Stonesfield

[SP 387 171] (Potential GCR site)

Highlights

The Stonesfield Slates (Middle Bathonian) of Stonesfield, Oxfordshire, are historically important for yielding a diverse and well-preserved fauna of selachian and bony fish remains. Many type species of fish have been described from the site, and new finds continue to be made through acid preparation of the limestones.

Introduction

The series of quarries and mines that formerly worked the Stonesfield Slate at Stonesfield (Figure 12.14) are famous for yielding one of the most diverse vertebrate faunas of the Middle Jurassic. The Stonesfield 'slates', or 'tilestones' (Richardson *et al.,* 1946, p. 33) of Stonesfield contain an unusual mixture of marine, freshwater and terrestrial forms (Arkell, 1947a, pp. 40–1). The remains are all isolated elements, but include those of terrestrial animals such as mammals, tritylodont 'mammal-like reptiles', dinosaur, and pterosaurs, as well as marine reptiles and an abundant fish fauna (Phillips, 1871; Platt, 1758). The site has also been designated an SSSI for fossil reptiles and fossil mammals, and is included in the recent GCR review of British fossil reptile sites by Benton and Spencer (1995). Although the quarrying industry at Stonesfield is now extinct, re-excavation could produce many more finds.

In Roman times, local country houses were roofed with squared slabs of limestone 'slate'. In the 16th or 17th century it was discovered that when the freshly dug stone was exposed to the frost, it would split into thinner sheets. The quarries expanded production, providing roofing materials for local houses and building material for more important buildings farther afield (Arkell, 1947b). They remained productive until the late 19th century. The stone was reached by vertical shafts, usually about 6 m deep, and horizontal galleries were driven through the bed. During the 18th and 19th centuries, slate-digging employed numerous craftsman. The slate-makers examined each slab, and put aside fossils for sale. The last mine closed in 1911 (Arkell, 1947b; Aston, 1974).

Description

The earliest references to the stratigraphical position the 'Stonesfield Slates' are by Fitton (1828) who gave a section from a working adit in Stonesfield itself (given as *c.* [SP 397 172] by Boneham and Wyatt, 1993). Stratigraphical sections through the type Stonesfield Slates have been given by Fitton (1836), Phillips (1871), H.B. Woodward (1894), Watford (1895, 1896, 1897), Richardson *et al.* (1946) and McKerrow and Baker (1988). The section given by M.G. Sumbler (*in* Boneham and Wyatt, 1993) in the SSSI site Home Close Shaft, Stonesfield [SP 392 172], is abbreviated as follows:

	Thickness (m)
Hampen Marly Formation	7.75
Taynton Limestone Formation	
Limestone, oolitic, shell-fragmental, sparry, cross-bedded	1.13
Marl, oolitic, shell-fragmental, shelly;pebbles of limestone and sandstone in lower part	0.31
Limestone, oolitic, shell-fragmental, sparry	0.27
Stonesfield Slate	
Sandstone, fine-grained, calcareous, hard, with scattered ooliths; soft, cross-laminated and fissile at 12.7813.13 m [depth in adit]; continuing below in hard, laminated, fissile sandstone with strings of ooliths; variably oolitic from 13.30 m with oyster shells	1.06

Limestone, coarse-grained oolitic, shell-fragmental, sparry 0.28

The Stonesfield Slate occurs low down within the Great Oolite sequence and in sedimentary character is typical of the succession as a whole, being composed mostly of shallow-marine carbonate facies (Figure 12.15). The Stonesfield Slate tilestone facies consists of quartz sands and siltstones with fine laminae (0.1–0.3 m apart) of ooliths. The unit is no more than 1.8 m thick at its type locality and it is confined to an elliptical area within 1.5 km around Stonesfield ((Figure 12.14), based upon work by Aston, 1974, and Bonham and Wyatt, 1993).

