Alderton Hill Quarry, Gloucestershire

[SP 006 345]

Potential GCR site

M.J. Simms

Introduction

Alderton Hill Quarry is the westernmost of three small, long-abandoned quarries excavated into the Marlstone Rock Formation (Uppermost Pliensbachian) and Whitby Mudstone Formation (basal Toarcian) successions on the southern flank of Alderton Hill (Figure 4.13). There are few records or specimens specifically from the other two quarries, Dumbleton Quarry and Naunton Farm Quarry, and both are extensively overgrown. More than a century ago Alderton Hill Quarry was said by Woodward (1893) to have been abandoned for some time. Frequent reference to the site as 'Dumbleton' probably reflects the location of all three quarries within the Dumbleton Estate.

The section at Alderton Hill Quarry exemplifies the dramatic facies and faunal changes that occurred across the Pliensbachian–Toarcian boundary. The limestones of the Marlstone Rock Formation contain a rich benthic fauna while the succeeding argillaceous Whitby Mudstone Formation (Toarcian) is dominated by nektonic taxa. This is the type locality for the Dumbleton Member of the Whitby Mudstone Formation, a succession of paper shales and laminated limestone nodules, including the 'Fish Bed' nodules, which can be recognized over a large area of southern Britain and beyond. The Marlstone Rock Formation and the Fish Bed nodules at this site have been the source of many figured and type specimens, of both vertebrates and invertebrates, particularly insects.

The three quarries were already well-known for their unusual fossil fauna by the mid-19th century, with a fine collection amassed by Miss Holland of Dumbleton Hall (Wright, 1863). The succession was described or mentioned briefly in various papers in the second half of the 19th century and early 20th century (Brodie, 1845, 1858, 1860a; Murchison, 1845; Hull, 1857; Moore, 1867b; Guise, 1880; Tomes, 1886; Smithe and Lucy, 1892; Woodward, 1893; Richardson, 1904, 1929b; Buckman, 1922), with elements of the fauna listed or described in several additional publications (Brodie, 1849; Buckman, 1853; Wright, 1863; Tomes, 1886; Crick, 1896, 1922; A.S. Woodward, 1911; H. Woodward, 1911; Tillyard, 1925, 1933; Ager, 1956–1967, 1990; Howarth, 1958, 1992).

Description

Despite the numerous publications, the succession at Alderton Hill Quarry has never been documented in detail. Of the sections published (Murchison, 1845; Brodie, 1860a; Guise, 1880; Smithe and Lucy, 1892; Woodward, 1893) only those by Tomes (1886) and Richardson (1929b) provided more than the most general description. Tomes (1886) recorded a total thickness of 8.7 m (28 ft 3 in.), including 'surface soil': Richardson (1929b) recognized at least 12 distinct units within a total exposed thickness of 10.75 m (35 ft). The different total thicknesses probably arose from the advance of the quarry face into the hillside, but there are also significant differences between the two recorded sections. That reproduced below attempts to combine the detail from both accounts; beds 1–3 and 7–13 are based on Richardson's (1929b) description, while beds 4–6 are taken from Tomes (1886).

	Thickness (m)
TOARCIAN STAGE	
Whitby Mudstone Formation	
Dumbleton Member	
13: Limestone, rubbly.	0.05 (2 in.)
12: Clay, pale blue-grey	1.5 (5 ft)
11: Shales, light violet, interspersed with nodular limestone.	0.9 (3 ft)

