Ardley Cuttings and Quarries, Oxfordshire

[SP 514 291]–[SP 558 250]

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Introduction

The GCR site known as Ardley Cuttings and Quarries', north-west of Bicester, Oxfordshire, comprises sections in the Ardley Fields Farm [SP 543 265] and Ardley Wood [SP 537 273] quarries, and a 6 km stretch of railway cutting [SP 514 291]–[SP 559 250] in which there are a number of discrete exposures. Together, they have displayed a succession ranging from the uppermost beds of the Lower Jurassic Lias Group to the top of the Great Oolite Group, including all of the Bathonian succession (Figure 4.8). The site is of special interest as the type locality of the Ardley Member of the White Limestone Formation. A number of authors have referred to these sections since Barrow's (1908) initial description. Odling (1913) provided the first full account of the Bathonian succession in the railway cutting and, later, a revised description was presented by Arkell *et al.* (1933). The Middle to Upper Bathonian succession in Ardley Fields Farm Quarry was recorded by Palmer (1973), and graphic logs of the same section were included by Barker (1976), Sumbler (1984) and Cripps (1986). Bradshaw (1978) and Cripps (1986) also provided graphic logs of the railway cutting and Ardley Wood sections (the latter referred to as Ardley Station Quarry'). Exposure in the railway cutting is now rather poor except for parts of the White Limestone Formation that can be seen to best advantage in the middle part of the cutting. Both Ardley Wood and Ardley Fields Farm quarries are largely backfilled, but preserved faces show up to 5 m of strata in the Ardley Member, and excellent sections of White Limestone Formation are visible in the extensive working quarry to the south of the latter site [SP 541 255].

Description

The several accounts of the succession exposed in the Ardley Cuttings and Quarries differ in detail, partly because there is much variation in lithology and thickness. The following generalized description is based mainly on the observations of Arkell *et al.* (1933), whose bed numbers are indicated where appropriate, supplemented by information from other sources, notably Palmer (1973) for the White Limestone Formation. The strata in the railway cutting dip gently south-eastwards from the mouth of the Fritwell Tunnel [SP 514 291], with minor flexuring. Much of the succession exposed in the cutting is repeated south-east of a reverse fault located close to the Ardley–Somerton road bridge (Odling, 1913).

Non-sequentially overlying the hard, massive to rubbly, bluish-grey to brown calcareous sandstone of the Northampton Sand Formation (the strata incorrectly classified by Arkell *et al.* (1933) as 'Hook Norton Beds'), the Bathonian succession starts with the Horsehay Sand Formation (Bed 6), the 'White Sands' of previous authors (see Horsehay Quarry GCR site report, this volume). These strata comprise up to 6.1 m of sand, the lower part of which is black, with a high carbonaceous content, and the upper 1.5 m of which is yellow, weathering white. At one point at least, this sand infills a channel perhaps 30 m wide and 3 m deep, cut down into the Northampton Sand Formation (Arkell *et al.,* 1933, pl. 34a).

Resting on the Horsehay Sand Formation, the Sharp's Hill Formation (beds 7 to 11) is about 1.4 m thick. The lower part (beds 7 to 9) consists of 0.30 m of grey and brown mottled sandy clay with paper-thin, white shell-fragments and many gastropods (cf. *Cerithium*) at the base, overlain by a 0.05–0.45 m-thick, black, carbonaceous seam with rootlets, and capped by a 0.10 m-thick, greyish-blue clay (the 'Peat Bed'). The overlying 0.9 m of the Sharp's Hill Formation (beds 10 and 11) probably correspond with the Charlbury Formation of Boneham and Wyatt (1993). These beds comprise a prominent unit of hard, pebbly limestone, overlain by grey clay and marl packed with the oyster *Praeexogyra hebridica* (Forbes).

The succeeding Taynton Limestone Formation (beds 12 and 13), perhaps up to 5 m in thickness, consists mainly of cross-bedded, flaggy, coarsely shell-fragmental limestones. Locally, however, the lower beds pass laterally into grey and greenish, muddy, shaly limestone and indurated marl.

