‘brush-organ' attached to the dorsal spine. The Bearsden material is referred to *S. altonensis*, which was first described from the Mississippian of Ohio, based on a large series of unornamented spines, i.e. spines unaccompanied by the ‘brush'. Complete specimens from the Bear Gulch Limestone of Montana allowed a fuller description (Williams, 1979, 1985; Lund, 1984). Wood (1982) suggested that the *S.* cf. *altonensis* from Bearsden may be synonymous with imperfect material *Cladodus neilsoni* from East Kilbride (Traquair, 1897b), but the name *Stethacanthus* is retained here.

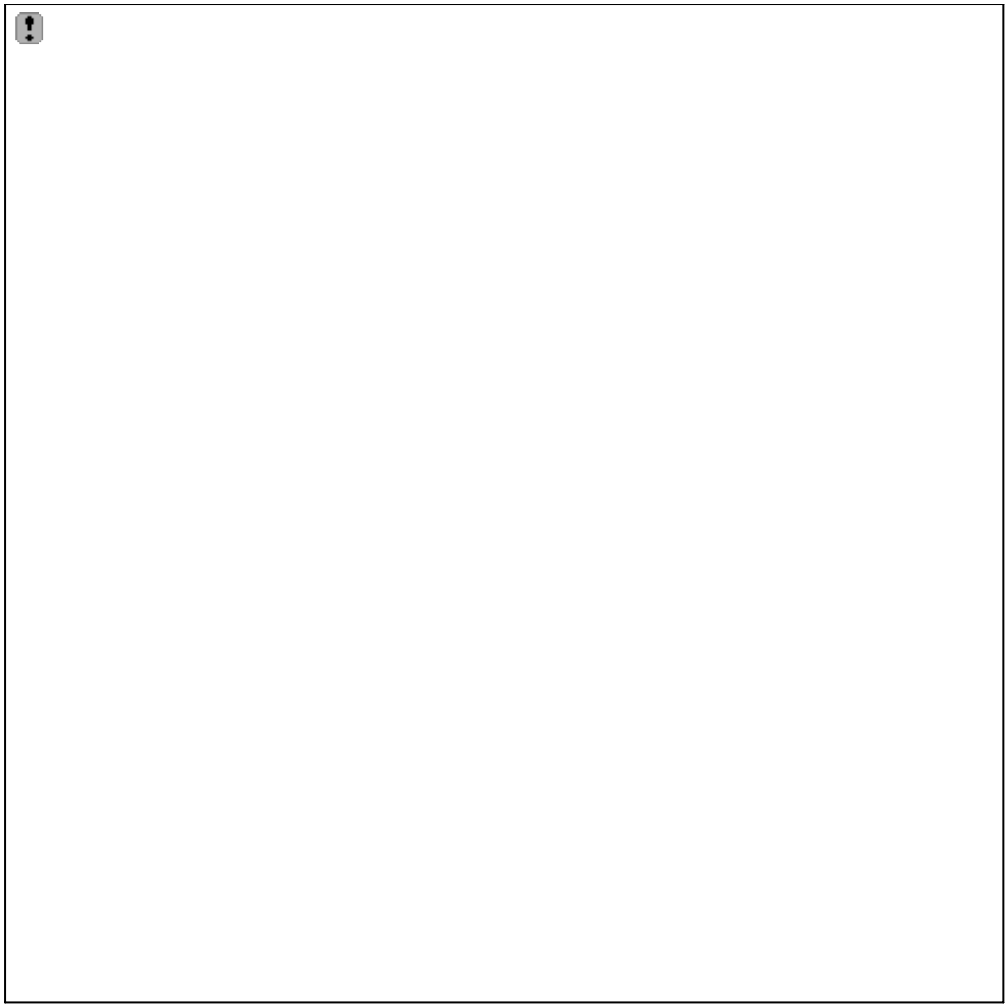
Stethacanthus is sole genus of the Family Stethacanthidae, known from the Late Devonian (Famennian) to Late Carboniferous (Moscovian) mainly of North America (Cappetta *et al.*, 1993). The taxonomy of species of *Stethacanthus* is much disputed (Williams, 1979, 1985; Zangerl, 1981, 1984; Lund, 1984, 1985a, 1985b, 1986).