The fauna consists of marine invertebrates (rare ammonites, belemnites, large numbers of bivalves and gastropods, 80 species altogether), rarer brachiopods, crustaceans, annelids and corals), land-derived plants (13 species), insects (seven species), about 40 species of fish, reptiles (about 14 species), and three species of mammals (Broderip, 1828; Phillips, 1871; A.S. Woodward, 1889a, 1890; H.B. Woodward, 1894; Richardson *et al.,* 1946; Benton and Spencer, 1995). The ammonite fauna has been assigned to the *progracilis* Zone (early Mid-Bathonian) with the Stonesfield Slates at Stonesfield as the stratotype (Torrens, 1974).

The bone in the Stonesfield Slate is well preserved and rarely abraded, although delicate processes may be broken off. The remains range from small elements (e.g. teeth and scales) to complete vertebrae and partial skulls. Skeletons are disarticulated. Thus there is evidence of short-term transport and sometimes violent breakage, and the bones may be associated with other coarse clasts (pebbles, shells, etc.).

Fauna

Major collections may be seen in the NHM, BGS(GSM), CAMSM, OUM. Most older university, city and private fossil collections in Britain have some teeth or bone scraps from Stonesfield, but are not recorded here.

Chondrichthyes: Elasmobranchii: Euselachii: Hybodontoidea

Asteracanthus semisulcatus Agassiz, 1837

A. *acutus* Agassiz, 1937

(*A.* (*Strophodus*) *favosus* (Agassiz, 1843) = A. *magnus*)

A. (*Strophodus*) *lingualis* (Phillips, 1871)

A. (*Strophodus*) *magnus* (Agassiz, 1838)

A. (*Strophodus*) *tenuis* (Agassiz, 1838)

Hybodus apicalis Agassiz, 1843 (fin spine)

H. dorsalis Agassiz, 1843

H. grossiconus Agassiz, 1843

H. Levis A.S. Woodward, 1889

H. marginalus Agassiz, 1843

H. polyprion Agassiz, 1843

Leptacanthus serratus Agassiz (fin spine), 1837

L. semisulcatus Agassiz (fin spine), 1839

Lissodus leiodus (A.S. Woodward, 1887)

Chondrichthyes: Elasmobranchii: Neoselachii: Batoidea

Breviacanthus (*Nemacanthus*) *brevis* (Phillips, 1871)

Chondrichthyes: Holocephali: Chimaeriformes

Ischyodus colei (Agassiz, 1843)

I. emarginatus Egerton, 1843

Ganodus bucklandi (Egerton, 1847) *nomen dubium*

G. dentatus Egerton, 1847

G. oweni (Agassiz, 1843) (= G. *falcatus* Egerton, 1843, *G. psittacinus* Egerton, 1843 and *G. neglectus* Egerton, 1843)

G. rugulosus Egerton, 1843 (= G. *curvidens* Egerton, 1843)

Pristacanthus securis Agassiz, 1837

Osteichthyes: Sarcopterygii: Dipnoi

Ceratodus pbillipsi Agassiz, 1838

Osteichthyes: Sarcoptcrygii: Actinistia

coelacanth indet.

Osteichthyes: Actinopterygii: Neopterygii: Halecostomi

Gyrodus perlatus Agassiz, 1844

Gyronchus (*Mesodon*) *rugulosus* (Agassiz, 1839–1844) (= *Gyrodus trigonus* Agassiz, 1837, *Pycnodus latirostris* Agassiz, 1844, *Pycnodus parvus* Agassiz, 1844)

G. (*Mesodon*) *tenuidens* (A.S. Woodward, 1895)

G. (*Scaphodus*) *heteromorphus* (A.S. Woodward, 1890) (= *Gyronchus ?oblongus* Agassiz, 1843)

Mesodon biserialis A.S. Woodward, 1889

M. bucklandi (Agassiz, 1833–1844) (= *Pycnodus hughii* Agassiz, 1844, *Pycnodus didymus* Agassiz, 1839–1844,

Pycnodus ovalis Agassiz, 1839–1844 and *P.* Agassiz 1844)

