Microfossils from the Wootton Bassett Mud Springs (Wiltshire, UK)

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On the 6th January 1997, the mud springs at Templars Firs, Wootton Bassett (Wiltshire) were designated a Site of Special Scientific Interest (SSSI) under Sections 28 of the Wildlife and Countryside Act 1981 (as amended). The springs are notified on the basis of their hydrogeological interest, although the fossils brought to the surface by the springs are well-known and show exceptional preservation (often with the original aragonite still present). In autumn 2003, spring 2004 and summer 2005 a series of samples were collected with the permission of English Nature and these have been studied for their microfossil content. While foraminifera and ostracoda are exceptionally preserved, we have also found many specimens of otoliths (fish "ear bones") that are quite rare in Jurassic strata. Their occurrence in our samples is, therefore, interesting. The fauna is dominated by forms identified as *Otolithus (Leptolepididarum)* cf. *simplex* Frost, 1924.

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Introduction

On the 6th January 1997 the mud springs at Templars Firs, Wootton Bassett (Wiltshire) were designated a Site of Special Scientific Interest (SSSI) under Section 28 of the Wildlife and Countryside Act 1981 (as amended). The springs are notified as an SSSI on the basis of their hydrogeological interest, although they are probably best known for their palaeontological interest. Water seeping through the Lower Calcareous Grit and Coral Rag (of Oxfordian age) liquefies the Ampthill Clay Formation which then migrates to the surface in a series of mud springs. Many of the fossils brought to the surface still display their aragonitic shells and are quite beautifully preserved. In autumn 2003, spring 2004 and summer 2005, a series of samples were collected with the permission of English Nature (now Natural England) and these have been washed for foraminifera, ostracods and other microfossils. The microfauna has been described in a BGS Report (Wilkinson, 1996) and by Harding *et al.* (2000), although the foraminiferal assemblage is much more extensive and yields all the taxa associated with this stratigraphical interval (see Henderson, 1997; Oxford, 2004). Many aragonitic taxa (epistominids) are beautifully preserved, including some of the stratigraphically significant taxa. Large agglutinated foraminifera (especially *Ammobaculties coprolithiformis*) appear to dominate one of the mud vents and are in an exceptional state of preservation. In the literature, many of these have been referred to modern taxa, although this is almost certainly incorrect. The material from Wootton Basset should allow for a more appropriate determination of these taxa.

Location and geological setting

In the years prior to designation as an SSSI, there was a period of relatively sustained media interest. In 1988 W.I. Stanton reported that his knowledge of the Wootton Bassett mud springs dated back to 1974 when, as the River Authority geologist, he had visited the Templars Firs site where a small stream (Hancocks Water) had been obstructed by a mass of grey clay. As workmen had tried to clear the clay from the stream, grey liquid mud "gushed into the channel from beneath tree roots". The mud is reported to have spurted ~30 cm into the air at a rate estimated at ~8 litres per second. As the village of Wootton Bassett was expanding at that time (mid-1970s), Stanton contacted the Nature Conservancy Council with a view to the site being recognised as an SSSI (Figure 1).

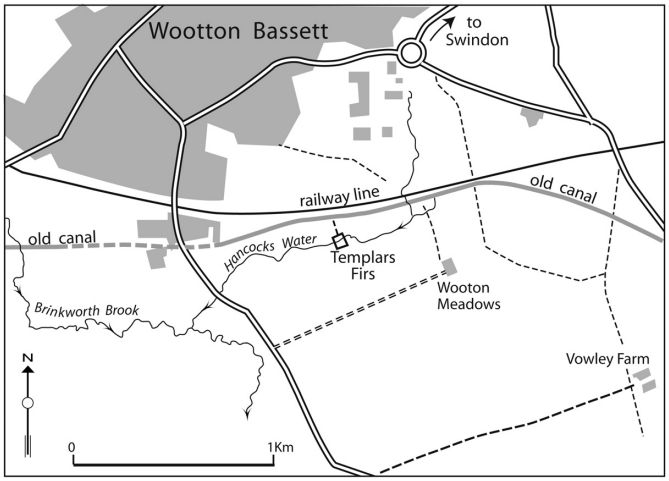

Figure 1. *Location of the Wootton Bassett Mud Springs SSSI.*

Stanton's (1988) article prompted a reply from R.P. Gosnell, a local resident of Wootton Bassett, who had recently visited the site to check if things had changed since 1974. Gosnell (1989) reported the occurrence of the brachiopod *Rhactorhynchia inconstans*, specimens of which had been identified by B.M. Cox of the British Geological Survey. Stanton (1996) described the changes to the site since his visit in 1974 and reported that the springs were about to be designated an SSSI by the NCC.