10: Limestone nodules, laminated - 'Fish Bed' (this was recorded as 1 ft (0.3 m) thick by Tomes and overlain by 4 ft (1.23 m) of 'surface soil').	0.15 (6 in.)
9: Paper shales, bluish, with nodules.	0.25 (10 in.)
8: Paper shales, violet (beds ?7, 8 and 9 were united by Tomes into a single 14 ft (4.3 m) unit of 'laminated blue shales').	3.9 (12 ft 9 in.)
7: Clay, light grey, shaly.	0.9 (3 ft)
6: Layer of intermittent nodules of hard stone containing 'fucoids' (described by Richardson as 'dark purple clay (*?Leptaena* Bed)').	0.08 (3 in.)
5: Shales, blue, laminated (beds 4 and 5 were combined into a single unit by Richardson, who described them as a 'hard band with limestone nodules').	1.15 (3 ft)
4: Clay, whitish-grey, hard, breaking up into angular lumps and weathering into a soft, light-coloured clay.	0.23 (9 in.)
3: Shale, light blue, hard. In the lower part are many belemnites, and in the upper part numerous small pyrite crystals, small ammonites (*?Dactylioceras pseudocommune* = *Ammonites bolandrei*), gastropods and *Thecocyathus tuberculatus.*	0.38 (1 ft 3 in.)
UPPER PLIENSBACHIAN SUBSTAGE	
Marlstone Rock Formation	
2: Marl, hard, containing *Tetrarhynchia tetrahedra, Pleuroceras spinatum,* belemnites and crinoid debris (Tomes described this as a 'friable shale, having the appearance of soft marlstone, brown or ferruginous in colour, and sometimes micaceous').	0.3 (1 ft)
1: **Marlstone Rock Bed** (with two other bands not exposed).	1.02 (3 ft 4 in.)

At the time of writing, the section was largely obscured by vegetation, although slumping of the upper part of the face in the early 1980s exposed 2 m of paper shales and the Fish Bed.

The Marlstone Rock Formation forms a conspicuous shelf below the quarry although its exact thickness remains unclear. That part of the pit was flooded when visited by Smithe and Lucy (1892), but Woodward (1893) reported its thickness as 'about 14 feet' (4.3 m), commenting that the beds were not fully exposed. Richardson (1929b) referred to 'two other bands not exposed', but it is unclear as to whether these were in the lower part of the Marlstone Rock Formation or in the underlying Dyrham Formation.

The Marlstone Rock Formation appears to be predominantly a shelly, micritic limestone, in places pyritic. It has been a prolific source of well-preserved fossils, particularly molluscs. Richardson (1929) listed almost 50 nominal species. Amaltheid ammonites are a common and conspicuous element of this fauna. It is the type locality for *Pleuroceras spinatum* var. *buckmani* (Moxon, 1841) and *Amaltheus sedgwicki,* a synonym of *A. margaritatus* (Howarth, 1958). It has also yielded a rich and fairly diverse brachiopod fauna, including the holotype of *Tetrarhynchia dumbletonensis* (Ager, 19561967). Murchison (1845) referred to crustacean and plant remains, including a carbonized cone, and the humerus of a pterosaur from here.

The succeeding Toarcian Dumbleton Member of the Whitby Mudstone Formation comprises mudstones and paper shales with a few grey, nodular, argillaceous limestone bands. In the absence of any bed-by-bed collecting, many of the species recorded by Richardson (1929b) and others cannot be tied into the lithostratigraphy. Tomes (1886) recorded numerous specimens of the solitary coral *Thecocyathus tuberculatus,* and a few *Trochocyathus* sp., from weathered Whitby Mudstone Formation clays at disused workings on Stanley Hill [SP 010 298], Gretton, just 5 km to the south. He collected two specimens of *T. tuberculatus* from the upper part or top of Bed 3 at Alderton Hill Quarry. S.S. Buckman

(1922) and Richardson (1929b) recorded abundant specimens of the minute brachiopods *Orthotoma globulin* (Ager, 1990) and *Nannirhynchia pygmaea* (Ager, 1956–1967) from beds 8 and 9, together with specimens of *Diademopsis* cf. *crinifera* with spines intact. Upton (1906) also noted that fish fragments, echinoid spines and *Pseudomytiloides dubius* were common in the paper shales, but ostracods and foraminifera were rare. More recent collecting from these shales in the 1970s and 1980s (M.J. Simms, unpublished observations) yielded disarticulated fish remains, a partial thorax of *Colela richardsoni,* and ammonites with aptychi in place.