?Lepidotes unguiculatus Agassiz, 1837

Lepidotes tuberculatus Agassiz, 1837

Macrosemius brevirostris Agassiz, 1844 *nomen dubium*

Osteichthyes: Actinopterygii: Neopterygii: Halecomorphi

Aspidorhynchus crassus A.S. Woodward, 1890 (= *Belonostomus flexuous* Philips, 1871 and *Sauropsis mordax* Agassiz, 1844) *Belonostomus leptosteus* Agassiz, 1844

Caturus pleiodus Agassiz, 1844 *nomen dubium*

Osteichthyes: Actinopterygii: Neopterygii: Teleostei

'*Allothrissops*' *disjectus* A.S. Woodward, 1890

Leptolepis woodwardi Nybelin, 1974

Pholidophorus minor Agassiz, 1843–1844 *nomen dubium*

Ctenolepis cyclus Agassiz, 1843 *nomen dubium*

Interpretation

Sellwood and McKerrow (1974, pp. 204–5) noted sedimentary structures in the Stonesfield Slates that are indicative of deposition in upper flow regime conditions. Storm-produced scours occur filled with shell lags. The fossils point to a shallow-marine environment with a large input of terrestrial material. The bones, plants and insects may have been concentrated by rapid burial in sands brought offshore by storm-induced rip-currents. The features of bone preservation in a disarticulated state, and in coarse clastic units, point to sorting and rapid deposition, possibly during storms.

As in much of the Great Oolite Group of Oxfordshire, the clastic sediments and the land-derived plants and animals reflect the influence of the nearby London–Ardennes and Pennine–Welsh landmasses (Cope *et al.,* 1992), but the ammonites indicate that the Stonesfield Member is one of the few beds in the Bathonian of Oxfordshire to be deposited in proximity to open marine conditions.

The dating and precise stratigraphical position of the Stonesfield Slate have been problematic because of its limited exposure and outcrop (Figure 12.14), and because of the scarcity of ammonites. Most authors have assumed that the Stonesfield Slate was laterally equivalent to the 'Stonesfield Slate' of Eyford, Gloucestershire (the Cotswold Slate or Eyford Member), and even to units near Bath and in Northamptonshire, and it was once regarded as a useful marker bed for the base of the Great Oolite (Fitton, 1836; Hull, 1859; H.B. Woodward, 1894; Walford, 1895, 1896).

Following the pioneering work of the 19th century and most importantly after the extinction of the mining industry at Stonesfield, recent stratigraphical positioning of the tilestones at Stonesfield has retained a degree of uncertainty. The most recent stratigraphical work on the tilestones (Wyatt, 1981; Boneham and Wyatt, 1993) was based upon a re-evaluation of the early sections at Stonesfield and boreholes in both the Stonesfield (Boneham and Wyatt, 1993) and Cheltenham (Wyatt, 1981) districts, and confirms the early sections. The 'slates' at Stonesfield were worked at several different horizons from within the Taynton Limestone Formation: to the west and in the village they occur at the top and in the middle of the formation, whilst in the east they occur at a much lower level towards the base of the formation ((Figure 12.15), after Boneham and Wyatt, 1993).

The lithostratigraphical term 'Stonesfield Member' of the Sharps Hill Formation has been abandoned (see review in Boneham and Wyatt, 1993), whilst the 'Cotswolds Slates' (formalized as the Eyford Member) were reassigned to the newly defined Charlbury Formation (Boneham and Wyatt, 1993, p. 134), based on work in the Cheltenham and Cirencester districts (Wyatt, 1981).

Selachian remains, both hybodonts and neoselachians, are an important element of vertebrate faunas (Figure 12.16). (Many hybodont shark taxa were described from scattered teeth and fin spines from Stonesfield in the 19th century (Agassiz, 1833–1845; Phillips, 1871; Woodward, 1889a, 1890) and some of the species are probably synonyms). *Hybodus* teeth are particularly common in most facies, and are dominated by *H. grossiconus* and *H. polyprion,* species common in the Great Oolite Group (Woodward, 1890). Young (1984) has suggested that the teeth of *H. grossiconus* from Stonesfield are structurally similar to those of the primitive neoselachian shark *Palaeospinax egertoni* from the Toarcian of Holzmaden. Rarer multicuspid teeth may represent at least one other species. Other hybodont remains are the large crushing teeth of *Asteracanthus* (*Strophodus*)*magnus* and of the smaller A. (*S*) *tenuis* and rare A. (*S.*) *lingualis,* which are present within most facies at Stonesfield (Woodward, 1890). *Asteracanthus* has a heterodont dentition of large lateral crushing teeth and smaller cuspate anterior teeth (Cappetta, 1987) and is considered to be a large marine form (possibly attaining lengths of up to 4 m) that fed on crustaceans and molluscs.