He reported (Stanton, 1996) that the two main vents had been deflated and flattened by visitors and River Authority workers. Of particular concern was an attempt to make the eastern spring "safe" by the tipping of truckloads of rubble, all of which had disappeared (in approximately 30 minutes according to Stanton, 1992). When about 100 tons of rubble had vanished completely this dumping operation was suspended, although some believe that more material was "unofficially" tipped into some of the vents. In his article, Stanton (1995) asked about the age of the mud springs, noting that the Templars Firs coppice was enclosed by a very regular wall (and ditch). It was suggested that the form of the earthworks could indicate a date of 200-300 years ago (*fide* Rackham, 1990, pp. 114-116). The walls had presumably been constructed to prevent the loss of cattle and other grazing animals. Other media reports at about the same time (Nuttal, 1995, 1996; Gosnell, 1996a,b; Anonymous, 1995; Evans, 1996; Hollingworth, 1996) all assisted in the promotion of the site. The report by Pentecost and Ponsford (1996) was the most detailed and provided the first map of the site. The main vents operating in 1996 can clearly be equated with the active vents from 2005 which are shown in Figure 2. The old oak tree is also indicated on their map adjacent to the ditch along the eastern margin of the site. The chemistry of the water and mud was presented at that time and led to the conclusion that the water was artesian and that the high mineral content of the water might have assisted in the liquefaction of the in-situ clay. The chemistry of the clays was certainly reminiscent of the Kimmeridge Clay Formation with, perhaps, the addition of some other material.

The Wootton Bassett Mud Springs is designated as a Site of Special Scientific Interest, notified on the 6th January 1997 under Section 28 of the Wildlife and Countryside Act 1981 as amended. The site is located in Wiltshire (National Grid Reference: SU 078815) on Ordnance Survey Sheet 1:50,000: 173 1:10,000: SU 08 SE. The Natural England citation (www.naturalengland.org.uk) is as follows: "Wootton Bassett Mud Spring is situated on low boggy ground in a small coppice approximately 1 km south-east of Wootton Bassett. The spring consists of several vents which emit liquid mud all year round and at accentuated rates after periods of prolonged rainfall. This mud dries and then accretes around the vents forming mud blisters. The spring emerges from clays (the Ampthill Clay Formation) through five vents described above. It is most active during the winter and also about a month after a period of heavy rain. The vents have been shown to contain liquid mud to a depth of about 6 m. Geochemical evidence indicates that the water contained in the mud appears to originate from an aquifer in the Coral Rag Formation, the top of which underlies the Ampthill Clay Formation at a depth of 20 m, and has a sufficient hydrostatic head to drive the spring. Augering in the vicinity of the springs revealed that the area is underlain by very soft clay at depth, possibly up to 20 m, indicating that the coppice may be underlain by large pockets of soft clay and mud. Wootton Bassett Mud Spring is an example of an hydrogeological phenomenon which is only represented by a few other examples in Britain. This site is the site where the mechanism of the phenomenon has been studied in detail".

The Wootton Bassett Mud Springs are located 1 km south-east of Wootton Bassett at Templars Firs [SU 0775 8155]. There are currently five vents (Figure 2) that ooze liquid mud, some of which enters the stream that crosses the site from east to west. The present configuration of the site has been influenced by human intervention (e.g., digging, dumping of rubble, etc.). When fully active after rainfall, macrofossils are found washed from the mounds into Hancocks Water from where they can be collected. The present flow directions are shown in Figure 2, and these agree with information previously published by Bristow *et al.* (1996, 2000) and Riding *et al.* (2000). Vent 4 had two active sources of liquid mud in summer 2005 and these are shown on the map as 4a and 4b.

Macrofossils can still be collected from the stream and there was evidence of collection activity on the south bank of the stream in summer 2005, despite the site being bounded by both

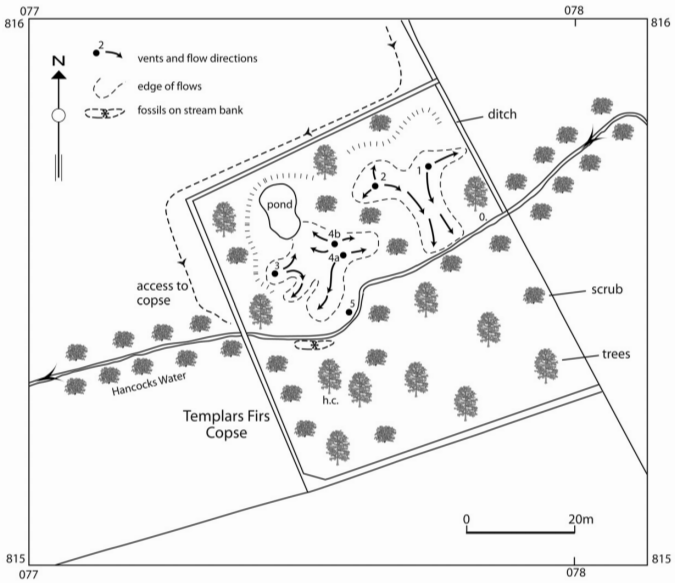

Figure 2. *Site plan of the mud springs active in summer 2005: mapped by the authors. '0' is a prominent oak tree on the north bank of Hancocks Water; 'h.c' is a prominent horse chestnut tree to the south of Hancocks Water where there is evidence of fossil debris on the bank.*