The succeeding Rutland Formation, about 8.4 m thick, is close to its western limit where it passes into the more fully marine Hampen Formation (Horton *et al.,* 1987, fig. 8). The lowest 5.6 m comprise green and dark-grey sandy clays, with some beds of sandy, muddy limestone. The fossiliferous basal bed (Bed 14) has yielded the bivalves *Modiolus imbricatus* J. Sowerby, *Pinna* and *Praeexogyra hebridica,* and the brachiopod *Burmirhynchia concinna* (J. Sowerby). The holotype of the ammonite *Procerites imitator* (S.S. Buckman) was collected from a little higher (Bed 15). There is much lignite at the top of these beds, which are succeeded by a conspicuous 0.7 m-thick bed of greenish, patchily cemented sandstone with rootlets attributed to *Equisetites;* this unit (Bed 17) is one of the few parts of the succession below the White Limestone Formation that is still well exposed [SP 516 289]. There follow 1.6 m of green sandy clay containing lignite, with abundant *P. hebridica* at the top (beds 18 and 19) succeeded by a 0.3 m-thick bed of grey, muddy limestone, which is shelly and ooidal at the base (Bed 20); it contains the oyster *Lopha costata* (J. de C. Sowerby), the brachiopod *Stiphrothyris* and echinoid debris. The Rutland Formation is completed by 0.25 m of grey clay and sandy clay with *Isognomon, Lopha costata, P. hebridica* and *Stiphrothyris* (Bed 21).

Within the succeeding White Limestone Formation, three regionally persistent units, in ascending order the Shipton, Ardley and Bladon members, are recognized (Palmer, 1979; Sumbler, 1984). The whole succession at Ardley (Figure 4.9) comprises mainly whitish-weathering micritic limestones, many of them pelletal and shell-detrital, with subordinate beds of clay or marl. There are several very fossiliferous beds.

The Shipton Member (beds 22 to 30) is about 3.5 m thick. The lower part is characterized by sandy limestones and sandstones, which may be laminated. These beds contain a wide variety of bivalves, including species of *Ceratomya, Gresslya, Lucina, Modiolus, Pholadomya, Pleuromya* and *Pseudotrapezium* (Odling, 1913); also the brachiopods *Burmirhynchia concinna* and '*Terebratula*' *globata* J. de C. Sowerby, the echinoid *Clypeus muelleri* Wright, and corals such as *Isastrea.* The ammonites *Tulites glabretus* S.S. Buckman and *T. subcontractus* (Morris and Lycett) have been collected from near the base. Palmer (1973) noted that the topmost limestone of the member, a 1 m-thick bed capped by a hardground with *Lithophaga* borings (the Excavata Bed), yielded *Homomya, Pholadomya* and *Pleuromya* in life position, as well as many *C. muelleri.* From the same bed, Barker (1976) collected the gastropods *Aphanoptyxis excavata* Barker (the index species) (see Barker, pp. 244–5, this volume), *Endlepolocus munieri* (Rigaux and Savage) and *Eunerinea arduennensis* (Buvignier). The full Shipton Member succession was formerly seen in the railway cutting and Ardley Wood Quarry, but only the topmost 1.9 m in Ardley Fields Farm Quarry.