Only the Fish Bed of the Dumbleton Member is of a sufficiently distinctive lithology to ensure that loose blocks and nodules can be assigned with confidence to this bed. Individual nodules may be 1 m of more across, though commonly breaking into smaller blocks, but seldom are more than 0.2 m thick. Externally they are of creamy-yellow laminated limestone, though they are commonly 'blue-hearted' at the centre. A fairly rich fauna has been obtained from the Fish Bed nodules here and at other sites on adjacent hills. The most abundant vertebrate is the small early teleost fish *Leptolepis coryphaenoides,* occasionally found intact (Figure 4.14) and with traces of soft tissues but more usually as scattered bones; it was originally described from here as a new species, *Leptolepis concentricus* (Egerton in Brodie, 1849). Several other fish species occur more rarely, with this the type locality for the semionotid *Tetragonolepis discus* and the only British locality for the pachycormid *Euthynotus* (A.S. Woodward, 1895, 1911). Reptile remains have been found only rarely in the Fish Bed nodules in this area. Moore (1867b) referred to what would appear to be a fairly complete skeleton of an ichthyosaur in the Fish Bed nodules at Dumbleton, and Smithe (1865) noted a tooth of *Teleosaurus* and a scapular arch or coracoid of a pterosaur from the Fish Bed nodules at Churchdown Hill [SO 880 190], near Gloucester.

The marine invertebrate fauna of the Fish Bed nodules are dominated by nektonic and planktonic species. Three species of ammonite, and isolated aptychi, have been recorded; *Hildaites murleyi* and *H. forte,* for both of which this is the type locality (Moxon, 1841; Howarth, 1992), and *Cleviceras elegans,* all indicating the Exaratum Subzone of the Serpentinum Zone. Of two species of belemnite, *Acrocoelites ilminsterensis* and *Cbondroteuthis wunnenbergi,* both have been found in exceptional states of preservation with phragmocone and proostracum intact (Crick, 1896; Doyle, 1990–1992), while isolated groups of hooklets may also belong to one or other of these species (Doyle, 1990–1992). Crick (1922) figured specimens of the teuthids *Geoteuthis agassizi* and *Teutbopsis brunelii* from the Fish Bed nodules of Alderton Hill. Among the other molluscs *Pseudomytiloides dubius* occurs sporadically and *Goniomya tetragona* only very rarely. By far the most abundant mollusc, or indeed fossil of any type, in the Fish Bed nodules is the tiny gastropod *Coelodiscus minutus.* This can occur evenly scattered through some Fish Bed nodules, though it is absent from others; intact fish remains are rarely, if ever, encountered in those Fish Bed nodules in which the gastropod is abundant (M J. Simms, unpublished observations). The only other invertebrates present are arthropods, represented by scarce benthic marine taxa, and a diverse and abundant fauna of insects, some of them extraordinarily well-preserved. The arthropods include the holotype of *Coleia richardsoni* (H. Woodward, 1911; Woods, 1925–1931), while examples of the insects have been figured by Buckman (in Murchison, 1845; Buckman, 1848, 1853), Brodie (1849) and Tillyard (1925, 1933). The Fish Bed nodules exposed in the quarries on the Dumbleton Estate were the source of numerous insect holotypes, including the dragonflies *Heterophlebia buckmani, H. angulata* and *Liassogomphus brodiei,* and the panorpoids *Actinophlebia anglicana, Orthophlebia brodiei, Protobittacus handlirschi, Necrotaulius pymgmaeus* and *Liassotipula anglicana.* More material was collected in the 1970s and 1980s (M J. Simms, unpublished; now held in Bristol City Museum; (Figure 4.15)): the entire entomofauna is in need of further investigation. (Figure 4.15) Incomplete wing (30 mm long) of the dragonfly *Heterophlebia buckmani,* from the Fish Bed of the Dumbleton Member at Alderton Hill Quarry. Specimen from the Simms Collection, in Bristol City Museum. (Photo: M.J. Simms.)

Interpretation

Although ammonites are common throughout the succession formerly exposed here, a detailed biostratigraphy cannot be established because few of the ammonites recorded were obtained in *situ.* Beds 1 and 2 contain abundant amaltheids, particularly species of *Pleuroceras,* and hence lie within the Spinatum Zone. The identification of the *Ammonites holandrei* from Bed 3 as *Dactylioceras pseudocommune* is, at best, questionable but may indicate an early Tenuicostum Zone (Paltus Subzone) age. The only other proven records are of *Cleviceras elegans, Hildaites murleyi* and *H. forte* from the Fish Bed, indicating a position within the Exaratum Subzone of the Serpentinum Zone.