Previous authors working on Bathonian specimens (e.g. Phillips, 1871; Woodward, 1890, 1892b) classified these different tooth forms (Figure 12.16) as several species, including A. (*S.*) *lingualis* and A. (*S*) *magnus* for the lateral teeth and A. (*S.*)*tenuis* for the anterior dentition, which are synonomous according to some authors (e.g. S. Metcalf and C. Underwood, pers. comm.). The fin spine taxon *A. semisulcatus* from Stonesfield was said by Woodward (1889a, p. 312) to be synonymous with the common tooth taxon, *A. magnus.*

Rarer hybodont teeth are represented by *Acrodus* sp., possibly synonymous with the small *Lissodus leiodus,* a species known from the Stonesfield Slates of Stonesfield, the Eyford Member of Minchinhampton and Severn-hampton, Gloucestershire, the Forest Marble of Afford, near Bath, Somerset, and Bajocian material from Brora, Scotland (Woodward, 1887b, 1889a, 1890; Savage, 1963; Duffin, 1985; S. Metcalf and C. Underwood, pers. comm.). Hybodont spines are uncommon, but are represented by *Hybodus apicalis* and *H. dorsalis* (probably synonymous with the most common tooth species, *H. grossiconus* and *H. polyprion;* Metcalf and Underwood, pers. comm.). The fin spine genus *Leptacanthus* represents a very rare element and is considered by some (e.g. Cappetta, 1987) to be congeneric with *Hybodus* or *Acrodus,* although earlier references (e.g. Woodward, 1890, p. 290) suggested a chimaeroid affinity.

No teeth of neoselachian sharks have been recorded from the Stonesfield Slates, but sampling may not truly reflect their absence.

Beak-shaped and triangular mandibular and palatine dental plates (Figure 12.16) are fairly abundant in both tilestone facies of the 'Stonesfield Slates' and Eyford Member and represent several species of the chimaeroids *Iscbyodus* (Figure 12.17) and *Ganodus.* Two species of *Ischyodus, I. colei* and *I. emarginatus,* three well-defined species of *Ganodus, G. oweni, G. dentatus* and *G. rugulosus,* and one poorly defined form, *G. bucklandi,* have been described from Stonesfield. Many more forms of *Ganodus* mandibular teeth were given specific names by Egerton (1843, 1847), but these were synonymized with the species listed above by Woodward (1889a).

The long list of bony fish remains from Stonesfield includes the type specimen of the lungfish *Ceratodus pbillipsi* and several bones, including gular plates and a pterygoquadrate in the NHM and OUM of an undetermined coelacanth (Woodward, 1890). The taxonomy of the pycnodonts from Stonesfield is a mess as numerous fragmentary dentitions and scales were given specific names by early workers (Prevost, 1825; Agassiz, 1833–1845; Phillips, 1871). Woodward (1889a, 1895a) attempted a revision of the faunal list. The type specimen (a vomerine dentition) of *Gyronchus* (*Macromesodon*) *rugulosus* was described from Stonesfield; this species also includes the species *Gyrodus trigonus,* named by Agassiz (1833–45) on an unabraded example (NHM) of the upper dentition, and *Pycnodus latirostris* and *P. parvus,* based respectively upon large and small splenial dentitions by Agassiz (1833–45; Woodward, 1895a). Other species described from Stonesfield *are Procinates biserialis* based upon lower dentition (Woodward, 1889a) and *Gyroncbus* (*Mesodon*) *tenuidens,* a small species known only from its splenial dentition (Woodward, 1895a, p. 207). The scale taxon '*Gyrodus perlatus*'is probably referable to *Macromesodon* (Woodward, 1889a, 1895a).