The succeeding Ardley Member is about 7 m thick, based on the record of Odling (1913). It comprises beds 31 to 42 of Arkell *et al.* (1933) plus additional beds (1 and 2 of Odling, 1913) not seen by them. The basal 0.75 m comprises soft, argillaceous, shelly, bioturbated, micritic limestone passing down into clay. The fauna includes the bivalves *Eonavicula minuta* (J. de C. Sowerby), *Plagiostoma subcardiiformis* (Greppin) and *Praeexogyra hebridica,* the coral *Isastrea,* and the brachiopod *Kallirhynchia;* a small unnamed or indeterminate terebratulid is also common. This bed is succeeded by a thin clay with *P. hebridica,* which is very conspicuous in the quarry faces. The overlying 'Roach Bed', 0.15–0.30 m thick, is a sandy limestone in which an abundant fauna of bivalves and gastropods is preserved as moulds, giving the rock a distinctive cavernous character. About 0.60 m above this bed, there is the Nerinea *eudesii* bed' of Arkell (1931) and Arkell *et al.* (1933), a shelly, ooidal limestone with an abundance of the gastropod *E. arduennensis* (Arduennensis Bed herein). '*Nautilus*' *subcontractus* Morris and Lycett has been collected from near the base of the overlying 1.8 m of dominantly marl beds, which are succeeded by a whitish, shelly, pelletal, micritic limestone, up to 0.8 m thick. This latter bed is capped by a hardground encrusted with oyster shells ('*Exogyra*') and penetrated by burrow-fills. This, the Ardleyensis Bed, is divided into upper and lower parts by a softer, marly limestone layer (Barker, 1976). The bed is packed with the diagnostic gastropod *Aphanoptyxis ardleyensis* Arkell. A massive, bioturbated, shelly, micritic limestone follows (Bed 42 of the cutting), locally (in Ardley Fields Farm Quarry) with a marl containing *P. hebridica* at the base, and a similar marl above it. The coral *Isastrea* in life position is present in this limestone, as well as the brachiopod *Epithyris oxonica* Arkell and the bivalves *Modiolus imbricatus* and *Plagiostoma subcardiiformis* (Greppin). The Ardley Member is capped by the Bladonensis Bed, the highest stratum ever exposed in Ardley Fields Farm Quarry. It is a massive micritic limestone, the top of which is a hardground featuring shrinkage cracks, algal laminae and 'birdseye' vugs. This is the 'Cream Cheese Bed' of early authors. The barren upper part passes down into shelly limestone yielding bivalves such as *Astarte, Corbula* and *Perna* (Palmer, 1973).

Recent mapping (Sumbler, in press) shows that the succeeding Bladon Member is present in the railway cutting to the south-east of Ardley Fields Farm Quarry, around the point where the M40 motorway crosses the cutting [SP 550 259]. Hereabouts, Barrow (1908, beds 7 and 8) recorded 1.52 m of 'grey shaly clay' representing the Fimbriphenotoni Bed (Sumbler, 1984); this is probably the 'clay with rootlets' recorded by Palmer (1973). It was succeeded by 0.76 m of 'grey, bedded limestone' comprising the Upper Epithyris Bed. Farther north-west, on the down-throw side of the fault, the Bladon Member may be absent having been cut out beneath the basal erosion surface of the Forest Marble Formation, although it seems likely that part at least of a 2.4 m-thick bed of 'dark blue and green clay' recorded here by Odling (1913), represents the Fimbriphenotoni Bed. The succeeding 3.1 m of blue clays with flaggy, cross-bedded limestone, belong to the Forest Marble Formation.

The Bathonian succession is completed by the Cornbrash Formation, up to about 3 m thick in total, which is present at the top of the cutting for 700 m at the south-eastern end of the GCR site, but has never been recorded.

Interpretation

A non-sequence separates the Aalenian Northampton Sand Formation from the Horsehay Sand Formation; it is prominently marked by channelling at the base of the latter. The controversy surrounding the age of the latter (the 'White Sands') is discussed elsewhere (see Horsehay Quarry GCR site report, this volume); it appears that they are largely Bathonian in age, being transitional between the non-marine Stamford Member (Rutland Formation) to the north-east and the fully marine Chipping Norton Limestone Formation to the south-west.

The Sharp's Hill Formation is known to have been deposited in mainly brackish-water to marine conditions, with intermittent episodes characterized by a marginal saltmarsh environment, attested to by rootlet beds, including that in the Ardley sequence. The abundance of carbonaceous plant-debris in this rootlet bed, and also in the Horsehay Sand Formation, signifies the proximity of the London Landmass. The pebbly bed corresponding with the base of the Charlbury Formation has the character of a transgressive lag deposit, whilst the overlying shell-packed clay and marl suggest the establishment of an oyster reef (cf. Palmer, 1979). The succeeding Taynton Limestone Formation indicates the onset of high-energy, shallow-water, current-dominated, carbonate shelf-sea conditions; less turbulent waters, perhaps located between carbonate sand-banks, are represented by the localized passage of the cross-bedded limestones into muddy limestones and marls. The clay, sandy clay and sand, which dominate the Rutland Formation in the Ardley district, were deposited in a nearshore region of shallow, brackish-water lagoons (Palmer, 1979); rootlet beds indicate the occasional development of saltmarsh conditions.