The thickness of the Marlstone Rock Formation has not been ascertained at this site: cited thicknesses vary from 1.32 m (Richardson, 1929b) to 4.3 m (Woodward, 1893). Both are possible since the formation shows a dramatic southward thinning in this area from more than 6 m on Bredon Hill [SO 957 399] to 0.5 m on Cleeve Hill [SO 979 256], a distance of only 14 km (Simms, 1990a). Alderton Hill Quarry is approximately midway between the thick, sandy facies of the Marlstone Rock Formation of Bredon Hill and the ferruginous, oolitic and conglomeratic facies of Oxenton and Stanley hills. It shows greater lithological similarity to Bredon Hill than to the other sites. However, only excavation of the site can establish its lithological succession.

The overlying (Toarcian) Dumbleton Member succession is characterized by nektonic and planktonic fauna, with evidence of a significant benthic fauna at some levels. The most notable of these is the presence of corals at or near the top of Bed 3, suggesting well-oxygenated conditions and a pause in sedimentation. The presence of burrow systems (the 'fucoids' of Tomes, 1886) in Bed 6 also indicates at least dysaerobic conditions for a brief period within the anoxic environment represented by the paper shales.

The unusual fauna of the Fish Bed was noted by many early authors and comparisons were drawn with correlative sections elsewhere. Brodie (1860a) and Moore (1867b) noted similarities between the section at Alderton Hill Quarry and correlative strata in Somerset. Similar 'Fish Bed' facies are known from Northamptonshire and elsewhere in the East Midlands (Brodie, 1860a; Judd, 1875; Howarth, 1978), and from farther afield in Normandy (Smithe and Lucy, 1892; Dineley and Metcalf; 1999). In Germany and Switzerland the Exaratum Subzone is developed as bituminous paper shales with a laminated limestone band, the Unterer Stein, in which the most common fossil is *Leptolepis coryphaenoides* (Etter and Kuhn, 2000).

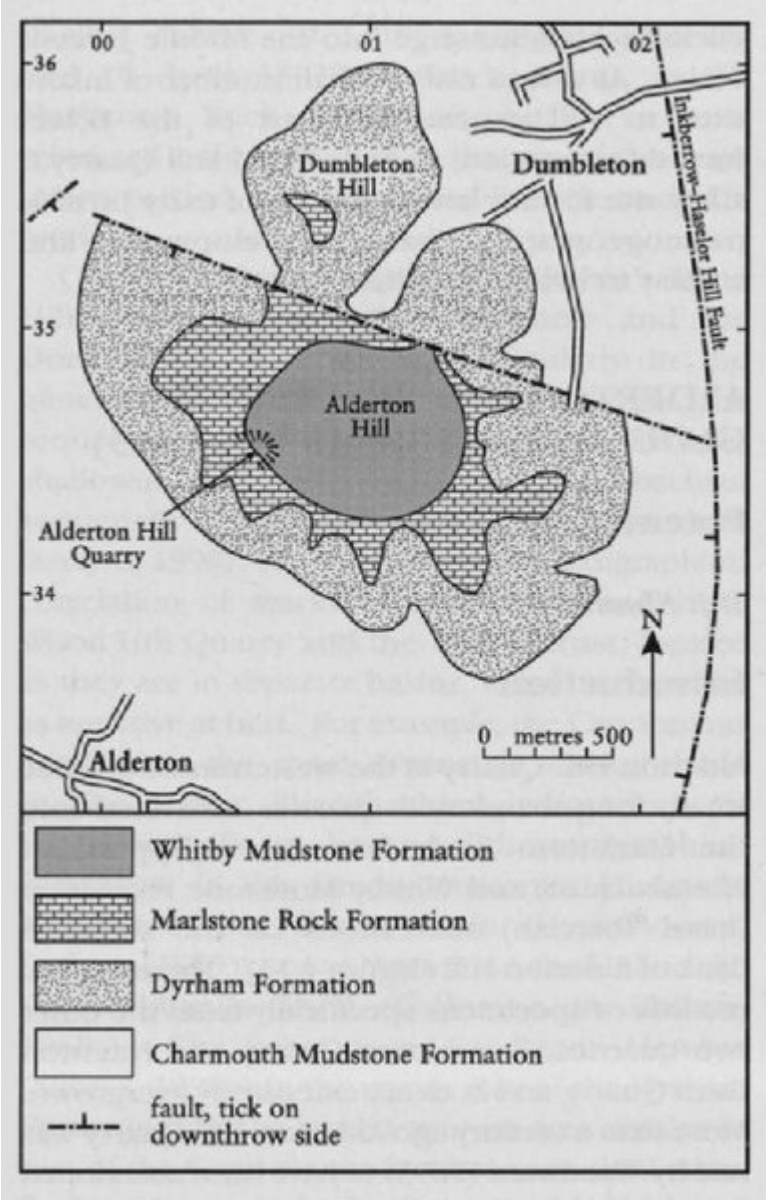
The mutual exclusion apparently shown by intact fish and the gastropod *Coelodiscus minutus* in the Fish Bed nodules, and the fact that the latter occur evenly scattered through some nodules but are absent from others, suggests that not all of the Fish Bed nodules occur at exactly the same level and that benthic oxygen levels were higher during deposition of the sediments containing abundant gastropods and only disarticulated fish. This is supported by the observations of Smithe (1865), and Simms (unpublished observations), who noted that Fish Bed nodules can be found throughout some 2.5 m (8 ft) of strata. The laminated nature of the Fish Bed nodules, the presence within them of uncrushed ammonites, and the similarity of the fauna in the surrounding paper shales, suggests that they represent early diagenetic carbonate segregations which developed within the shales. Those that grew at horizons representing the most anoxic periods during shale deposition contain the best-preserved insects and vertebrates. In contrast, those that formed at levels representing less anoxic conditions contain only poorly preserved vertebrates together with a greater or lesser abundance of benthic invertebrates, including an abundance of gastropods. A detailed account of the faunal distribution within the Fish Bed nodules and adjacent paper shales must await a more detailed investigation of the site.