The semionotid *Lepidotes tuberculatus* Agassiz, 1837 is a dubious species described from scattered skeletal remains and scales in the Stonesfield Slates and other Bathonian deposits (Woodward, 1895a, pp. 88–9). *Macrosemius brevirostris* was named by Agassiz (1833–45) from material (a possible maxilla and left den-tary bone) recovered from the 'Stonesfield Slates', but Woodward (1895a, pp. 180–1) found them insufficient for taxonomic determination and the species should be regarded as a *nomen dubium.*

The aspidorhynchid *Aspidorhynchus crassus is* a small species known only from isolated jaws and skulls in the Stonesfield Slates of Stonesfield. Agassiz (1833–45) gave the name *Sauropsis mordax,* but did not figure or describe the remains, which A.S. Woodward later referred to this halecostome genus not previously recorded from the Middle Jurassic (Woodward, 1889a, p. 296). Agassiz (1833–45) recorded by name only the presence of *Belonostomus leptosteus* in the tilestones at Stonesfield, which Phillips (1871) later figured. Although this genus is easily confused with *Aspidorhynchus,* it may be a valid taxon (Woodward, 1889a, p. 296), as fragmentary skulls in the NHM suggested the presence of *Belonostomus in* the 'Slates'.

The teleosts are represented by *Leptolepis* and *Pholidophorus,* ' *Allothrissops*' (Figure 12.17)B and a dubious form based on rounded flank scales of an unknown actinopterygian, called *Ctenolepis cyclus* (Woodward, 1890). '*Allothrissops*' *disjectus* and '*L.*' *woodwardi* Nybelin are valid species based on abundant and well-defined fragmentary specimens, but *Pholidophorus minor* is based on a poorly preserved cranial roof and is a pholidophorid.

The reptile fauna of Stonesfield includes several aquatic piscivorous forms, such as the long-snouted crocodilians *Teleosaurus* and *Steneosaurus* (Steel, 1973). The remains of plesiosaurs and ichthyosaurs from Stonesfield have been mentioned by Phillips (1871, p. 183) and Lydekker (1889a, p. 245), and the pterosaur *Rhamphocephalus* is known from the Stonesfield Slate. These also are considered to have subsisted on fish.