The pelletal, shell-detrital, micritic limestones that characterize much of the White Limestone Formation, were deposited in the shallow, restricted, low-energy waters of an extensive lagoon, which formed the proximal part of an extensive shelf-sea marginal to the London Landmass. The common occurrence of bioturbation in these limestones reflects the activity of a variety of burrowing bivalves, which are sometimes preserved in life position. The greater proportion of marly limestone and marl beds than is typical of the Shipton Member, together with the presence of sandy limestones at the base, indicates greater proximity to the source of terrigenous sediment. These features appear to be the first indication of a passage eastwards into a corresponding sequence dominated by clay and marl, as seen at Stratton Audley (see GCR site report, this volume). The three hard-grounds in the succession (Excavata, Ardleyensis and Bladonensis beds) indicate distinct pauses in sedimentation, associated with lithification of the substrate; they formed at the tops of shallowing-upwards, regressive units, at times when sea level fell to its lowest levels, as demonstrated by 'dinosaur trackways' recently uncovered in the working quarry to the south of the GCR site. The shrinkage cracks, 'birdseye' vugs and lamination of the Bladonensis Bed are interpreted as being indicative of deposition on a temporarily emergent algal mat (Palmer and Jenkyns, 1975).

The Bladon Member represents a transition between the carbonate regime of the underlying Ardley Member and the clays of the Forest Marble Formation; this reflects a change to dominantly terrigenous mud sedimentation in relatively quiet waters. The basal erosion surface of the Forest Marble Formation and its cross-bedded limestones indicate an episode of high-energy, shallow-water deposition, influenced by current activity.

The stratigraphically diagnostic ammonites *Tulites glabretus* (S.S. Buckman) and *T. subcontractus* (Morris and Lycett), collected from the basal bed of the White Limestone Formation (Shipton Member), indicate that the lower part of the member belongs to the Subcontractus Zone. The Excavata Bed that caps the member is thought to mark the top of the overlying Morrisi Zone throughout the Cotswolds (Torrens, 1980b); thus, the Shipton Member is inferred to span both the Subcontractus and Morrisi zones. The Ardley Member can, in turn, be referred to the Bremeri and Retrocostatum zones. *Procerites glabretus* and *P. imitator,* from close to the base of the Hampen Formation, are not sufficiently diagnostic for use as zonal indicators. However, correlation of rhythmic, depositional units (Wyatt, 1996a,b) suggests that the uppermost part of the Hampen Formation belongs to the Subcontractus Zone and the remainder to the Progracilis Zone and also suggests that the Arduennensis Bed (formerly the *Nerineaeudesii* bed') at Ardley corresponds to the *Modiolus–Epithyris* Bed at Woodeaton (see GCR site report, this volume); according to Barker (1976), the gastropods of the former are *Eunerinea arduennensis* (Buvigner). The eponymous gastropods found at Ardley Cuttings and Quarries in the Excavata and Ardleyensis beds identify the latter as regionally persistent and correlatable horizons; the Bladonensis Bed is also a useful marker (see Barker, pp. 244–5, this volume). Using these and other indicators, satisfactory correlation can be made with the succession near Oxford (Wyatt, 1996a,b; see Woodeaton GCR site report, this volume) and beyond.

Conclusions

At the Ardley Cuttings and Quarries GCR site, a complete Bathonian succession, from the basal Horsehay Sand Formation up to the Cornbrash Formation, is present. It is therefore one of the key sites for this stage in southern England. The site is also the type locality of the Ardley Member of the White Limestone Formation. The succession is transitional between those of the Cotswolds (open marine environment) and the East Midlands (nearshore, brackish-water–freshwater environment); it thus has particular significance for regional correlation. The succession exhibits sedimentological features, such as hardgrounds, an emergent surface, rootlet beds and channel-fills, as well as regionally persistent, fossiliferous marker beds.

