Steeplehouse Quarry

[SU 288 554]

Highlights

Fossil fishes are very poorly known from Dinantian limestone sequences, and Steeplehouse Quarry in Derbyshire has produced the best fauna from this kind of offshore-marine facies. This site is the oldest UK stratigraphical occurrence of a neoselachian (modern-type) shark, and of the shark *Lissodus,* and the fish assemblage is dominated by sharks that lived in and around an ancient coral reef.

Introduction

A new fish bed was discovered in the early 1960s at Steeplehouse Quarry, Derbyshire, in a 1.5 m unit of crinoidal limestones with shale partings (Ford, 1964). A unit of these limestones, 1 m thick, contains large numbers of dermal dentides of *Petrodus patelliformis* plus other rarer fish teeth and fragments. Fish remains were first noted in this quarry by Shirley (1958), and the rich deposits were discovered soon after by Ford.

Ford (1964) suggested that Steeplehouse Quarry might be the type locality of M'Coy's (1848a) original description of *Petrodus patelliformis* for several reasons (see below). Bulk sampling by Ward and Duffin between 1972 and 1979 provided several rare teeth including two new species of shark (Duffin and Ward, 1983a; Duffin, 1985).

Description

The beds in the quarry are part of the Cawdor Limestones at the top of the Lower Carboniferous (Dinantian) succession in Derbyshire, and referred to the P^1 goniatite Subzone of the Upper Viséan (Shirley, 1958; Ford, 1964; Duffin and Ward, 1983a). This unit is dated as latest Viséan (late Brigantian), and probably P^2 Subzone, by George *et al.* (1976, p. 30).

A varied fauna of invertebrates found in both the limestones and the shale partings includes corals, brachiopods, bryozoans and crinoids (Ford, 1964). The fish remains are present as scattered pieces throughout the 1 m of limestones, but are concentrated at the top of each limestone bed and within the shale parting itself. Samples of the shale partings reached 20% by weight of dermal denticles. The shale partings die out laterally southwards; and the presence of denticles within the limestone also thins rapidly westwards. Their occurrence was shown to be concentrated within a small thickness of beds over an area not more than 50 m across from north to south (Ford, 1964). Duffin and Aldridge have continued to study microvertebrate material from Steeplehouse Quarry and have kindly provided additions to the formal list.

Fauna

Chondrichthyes: Elasmobranchii *incertae sedis*

Cooleyella fordi (Duffin and Ward, 1983)

Lissodus wirkworthensis Duffin, 1985

Thrinacodus ferox (Turner, 1982)

Pristodus cf. *falcatus* Davis, 1884

Protocrodus sp.

Symmorium cf. *reniforme* Cope, 1893

?Triodus sp.

'*Harpagodens*'(= Thrinacodus)

Petrodus patelliformis M'Coy, 1848

Cladodus sp.

Indeterminate xenacanth, petalodont, and hybodont teeth, dermal denticles and plcoid scales

Osteichthyes: Actinopterygii

Indeterminate actinopterygian teeth, scales, and vertebrae

Denticles described as *Petrodus* or *P. patelliformis* are known worldwide in the Carboniferous (Zangerl and Richardson, 1963; Chorn and Reavis, 1978). Denticles of this type occur on many different kinds of chondrichthyans, in the same way as those called *Listracanthus* (Zangerl, 1981). A specimen, from the Upper Carboniferous of Arkansas, USA, is described with *Petrodus* denticles in association with teeth which can be identified as *Carcharopsis* (Zangerl, 1981). *Listracanthus* denticles consist of dense dentine and have been thought to be spines in the past because they may be 0.05 m long, or more. *Petrodus* denticles consist of trabecular dentine beneath a thin layer of orthodentine (Zangerl, 1981). Zangerl (1981) believed that *Listracanthus* has a dermal skeleton of listracanthi and petrodi, whereas *Petrodus* was a very large animal (about 1 m long) armoured exclusively with petrodi, and with a dentition of *Carcharopsis* teeth. Neither *Listracanthus* nor *Carcharopsis* have been recorded from Steeplehouse Quarry.

M'Coy (1848a) regarded *Petrodus patelliformis* as 'abundant in some parts of the Derbyshire limestone' but gave no locality. The type material was collected by Hopkins, who discussed the Derbyshire limestones (Hopkins, 1834) without referring to any fish localities. Green and Strahan (1887) did not list Steeplehouse as a fish locality, and did not list *Petrodus patelliformis* as occurring at the other Derbyshire fish sites, so Ford (1964) suggested that it is possible that this is the type locality for the species.