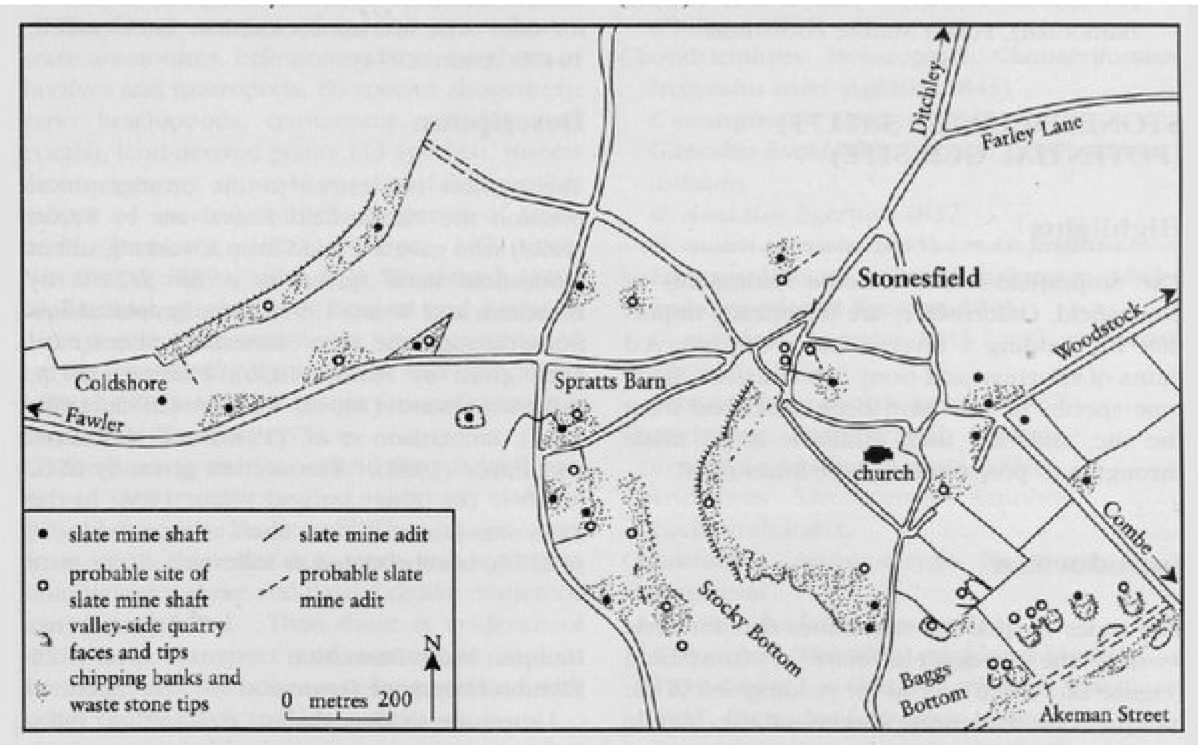
Comparison with other localities

The fossil fauna of the Stonesfield Slate is unique. However, comparisons may be made with other Early and Mid-Bathonian faunas which contain some of the same species, and in particular with the Cotswold Slate (Eyford Member) to the west of Stow-on-the-Wold (*progracilis* Zone, Mid-Bathonian). Localities such as Huntsmans Quarry [SP 125 254], Eyford Quarries ([SP 135 255], etc.) and Kyneton Thorns Quarry [SP 122 264] have yielded a similar, but less diverse, fish fauna including a range of neoselachian and hybodont sharks, chimaeroids, halecostomes and a few possible teleost genera. However, the specimens are not nearly as well preserved as those from Stonesfield. The poor record of neoselachians in the Stonesfield Slates compared with that from the Eyford tilestones at Huntsmans Quarry is due to collection bias, as many neoselachian teeth are less than 1–2 mm across and may have been overlooked by the early collectors. The conditions of deposition and faunal composition of the Cotswold Slate are very like those of the Stonesfield Slate, and the two units were formerly regarded as identical.