Figure 3A. *Tim Frayling at Vent 4b.*

Figure 3B. *Flowing mud after ground surface near Vent 4b has been "agitated" by a person standing on it (see A above).*

the old walls and modern barbed wire fencing. Entry is restricted as the site is potentially dangerous. Permission to enter must be obtained from Wiltshire County Council and Natural England should be consulted before attempting to collect fossils or samples of the mud. Within the stream, and on the riverbank, the oyster *Deltoideum delta* is the most obvious fossil, although belemnites are also quite abundant. Ammonites with their aragonitic shell preserved are also found and indicate horizons within the Ampthill Clay Formation (Cox and Gallois, 1979; Cox *et al.*, 1994; Geddes, 2003). The work by the British Geological Survey (see Bristow *et al.*, 2000) identified the water in the mud as coming from the "Coral Rag" and percolating through the Ampthill Clay Formation *en-route* to the surface (Bristow *et al.*, 2000, figure 4).

METHODOLOGY

Samples were carefully collected from several of the mounds and placed in plastic bags in the field. On return to the laboratory the samples were initially soaked in de-ionised water and then washed on a 63 µm sieve. Residues were collected into bowls and dried in a cool (<40°C) oven. The dried residues were studied in the following size fractions: >500 µm, 500-250 µm, 250-125 µm, and 125-63 µm. Initially samples were investigated by optical binocular microscope, with selected otoliths being coated with ~10 Å of gold and photographed using a JEOL 5600 scanning electron microscope, while the agglutinated foraminifera were photographed (un-coated) at the Natural History Museum, London, using an Alicona Infinite Focus Microscope (Figure 4).