Aphanoptyxis excavata sp. nov. — eponymous gastropod of the Excavata Bed (White Limestone Formation)

(see (Figure 4.10))

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The index species of the Excavata Bed has never been formally published, but has been described and figured in an unpublished PhD thesis (Barker, 1976). The opportunity is taken here to remedy this situation, and also to illustrate the other gastropod indices of marker beds in the White Limestone —*Aphanoptyxis langrunensis* (d'Orbigny, 1850b), *A. ardleyensis* Arkell, 1931 and A. *bladonensis* Arkell, 1931, as well as *Eunerinea arduennensis* (Buvignier, 1852) (see (Figure 4.10)).

Derivation of name: Latin *ex* = out of *cavus* = hollow; pertaining to the conspicuously concave ('hollowed out') whorls.

Type material: Holotype (Oxford University Museum (OUM) J29500) and paratypes (OUM J29501–J29523) from the Excavata Bed (Bed 5 of Barker, 1976; or Bed 4 of Sumbler, 1985) at the top of the Shipton Member, White Limestone Formation, Great Oolite Group (Middle Bathonian, uppermost Morrisi Zone) of Sturt Farm (or Whitehill North) Quarry [SP 271 109] (Barker, 1976; Sumbler, 1984, 1985).

Diagnosis: A small (maximum observed height 38 mm) nerineid gastropod with neither internal folds nor umbilicus. Whorls are wide and low (whorl width/height ratio 2.29), conspicuously concave and usually without ornament. Growth lirae commonly visible. The base is convex and ornamented with 6–8 prominent spiral cords, beaded when crossed by growth lirae. The junction of the shell side and base is angular and carinate. Suture on raised carinae of which the adapical caring (i.e. juxtasutural selenizone) is more prominent, wider and bears crescentic lunulae. Where preserved, the juxtasutural slit is deep (up to one sixth of whorl). The aperture is quadrate with columellar-parietal junction rounded;

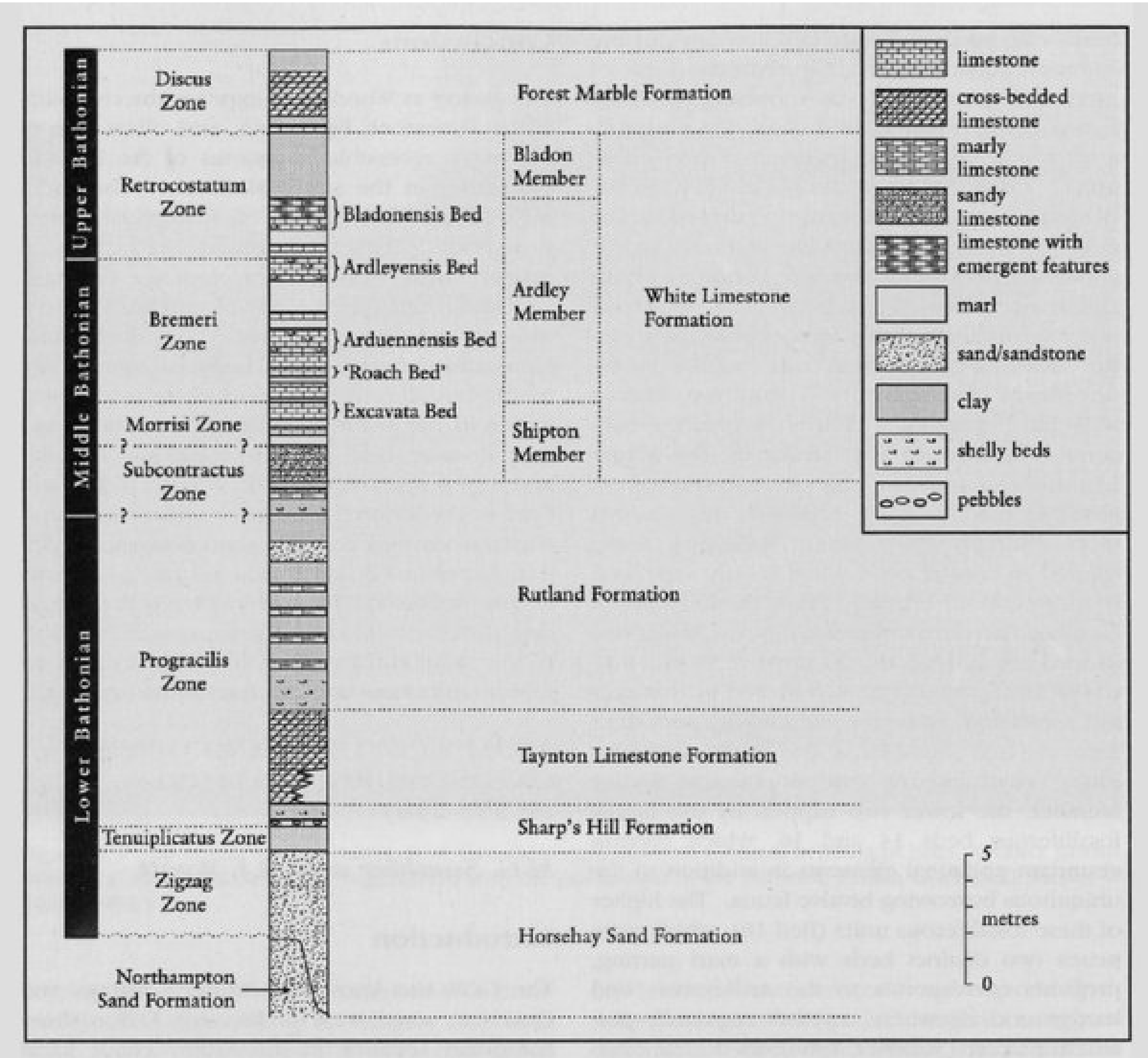
small amounts of inductura on columellar lip. The siphonal canal is short.