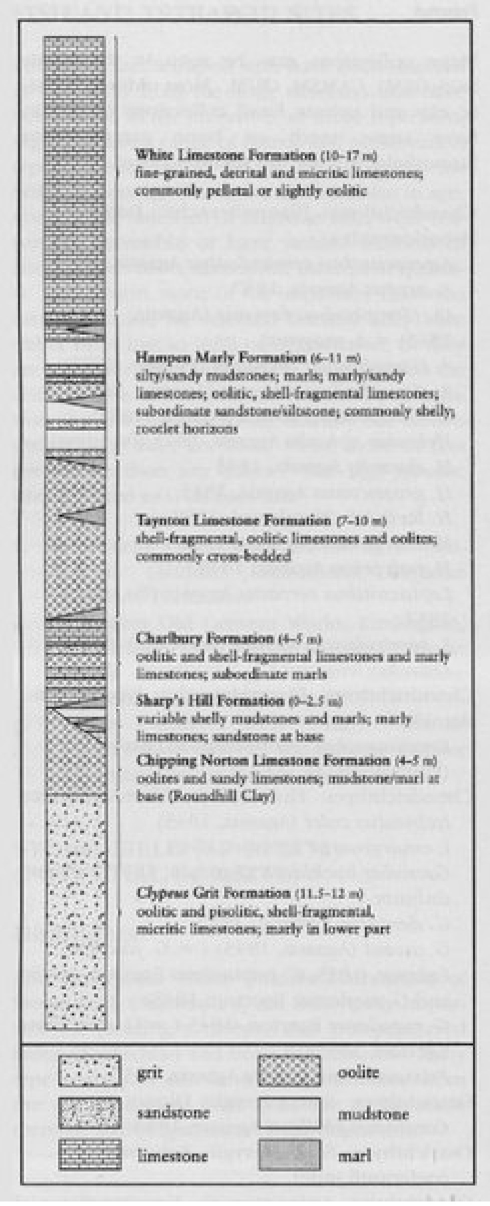
Conclusion

The conservation value of Stonesfield results from it being arguably the most important Middle Jurassic fossil fish site in the world, and its fauna is diverse and abundant, though consisting mainly of dispersed skeletal elements. It is important for the study of fossil fishes because its fauna is abundant, diverse and well preserved. There is much potential for further investigation of old collections held by museums in Britain and elsewhere, and possibly for reopening of quarry sections.

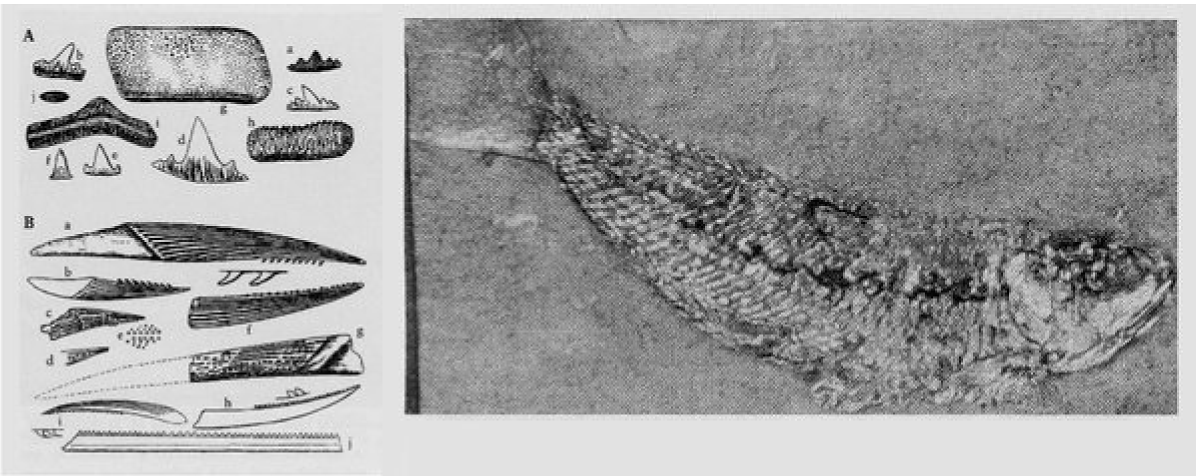
References



(Figure 12.14) Map of the mines and workings in the Stonesfield Slate around Stonesfield (after Aston, 1974).