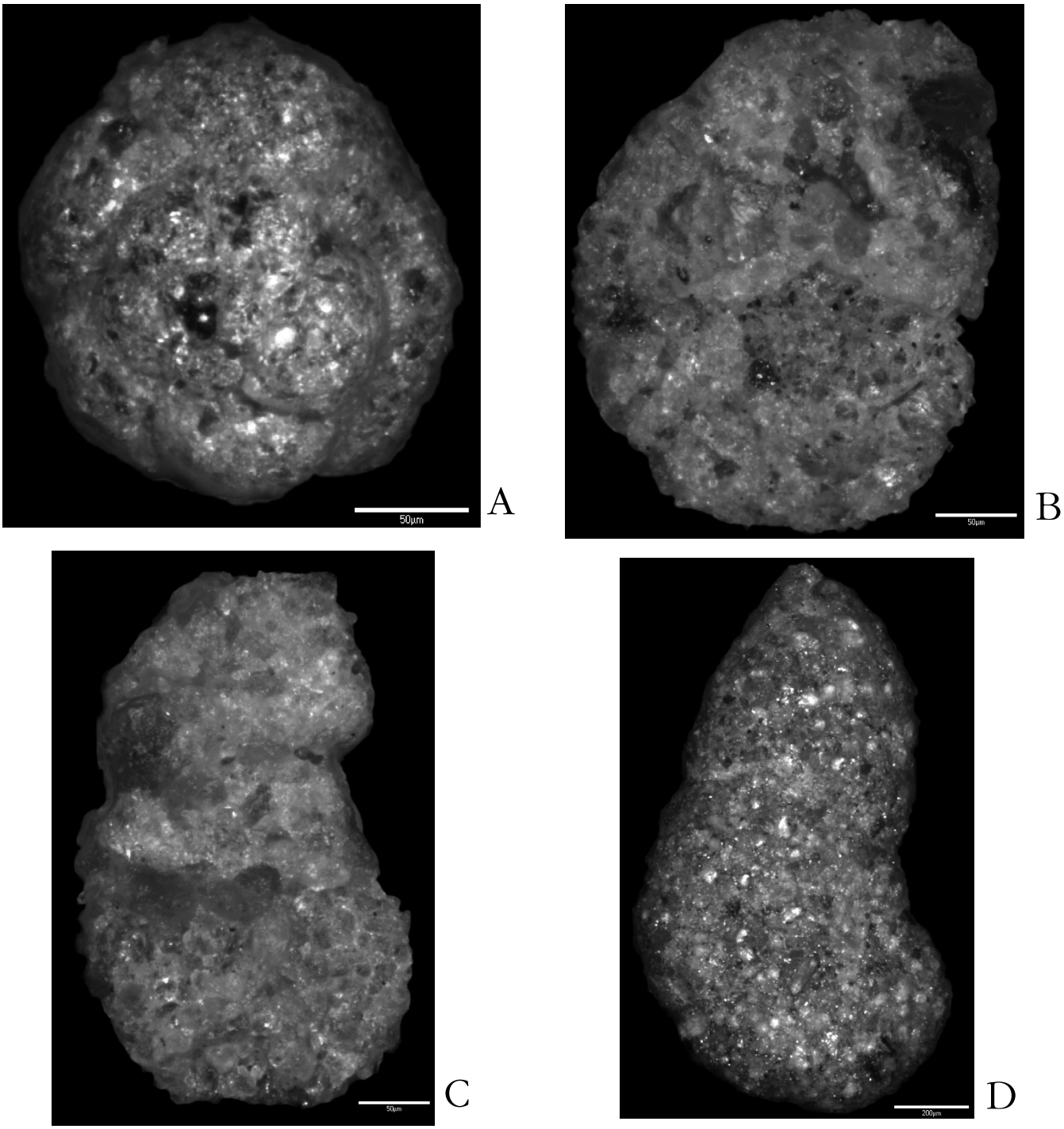

Figure 4. *Agglutinated foraminifera from the mud springs.* ***A.*** Trochammina *sp. cf.* Trochammina globigeriniformis *(Parker & Jones):* ***B.*** Kutsevella *sp.:* ***C.*** Ammobaculites agglutinans *(d'Orbigny):* ***D.*** Ammobaculites coprolithiformis *(Schwager). Scale bars are A = 50 µm, B = 50 µm, C = 50 µm, D = 20 µm.*

MICROFAUNA

Mud samples from all the vents are rich in foraminifera and ostracoda. These assemblages have been described by Wilkinson (1996), Bristow *et al.* (2000) and Harding *et al.* (2000) although, in our samples, the foraminifera are much more diverse than suggested in the above papers. The proportions of the various taxa vary from vent to vent and, as yet, we have no explanation for this variation aside from the fact that the springs are possibly tapping a variety of levels within the underlying succession. *Epistomina tenuicostata* is quite abundant and normally well-preserved. In some of the vents the agglutinated foraminifera dominate the assemblage with *Ammobaculties coprolithiformis* being the most abundant taxon (Figure 4). Unfortunately many of the names applied to these agglutinated species (e.g., *Ammobaculites coprolithiformis* (Schwager), *A. agglutinans* (d'Orbigny)) are those of extant taxa and one must question whether the use of such names for Jurassic taxa is both justified and appropriate. As much of the literature on Jurassic agglutinated foraminifera is of Russian origin (e.g., Dain, 1972) the checking of appropriate names is both challenging and time consuming; this work is still in progress.

Many of the ostracoda found in the clays are long-ranging (Kilenyi, 1978; Wlkinson, 1996, 1998; Bristow *et al.*, 2000; Harding *et al.*, 2000) although Wilkinson's identification of the most likely age as being the Glosense to Regulare zones of the Upper Oxfordian is almost certainly correct.

While holothurian sclerites have been recorded (especially the "rings" of *Theelia* spp.) little is known of their taxonomy or stratigraphical ranges (see Henderson *et al.*, 1992). We have not studied the dinoflagellates as there is a full account of this group in Harding *et al.* (2000).

Harding *et al.* (2000) also report the occurrence of otoliths, although no taxa are identified. Otoliths are quite common in our samples, although most appear to belong in the same general group of leptolepids. As these are exceptionally rare in most Jurassic samples a study of this assemblage is important.

Otoliths are the stato-acoustic organs of bony (teleost) fish and are often quite well preserved as fossils as they are composed of calcium carbonate (Lowenstein, 1971). On each side of the fish the "labyrinth" has three otoliths which are located adjacent to the sensory spots (Figure 5). The largest is the *sagitta* and is located in the sacculus. The second otolith lies in the lagena or caudal part of the sacculus, and is called the *asteriscus*. The third, or *lapillus*, is situated in the utriculus. In fossil assemblages it is the *sagitta* that is normally encountered. The side of the *sagitta* facing the median plane of the body is named the 'inner side' and this usually appears flatter, in comparison to the 'outer side' which usually displays a series of grooves or other ornamentation (Figure 6). The oldest known otoliths are of Permian age and while none are described from the Triassic they are known from the Jurassic (see Stinton and Torrens, 1968) and Cretaceous. They are quite abundant in the Eocene (Cenozoic) and have been described in detail by Stinton (1975-1984).