Several complete specimens of *Stethacanthus* were found at Bearsden, but the following

description is based on the Bear Gulch specimens, which might not be the same species (Figure 9.29C). The Bearsden specimens have been briefly described byWood (1982), but await detailed examination. They show details of braincase, gill-rakers and gut contents, never before seen in related material, and refute the interpretations of Zangerl (1981; M.Coates, pers. comm., 1992). The brush spine is a broad triangular object whose outer surface is unornamented and which articulates with the mobile ‘brush'. It is much larger in the male. This is not a typical shark fin spine as it lacks an outer layer of orthodentine. The outer layer is probably trabecular dentine and it surrounds a conical central (pulp?) cavity (typical shark spines are like enlarged denticles in structure). Since the cavities in the trabecular dentine represent what is left of the pulp cavity, and since these extend to the spine's surface, the spines were probably covered by epidermis (Zangerl, 1981). The ‘brush' consists of fine fibres radiating upward and backward from the postero-ventral corner of the spine. The well-preserved Bearsden specimens show that it was calcified, thick, apparently inflexible and triangular in shape (Wood, 1982).







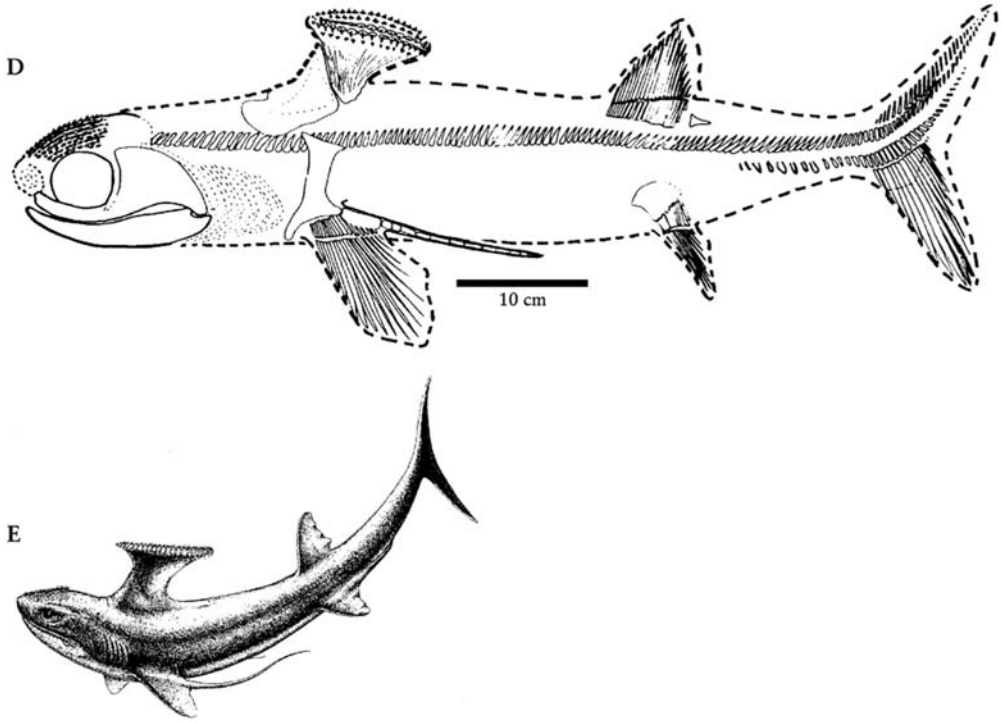


Figure 9.29: Bearsden fishes: (A) the acanthodian Acanthodes sp., GLAHM unnumbered photo in toluene and figured as a restoration in lateral view; (B) Deltoptychius, GLAHM unnumbered photo in toluene at × 0.3; (C) Stethacanthus sp. (the 'Bearsden Shark') GLAHM V8246 at × 0.25 (Photos: courtesy of Hunterian Museum,, Glasgow). (D) reconstruction of the Stethacanthus skeleton (after Zangerl, 1981); (E) the Bearsden

shark Stethacanthus sp., c. × 0.1.

There is no trace of shagreen denticles like those that are normally found in the skin of some sharks, except for patches on the ‘brush-organ' and head and along part of the lateral line (Zangerl, 1981). *Stethacanthus* has modified denticles covering the dorsal surface of the head and the upper edge of the ‘brush'. These are monocuspid, and those of the dorsal fin have polygonal bases that fit together into a mosaic pattern. The belt of denticles is between seven and nine wide at the front tapering to four or five at the posterior end of the ‘brush', and differs between male and female specimens. The male has a median row of denticles which are lengthened and straighter than the other denticles. These reach approximately 20 mm in height (Lund, 1974). The Bearsden specimens are described as increasing in size posteriorly in the male (Wood, 1982).