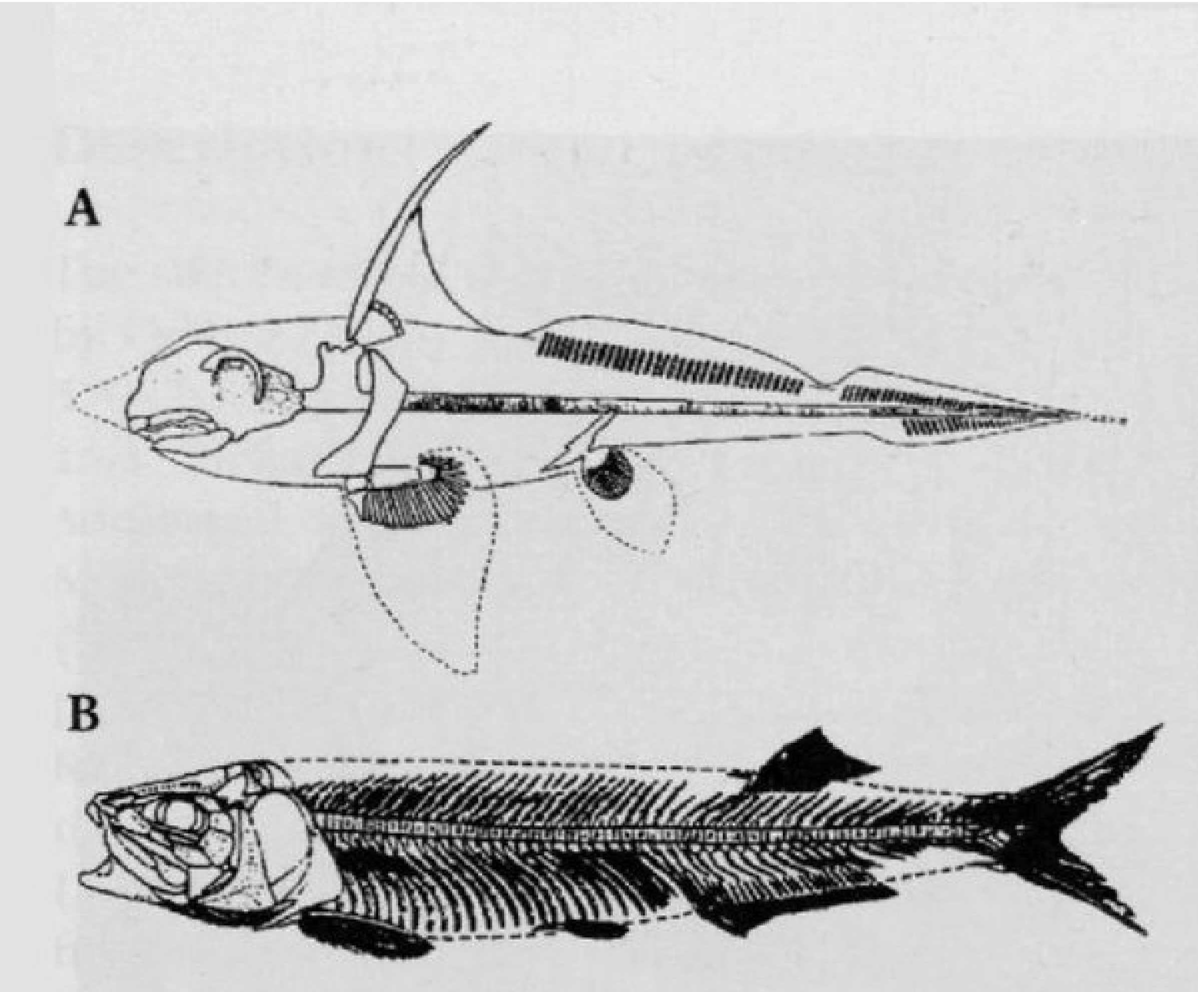


(Figure 12.15) The Bathonian succession at Stonesfield, where the 'slate' occurs within the Taynton Limestone Formation (after Boneham and Wyatt, 1993).



(Figure 12.16) Vertebrate remains from the Stonesfield Slate were well known when Phillips published this plate in his Geology of Oxford and Thames Valley (1871): (A) all at x 1; a and b, Hybodus jugosus Phillips; c, H. polyprion Agassiz; d-1 H. grossiconus Agassiz; g, Strophodus magnus Agassiz; h, S. lingualis Phillips; i, S. tenuis Agassiz; j, Acrodus sp. (B) all at x 0.5; a, Hybodus dorsalis Agassiz; b, H. apicalis Agassiz; c, Nemacanthus brevis Phillips; d, Ischyodus sp.; e, granulated surface; f, H. marginatus Agassiz; g, Asteracanthus tenuistriatus Agassiz; Leptacanthus striatus Agassiz; i, L.

semistriatus Agassiz; j, *Pristacanthus securis* Agassiz. Several of these names are now invalid — the specimens belong to pre-established taxa. (Continued on p. 388.)Vertebrate remains from the Stonesfield Slate (C) *Pholidophorus* sp. in lateral view showing rare excellent preservation of fish in this facies, x 1.0 (Photo: courtesy The Natural History Museum, London, T00848/A).*



*(Figure 12.17) Fishes from the Stonesfield Slate. (A) The chimaeroid *Ischyodus* sp. in lateral view, x 0.5; (B) *Allothrissops*, x 0.3, restoration in lateral view (after Taverne, 1977).*