Only dermal denticles have been found at Steeplehouse, and they have been assumed to represent a hybodont (Ford, 1964), identical denticles being found on a specimen from Pendlesides in association with a pectoral girdle and skull, and used to describe the species as a hybodont (Moy-Thomas, 1935). This has since been referred to a new genus and species, *Moyacanthus thomasi* Zangerl, 1981, but the denticles are removed from the species description because they are ubiquitous in the Carboniferous and do not appear to have any specific relationship to the bones in the specimen, being described as 'strewn amongst the cartilages' (Zangerl, 1981).

The teeth of *Lissodus* are distinct from other hybodont teeth (Figure 9.26). They are small to moderately large, with deep crowns. A small labial peg is present and supported by a labial root buttress in some species (Duffin, 1985). *Lissodus* is widespread, known from freshwater and marine deposits from the Lower Carboniferous (Viséan) to Upper Cretaceous (Maastrichtian) of Britain, north-west Europe, Russia, USA and South Africa (Duffin, 1985, 1989). This is its oldest site. It is normally thought of as a Mesozoic genus, many species occurring in the Jurassic and Cretaceous.

Lissodus wirkworthensis is represented by 29 teeth, 1–2 mm long obtained by bulk sampling from Steeplehouse Quarry (Duffin, 1985).

Duffin and Ward (1983a) erected a new family, the Anachronistidae, for teeth found in the Lower Carboniferous of England and Wales, and the Early Permian of Nevada, USA. *Anachronistes fordi* from Steeplehouse is the type species. Recently, however, Duffin, Richter and Neis (in prep.) have amended the diagnosis while reporting *Anachronistes* to be a junior synonym of *Cooleyella* Gunnell (1933). Duffin (1980a) and Duffin and Ward (1983a) suggest that the arcuate or V-shaped basal root face is typical of neoselachians of superorders Squalomorphii, Squatinomorphii or Galeomorphii, and this is probably a synapomorphic character.

The neoselachian *Cooleyella* shares several characters such as the labial buttress and the central vascular root pit with the teeth of the Early Jurassic *Squatina* and *Orectolobus.* The teeth of *Cooleyella* are envisaged as being arranged in distinct tooth rows, either as in *Squatina,* or with an overlap between lateral blades of teeth in successive tooth rows. The tooth shape shows that this shark was adapted to a durophagous and bottom-living habit. Duffin and Ward (1983a) suggested that it might have been dorso-ventrally flattened, with large pectoral fins, like the recent wobbegong (*Orectolobus*)and angel shark (*Squatina*).

Thirty-five teeth of *Cooleyella fordi,* varying from 1–2 mm in length, were obtained from Steeplehouse Quarry by Duffin and Ward (1983a). A single tooth was also found in Clwyd, North Wales. These are typical neoselachian teeth with a conical central cusp, well developed lateral blades and a basal flange, a V-shaped basal face to the root, and root vascularization. These specimens represent the earliest known neoselachian.

The pheobodont shark *Thrinacodus ferox* has now appeared at Steeplehouse Quarry (Duffin, 1993a) and teeth ascribed to this taxon have also been recorded from Late Devonian (Famennian) to Early Viséan rocks in Australia, Thailand, Poland, Morocco, New Mexico and China.