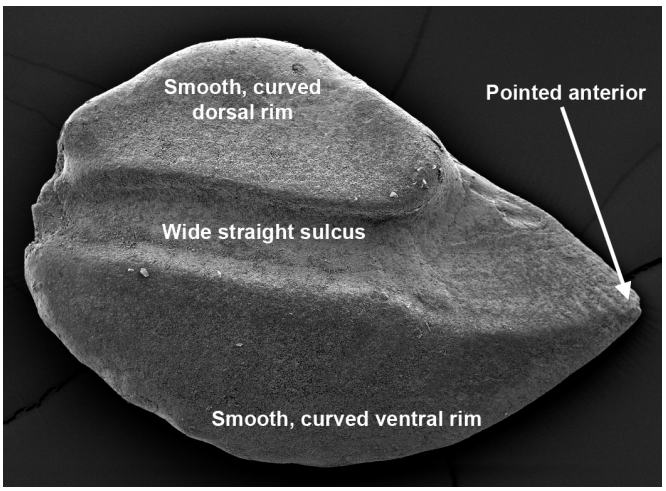

Figure 6. Otolithus (Leptolepididarum) *cf.* simplex *Frost, 1924 with the major features indicated.*

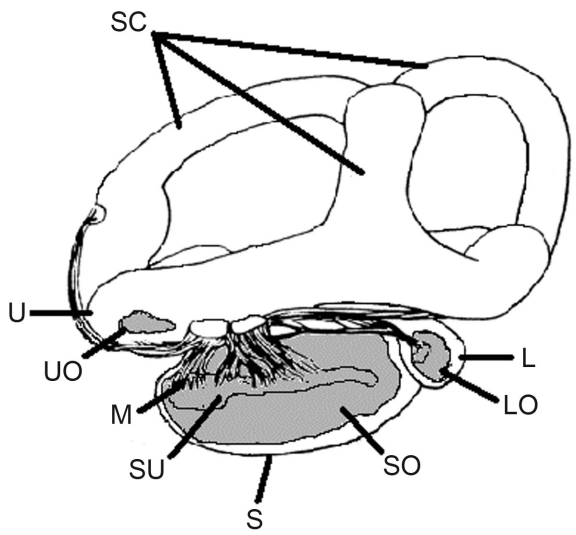

Figure 5. *Morphology of the inner ear of a fish with the location of the otolith (after Popper and Coombs, 1982). SC – Semicircular Canals; U – Utriculus; UO – Utricular Otolith or Lapillus; M – Macula; SU – Sulcus; S – Sacculus; SO – Saccular Otolith or Sagitta; L – Lagena; LO – Lagenar Otolith or Asteriscus.*

Our knowledge of Oxfordian otolith taxa is quite limited. In the UK, the only papers dealing with Jurassic otoliths are by Frost (1924) on the fauna of the Kimmeridge Clay in Buckinghamshire and Wiltshire, and Frost (1926) on the Jurassic of Buckinghamshire and Dorset. Frost was principally a biologist, publishing a complete suite of papers on neopterygian fish in the early 1920s. In Germany papers by Martin and Weiler (1954, 1957) and Schröder (1956) have described Jurassic and Wealden faunas while a number of other authors (Frizzell, 1965a; Frizzell and Koenig, 1973; Nolf and Stringer, 1996) have described Cretaceous taxa (primarily from North America). The Wootton Bassett fauna is interesting in that it is one of the first descriptions of a fauna from the Ampthill Clay Formation. Some of the specimens (Figure 7b) from Wootton Bassett are quite close to the form described by Frost (1924) as *Otolithus (Leptolepididarum) simplex* from the Upper Kimmeridgian of Buckinghamshire (Figures 6, 7b). As this species is not reported by Martin and Weiler (1954) in their monograph on Jurassic otoliths from Germany it is, therefore, only known from the description of Frost (1924). The key features of the species are the smooth, elliptical shape with rounded dorsal and ventral rims. The front end is sharply pointed while the posterior is rounded. There is a distinctive wide, straight sulcus.

Martin and Weiler (1954, p. 138) only mention *O. (L.) simplex* Frost in the discussion of the new species *Otolithus (Leptolepididarum?) ventroundulatus* Weiler (in Martin and Weiler, 1954) although the forms illustrated by Martin and Weiler (1954, pl.2, figs 53, 54) are not so smooth in outline, less symmetrical in overall shape and not so pointed at the anterior end. They also have a 'crenulated' ventral margin, unlike any of the forms from Wootton Bassett. The other two leptolepid otoliths in Figure 7 (c and d) cannot be identified to species level at the present time although both appear to have quite characteristic features. Work on the taxonomy of this fauna continues. Further large samples may have to be collected in the hope that more specimens can be recovered.