Biometric data (based on specimens from the type locality): Apical angle: mean = 24.8°, SD = 3.3°, n = 27; whorl width/height ratios: mean = 2.29, SD = 0.22, n = 80; reduced major axis: height = 0.456, width = 0.01, CC = 0.881.

Remarks: A. excavata has the largest mean apical angle of all known species of Aphanoptyxis. The presence of spiral ornament on the base, smaller size and angulated periphery readily serve to distinguish it from A. bladonensis with which there is otherwise some morphological overlap. A. excavata is somewhat variable depending upon the development of the sutural carinae, spiral ornament and growth lines that affect the degree of whorl concavity and ornament. It is the oldest species of a short evolutionary lineage (A. excavata–A. langrunensis-A. ardleyensis) that exhibits systematic changes in morphology through the White Limestone Formation and which provides reliable local biostratigraphical indices (Barker, 1976; Torrens, 1980c; Barker, 1994).

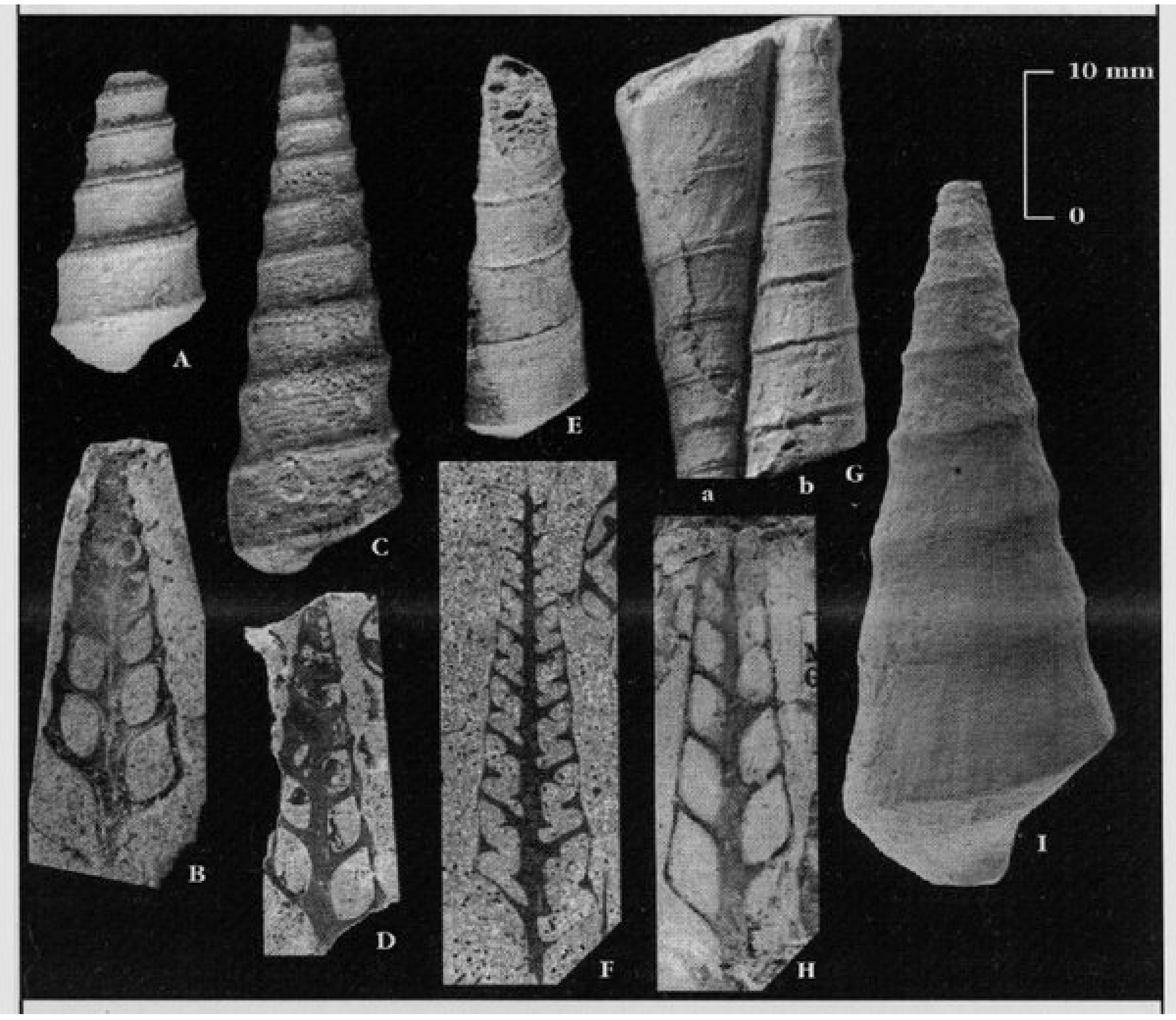
Distribution: A. excavata is the most geographically widespread of the Aphanoptyxis species in the White Limestone Formation. It gives its name to and is noticeably concentrated in considerable abundance in the Excavata Bed at the top of the Shipton Member.

References



(Figure 4.8) Graphic section of the Bathonian succession at the Ardley Cuttings and Quarries GCR site.)