Interpretation

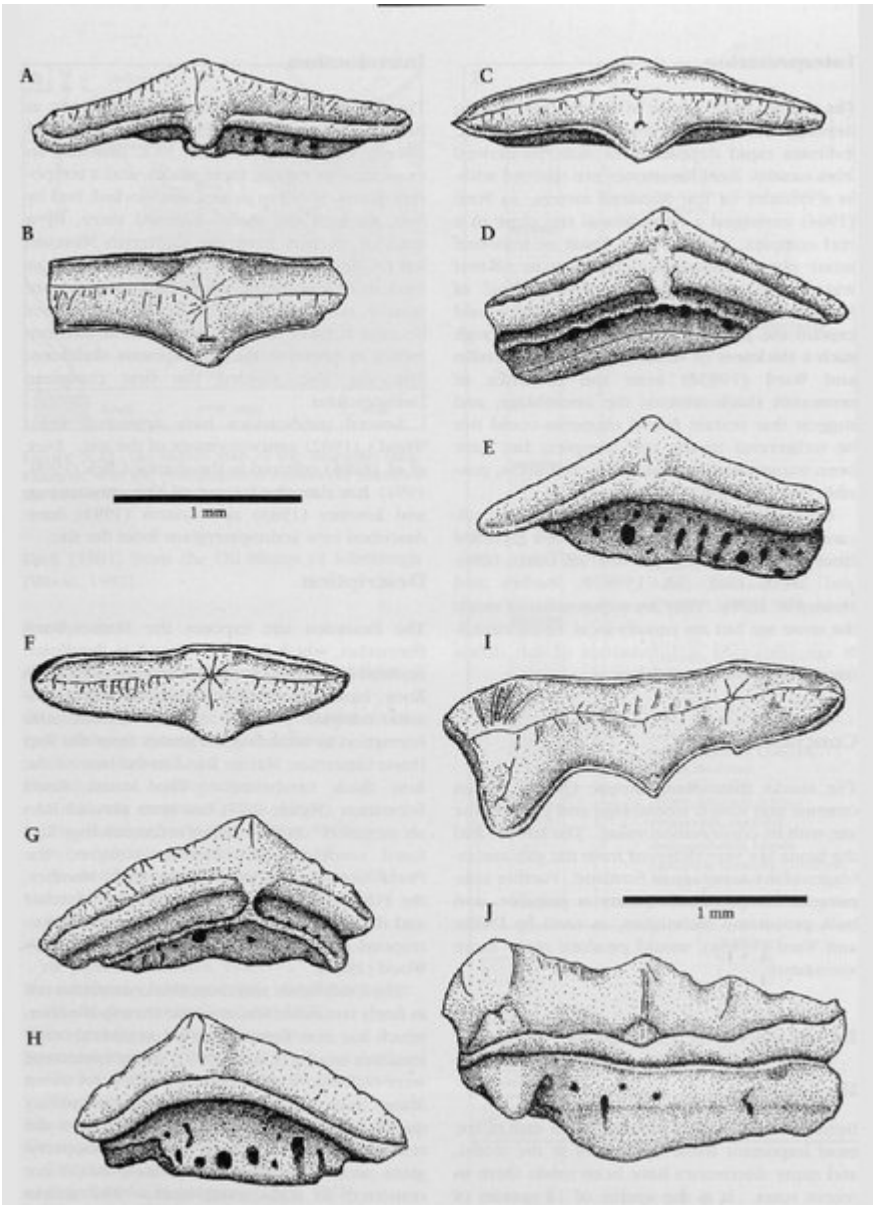
The coarse elastic nature of the denticle-bearing deposit, with the larger fossils being little-worn, indicates rapid deposition of material derived from nearby. Reef limestones are situated within a distance of few hundred metres, so Ford (1964) envisaged a depositional site close to a reef complex, perhaps as a result of inter-reef scour plus subsequent deposition in off-reef waters. It is also possible that a shoal of *Petrodus* inhabited the reefs, which would explain the presence of their remains through such a thickness of strata (Ford, 1964). Duffin and Ward (1983a) note the presence of xenacanth shark teeth in the assemblage, and suggest that certain faunal elements could not be indigenous to the reef complex, but have been transported in from freshwater areas, possibly from lagoons.

Other instances of shark teeth in off-reef calcarenites and 'Beach Beds' have been reported from Bolt-Edge Quarry ([SK 088 798]; Davis, 1886) and Treak Cliff ([SK 139 829]; Barkes and Holroyde, 1896). They are within strata of much the same age but are equally local, being virtually untransported accumulations of fish debris from large numbers of fishes.

Conclusion

The sharks from Steeplehouse Quarry are an unusual and varied assemblage and provide the site with its conservation value. The habitat and the fauna are very different from the fish assemblages of the same age in Scotland. Further sampling at Steeplehouse Quarry is possible, and bulk processing techniques, as used by Duffin and Ward (1983a), would produce many more specimens.

References



(Figure 9.26) Steeplehouse Quarry elasmobranchs. Teeth of the hybodont selachian Lissodus wirksworthensis Duffin: (A) NHM P 60741 in labial view; (B) P 60739 in occlusal view; (C) holotype P 60740 in occlusal view; (D) in lingual view; (E) labial view; (F) P 60752 in occlusal view; (G) labial view; (H) lingual view; (I) P 60748 in occlusal view; (J) labial view (after Duffin, 1985).