One problem is the identification of Figure 7a as an albulid otolith. The overall shape is quite distinctive and appears close to a Cretaceous form described by Frizzell (1965b). In another sample from the same vent there are some calcareous dinoflagellates that also look to be Cretaceous in origin. These were associated with one (beautifully preserved) *Praehedbergella* sp. close to *P. tuschepensis* (Antonova). This species is associated with strata of Barremian-Aptian age. While Oxford (2004) found one or two specimens of this species in Cambridgeshire, the majority of the previous records are not in the UK.

If the albulid otolith and the other planktic microfossils are correctly identified as Cretaceous taxa, how can they be associated with a fauna of benthic foraminifera that are 100% Oxfordian in age and an ostracod fauna that is so highly diagnostic (Wilkinson, 1998; Bristow *et al.*, 2000) In their paper on the macrofauna, microfauna and microflora, Harding *et al.* (2000) report no "exotic elements". The sample in which the *Praehedbergella* was found was processed by ASH at the Natural History Museum, while the abulid otolith was found (TA) in a sample processed at a different time at the University of Plymouth by MBH. Laboratory or processing contamination can, therefore, be discounted when the exotic elements appeared in two laboratories at different times. Natural contamination also seems impossible as marine strata of Cretaceous age, with this fauna, is unknown in the UK.

We do know that "rubble" has been dumped into the mud springs at various times and it may be possible to trace where this came from through Wiltshire County Council. We regard it extremely unlikely that they sourced this material from anything but a local quarry (or construction site) and, again, this appears an unlikely source of the well preserved fauna.

Summary

The Wootton Bassett Mud Springs yield an interesting microfauna and microflora, much of which has been documented elsewhere. The presence of a relatively diverse assemblage of otoliths is significant as we know little of such faunas in the Jurassic of the UK. As work continues on the material we anticipate finding an expanded range of otolith taxa including, perhaps, more of the exotic elements that may either allow us to track down the source or – if not contaminants – provide revisions to our understanding of the taxonomy and evolution of the taxa involved.

Acknowledgements

We thank Wiltshire County Council for permission to enter the site and English Nature (Natural England) for permission to sample the locality. Adrian Rundle provided invaluable help with the identification of the otolith taxa. John Abraham prepared the figures and Roy Moate and his staff assisted with the SEM photography in Plymouth. Chris Smart assisted in the production of Figure 7.