(Figure 4.9) Ardley–Fritwell railway cutting (Ardley Cuttings and Quarries GCR site) showing the White Limestone Formation. (Photo: British Geological Survey, No. A9865; reproduced with the permission of the Director, British Geological Survey, © NERC, 1960.))



(Figure 4.10) Stratigraphically useful nerineid gastropod species. (A,B) Aphanoptyxis excavata sp. nov.; (A) OUM J29500 holotype; (B) OUM J29501 paratype; White Limestone Formation: Shipton Member, Excavata Bed; Sturt Farm (or 'Whitehill North) Quarry, Burford, Oxfordshire. (C,D) Aphanoptyxis langrunensis (d'Orbigny); (C) UP 77/50, Hydrequent, Pas de Calais, France; (D) UP EC/43; White Limestone Formation, Ardley Member, Bed 14 of Barker (1976); Eton College Quarry, Asthall, Oxfordshire. (E,F) Eunerinea arduen-nensis (Buvignier); (E) UP Sl.H.Ox./5/296; (F) UP Sl.H.Ox/5/23; White Limestone Formation, Ardley Member, Bed 5 of Barker (1976); Slape Hill, Wooton, Oxfordshire. (G,H) Aphanoptyxis ardleyensis Arkell; (Ga) OUM J829 lectotype; (Gb) OUM J828 paratype; (H) OUM J830 paratype; White Limestone Formation, Ardley Member, Ardleyensis Bed; Ardley-Fritwell railway cutting, Ardley, Oxfordshire. (I) Aphanoptyxis bladonensis Arkell; OUM J840 holotype; White Limestone Formation, Ardley Member, Bladonensis Bed; Orchard Quarry, Bladon, Oxfordshire. (OUM = Oxford University Museum UP = University of Portsmouth.))