The sudden lithological change exposed in the succession at Alderton Hill Quarry, from the shallow-water facies of the Marlstone Rock Formation with its abundant shelly benthic fauna, overlain by the laminated mudstones and limestones of the Dumbleton Member with its nektonic fauna and low-diversity benthos, marks a rapid eustatic rise in sea level in earliest Toarcian times (Hallam, 1981; Hesselbo and Jenkyns, 1998), which affected vast areas of northern Europe and beyond, and that produced dramatic changes in marine faunas (Hallam, 1987a; Vorüs, 2002).

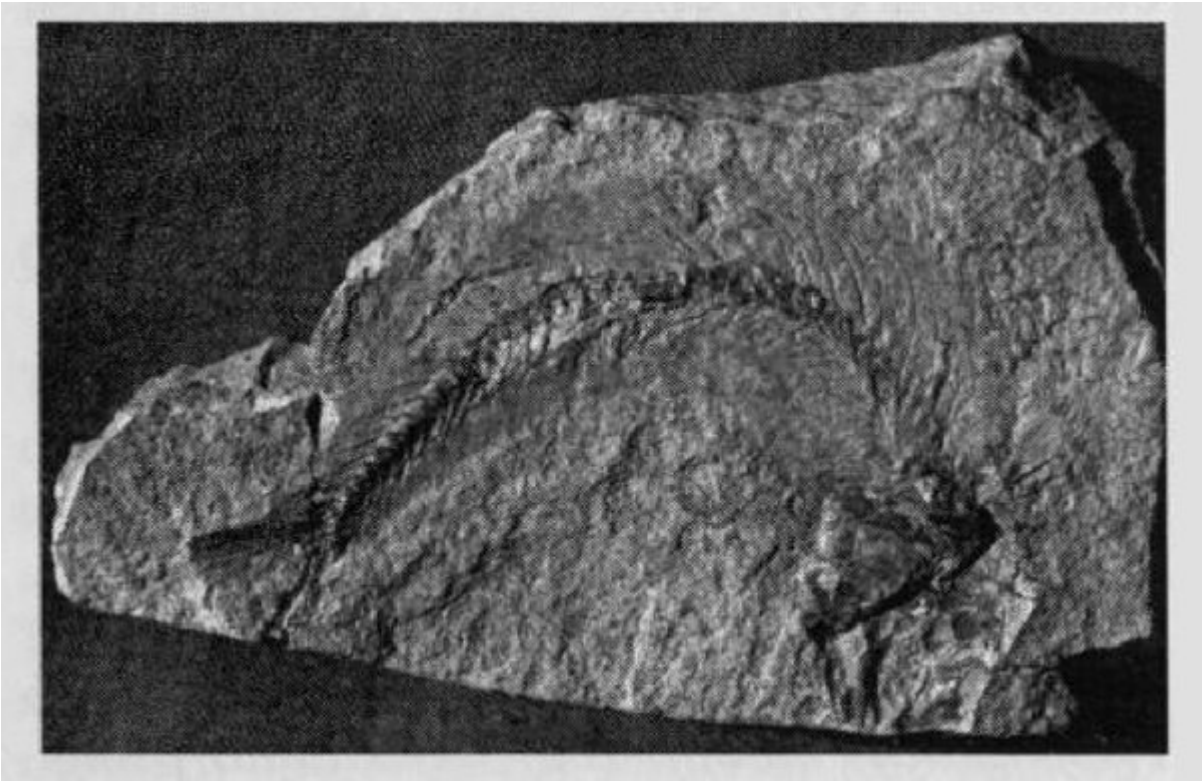
Conclusions

Alderton Hill Quarry exposes a section representative of the dramatic palaeoenvironmental changes that occurred in south-west England between the Marlstone Rock Formation and the Whitby Mudstone Formation. Sandstones with abundant shelly benthic faunas were replaced by mudstones with an overwhelmingly nektonic fauna that was