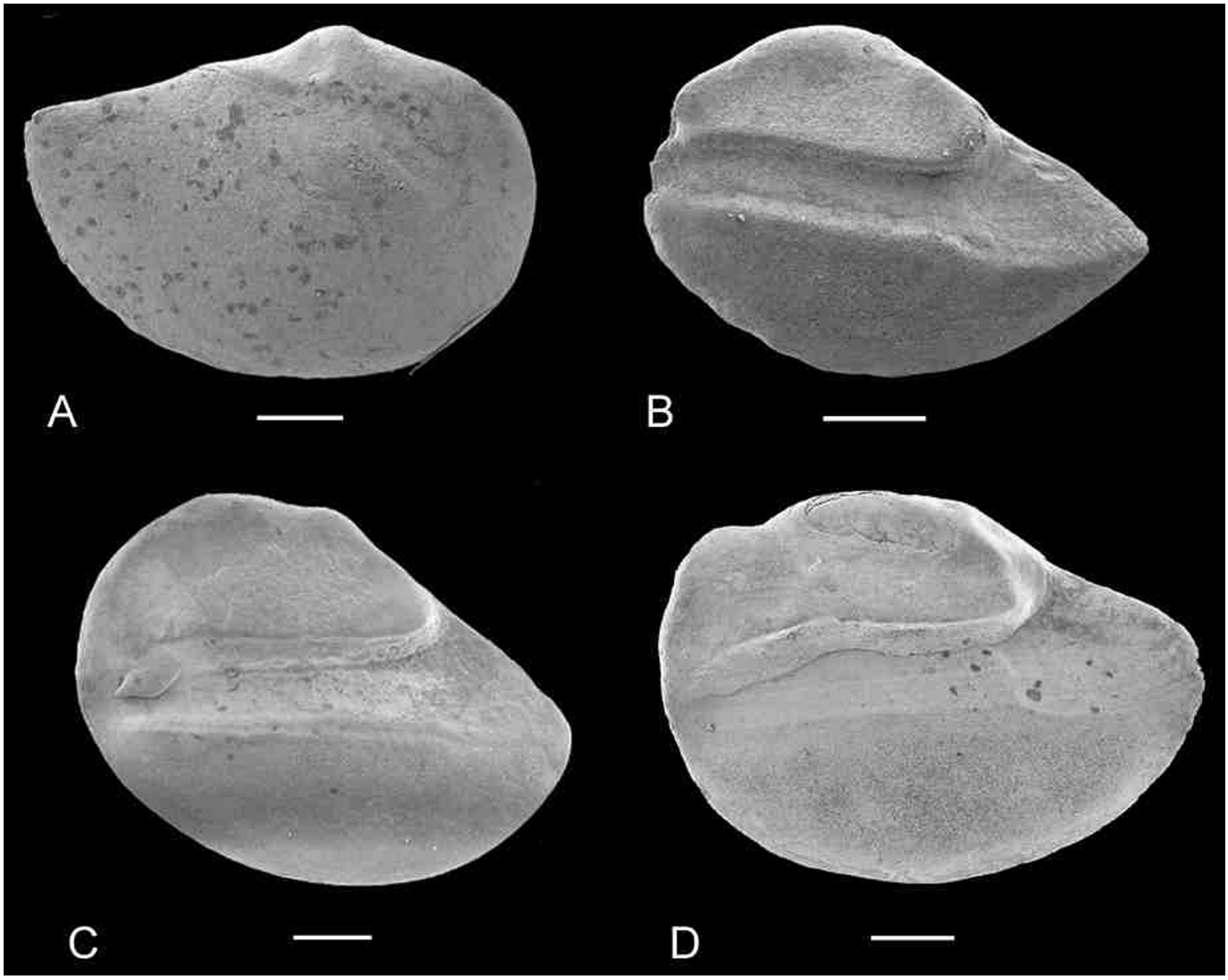

Figure 7. *Four otoliths from vent 4a/b (see Figure 3) illustrate the general character of the assemblage. All the scale bars are 500 µm.* ***A.*** *An unidentified albulid otolith:* ***B.*** Otolithus (Leptolepididarium) *cf.* simplex *Frost, 1924:* ***C, D.*** *Two unidentified leptolepid otoliths.*

References

ANONYMOUS. 1995. Iridescent fossils rise up from volcano. *New Scientist*, **148**, (1998), 10.

BRISTOW, C.R., GALE, I.N., FELLMAN, E. and COX, B.M. 1996. The Mud Springs at Templars Firs, Wootton Bassett, Wiltshire: An assessment of their hydrogeological significance. *British Geological Survey, Technical Report WD/96/38C.*

BRISTOW, C.R., GALE, I.N., FELLMAN, E. and COX, B.M. with WILKINSON, I.P. and RIDING, J.B. 2000. The lithostratigraphy, biostratigraphy and hydrogeological significance of the mud springs at Templars Firs, Wootton Bassett, Wiltshire. *Proceedings of the Geologists' Association*, **111**, 231-245.

COX, B.M. and GALLOIS, R. 1979. Description of the standard stratigraphical sequence of the Upper Kimmeridge Clay, Ampthill Clay and West Walton Beds. *Report of the Institute of Geological Sciences*, **78/19**, 68-72.

COX, B.M., GALLOIS, R. and SUMBLER, M.G. 1994. The stratigraphy of the BGS Hartwell Borehole near Aylesbury, Buckinghamshire. *Proceedings of the Geologists' Association*, **105**, 209-224.

DAIN, L.G. 1972. Foraminifera of the Upper Jurassic deposits of Western Siberia. *Trudy Vseoivznogo Neftianogo Nauchno-Isseledovat – El'skogo Geologoraz – Vedochnogo Instituta (VNIGRI)*, **317**, 1-272.

EVANS, C. 1996. The town that hopes its name will be mud. *Daily Mail*, 19th October 1996.

FRIZZELL, D.L. 1965a. Otoliths of new fish (*Vorbisia vulpes*, n.gen., n.sp. Siluroidei?) from Upper Cretaceous of South Dakota. *Copeia*, **1965**, 178-181.

FRIZZELL, D.L. 1965b. Otolith-based genera and lineages of fossil bonefishes (Clupeiformes, Albulidae). *Senckenbergiana Lethaea*, **46a**, 85-110.

FRIZZELL, D.L. and KOENIG, J.W. 1973. Upper Cretaceous ostariophysine (*Vorbisia*) redescribed from unique association of utricular and lagenar otolith (lapillus and asteriscus). *Copeia*, **1973**, 692-698.

FROST, G.A. 1924. Otoliths of fishes from the Upper Kimmeridgian of Buckinghamshire and Wiltshire. *Annals and Magazine of Natural History*, **14**, 139-143.

FROST, G.A. 1926. Otoliths of fishes from the Jurassic of Buckinghamshire and Dorset. *Annals and Magazine of Natural History*, **18**, 81-85.

GALLOIS, R.W. and COX, B.M. 1994. The Kimmeridge Clay and underlying strata (Upper Jurassic) at Swindon, Wiltshire. *Proceedings of the Geologists' Association*, **105**, 99-110.

GEDDES, I. 2003. *Hidden depths - Wiltshire's geology and landscapes*. Ex Libris Press, Bradford-on-Avon, Wiltshire.