There is much variety in brush-organ shape, character of denticles and of the joints between the parts (and the brush-organ is often all that is preserved of a specimen). This could possibly be because more than one species is represented in the collections from North America.

The males were larger and had claspers. The pectoral fins were typical of the Symmoriida, and made up of two parts, a triangular ‘metapterygium' followed by a long, jointed free axial whip (Figure 9.29). This axial whip extends backwards well beyond the pelvic fins in the Bearsden male. Wood (1982) suggested that it could have been used to grip the female during copulation.

Wood (1982) described a Bearsden specimen of a dorsal spine and basal plate in articulation identical with that of the ‘primitive' Upper Devonian *Cladoselache*. Maisey (1977a) suggested that the unornamented dorsal spine of *Cladoselache* was deeply inserted, but Wood suggests that it might have been shallowly based like that seen in the life position in the Bearsden shark. Both species differ from most sharks in having the dorsal fin completely covered by epidermis (Zangerl, 1981).

Tristychius is a hybodont with fusiform body and relatively large fins. Not enough is known to group the Palaeozoic hybodonts adequately into families (Dick, 1978; Zangerl, 1981, p. 56).

Onychoselache traquairi is presumably that described by Wood (1982) as ‘a second shark species'; 125 mm long, with small cladodont teeth and a series of radials above the vertebral column.

Two Bearsden specimens of the first complete fossil bradyodont, *Deltoptychius* sp., to have been found in Britain await description (Figure 9.29B). They show how five separately named fossil fragments fit together to form one animal and that the eyes of *Deltoptychius* had previously been restored in entirely the wrong part of the head (M. Coates, pers. comm., 1992). *Deltoptychius* is the only genus of the Family Deltoptychiidae, defined as chimaeroids in which the headshield is fused into a single plate bearing the supraorbital sensory canals. Incomplete material of *D. armigerus* is known from several Scottish Early Carboniferous localities (Glencartholm, Ardross Castle and Abden; q.v.).

Interpretation

The shales of the Manse Burn Formation may have been deposited in conditions of varying salinity and oxygenation. The Shrimp Member, which contains the fishes and many crustaceans, shows evidence of sequential marine and non-marine environments, subject to seasonal fluctuations (Coates, 1993). The four marine communities proposed by Schram (1981) at Glencartholm occur together, indicating a broader range of ecological niches at Bearsden (Wood, 1982).

The ‘brush-organ' is one of the strangest features of *Stethacanthus*. Dorsally, the ‘brush' forms a platform that bears many dermal denticles (Zangerl, 1981). Lund (1974) misinterpreted this three-dimensional pectoral spine assemblage as a flat first dorsal fin. Williams (1979) re-examined the Bear Gulch specimens and noted the three-dimensional nature of what is now preserved flattened. The ‘brush' was vertically hinged upon the spine. Williams (1979) interpreted the function of the brush-organ complex as being for sexual display, rather than

locomotion, as Lund (1974) had thought. The male brush and spine are larger than the female and have a bigger platform with larger denticles. The male has a median row of lengthened denticles, the female has its smallest brush denticles along the midline. Zangerl (1981) described how the jointing could be used to change the shape of the organ, perhaps for sexual display, or could possibly be used as a threat, because the top of the head and the denticled brush-organ could take on the appearance of an enormous tooth-studded mouth. Wood (1982) suggested that the brush could have had a more violent purpose during foreplay, by comparison with some extant sharks that damage the females during sex.

Conclusions

The conservation value of the Bearsden site arises from its importance as one of the best Carboniferous fish sites in the world, and may be ranked alongside Glencartholm (q.v.) and Bear Gulch, Montana. Well-preserved fossil fishes of this age are universally rare, and the Bearsden sharks are the best-preserved cartilaginous fishes known from the Palaeozoic, matched only by species from the Bear Gulch Limestone in Montana. The collection also includes the first well preserved Carboniferous acanthodian braincase.

The controlled excavation of a small area of the fish-bearing units in the Manse Burn Formation in 1981 showed the wealth of the fauna, not only of fishes, but also of crustaceans, and the potential here for future excavation and collection.

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