preserved in the predominantly anoxic seabed conditions that prevailed during deposition of the Dumbleton Member. The site has long been a rich source of fossil material, particularly from the Marlstone Rock Formation and the Fish Bed, and has been an especially important source of fossil insect remains.

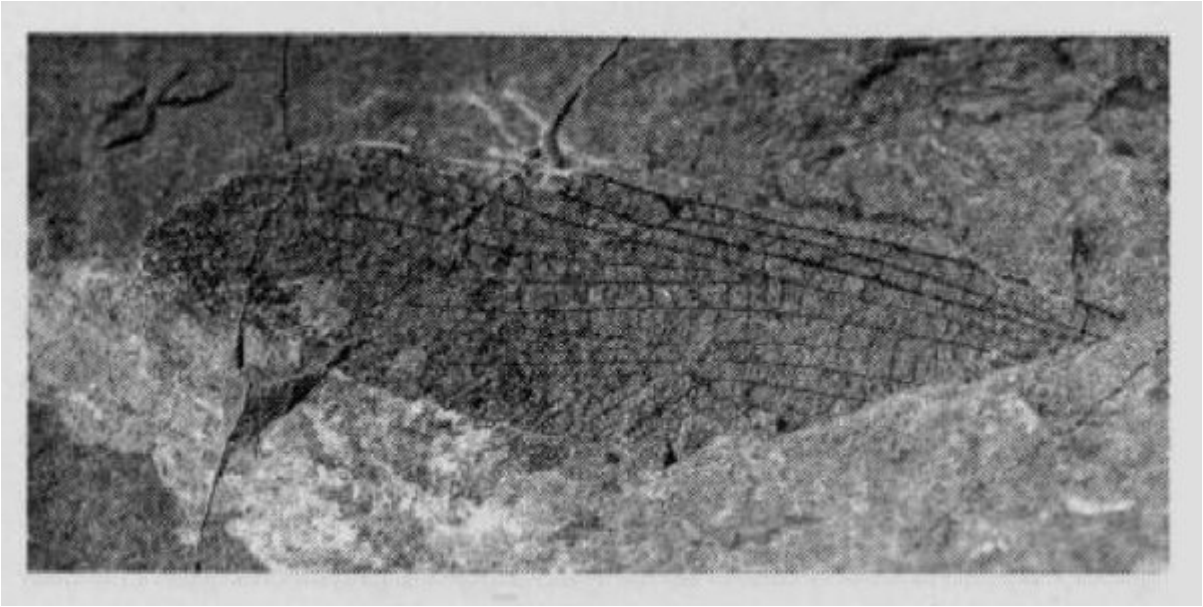
References



(Figure 4.13) Geology and location map for the Alderton Hill Quarry GCR site.



(Figure 4.14) Large specimen (70 mm across) of the early teleost Leptolepis coryphaenoides, from the Fish Bed of the Dumbleton Member at Dumbleton Pit, just to the east of Alderton Hill Quarry. Specimen from the Simms Collection, in Bristol City Museum. (Photo: M.J. Simms.)



(Figure 4.15) Incomplete wing (30 mm long) of the dragonfly Heterophlebia buckmani, from the Fish Bed of the Dumbleton Member at Alderton Hill Quarry. Specimen from the Simms Collection, in Bristol City Museum. (Photo: M.J. Simms.)