GOSNELL, R.P. 1989. Mud springs at Wootton Bassett. *Geology Today*, **5**(3), 87.

GOSNELL, R.P. 1996a. Wootton Bassett. *Geology Today*, **11**(5), 172-173 [for 1995].

GOSNELL, R.P. 1996b. More on the Wootton Bassett mud springs. *Geology Today*, **12**, 61-62.

HARDING, I.C., ARMITAGE, J., HOLLINGWORTH, N. and AINSWORTH, N. 2000. Sourcing mudsprings using integrated palaeontological analyses: an example from Wootton Bassett, Wiltshire, England. *Geological Journal*, **35**, 115-132.

HENDERSON, A.S. 1997. *The palaeo-ecology and biostratigraphy of the foraminifera from the Oxfordian of North Dorset*. Unpublished PhD thesis, University of Plymouth.

HENDERSON, A.S., TALWAR, A.D. and HART, M.B. 1992. Some holothurian Sclerites from the Corallian Group of North Dorset. *Proceedings of the Ussher Society*, **8**, 11-14.

HOLLINGWORTH, N. 1996. Mud Springs Eternal: The Wiltshire Mud Bog Mystery. *NERC News*, **35** (April), 22-23.

KILENYI, T. 1978. The Jurassic Part lll Callovian – Portlandian. In: BATE, R.H. and ROBINSON, E. (eds), *A Stratigraphical Index of British Ostracoda*. Geological Journal Special Issue **8**, Seel House Press, Liverpool, 259-298.

LOWENSTEIN, O. 1971. The Labyrinth. In: HOAR, W.S. and RANDALL, D.J. (eds), *Fish Physiology, Volume 5, Sensory Systems and Electric Organs*. Academic Press Inc., London, 207-240.

MARTIN, G.P.R. and WEILER, W. 1954. Fisch-otolithen aus dem deutschen Mesozoikum (Dogger bis Wealden). *Senckenbergiana Lethiae*, **35**, 119-192.

MARTIN, G.P.R. and WEILER, W. 1957. Das Aldorfer Otolithen-'Pflaster' und seine Fauna. *Senckenbergiana Lethiae*, **38**, 211-249.

NOLF, D. and STRINGER, G.L. 1996. Cretaceous fish otoliths – a synthesis of the north American record. In: ARRATIA, G. and VIOHL, G. (eds), *Mesozoic fishes – Systematics and paleoecology*. Verlag Dr. Friedrich Pfeil, München, 433-459.

NUTTALL, N. 1995. Bottomless' mud springs baffle scientists. *The Times*, 27th September 1995, p. 18.

NUTTALL, N. 1996. Mud springs a surprise after 165 million years. *The Times*, 2nd May 1996, p.7.

OXFORD, M.J. 2004. *Foraminiferal distribution and sequence stratigraphy of Oxfordian successions in the Wessex/Anglo-Paris Basin*. Unpublished PhD thesis, University of Plymouth.

PENTECOST, A. and PONSFORD, S. 1996. Some new observations on the mud springs of Wootton Bassett, Wiltshire. *Geology Today*, **12**(6), 213-214.

POPPER, A.N. and COOMBS, S. 1992. The morphology and the evolution of the ear in actinopterygian fishes. *American Zoologist*, **22**, 311-328.

RACKHAM, O. 1990. *Trees and Woodland in the British landscape* [Revised Edition]. Orion Publishing Group, London.

SCHRÖDER, G. 1956. Otolithen aus dem Lias und Dogger des Frankischen Jura. *Geologische Blätter No.-Bayern*, **6**, 128-153.

STANTON, W.I. 1988. Mud springs in Britain. *Geology Today*, **4**(6), 187.

STANTON, W.I. 1992. Mud springs in Britain: an update. *Geology Today*, **8**(5), 175.

STANTON, W.I. 1996. Wootton Bassett: Fame at last for mud springs. *Geology Today*, **11**(5), 172 [for 1995].

STINTON, F.C. 1975-1984. Fish otoliths from the English Eocene. *Monographs of the Palaeontographical Society, London*, Part 1 (1975), 1-56; Part 2 (1977) 57-126; Part 3 (1978), 127-189; Part 4 (1980) 191-258; Part 5 (1984) 259-320.

STINTON, F.C. and TORRENS, H.S. 1968. Fish otoliths from the Bathonian of southern England. *Palaeontology*, **11**, 246-258.

WILKINSON, I.P. 1996. Calcareous microfaunas from the Templars Firs mudsprings, Wootton Bassett. *British Geological Survey, Technical Report, WH96/132R.*

WILKINSON, I.P. 1998. Calcareous micropalaeontological biostratigraphy of the Templar's Firs (Wootton Bassett) Borehole. *British Geological Survey, Technical Report, WH98/166R.*