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Corals not serpulids: mineralized colonial fossils in the Lower Jurassic marginal facies of South Wales

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SIMMS, M. J., LITTLE, C. T. S. & ROSEN, B. R. 2002. Corals not serpulids: mineralized colonial fossils in the Lower Jurassic marginal facies of South Wales. *Proceedings of the Geologists' Association*, **113**, 31–36. Poorly preserved colonial corals occur near the base of the Lower Jurassic marginal facies at Southerndown, South Wales. Previously they have been interpreted as serpulid colonies, despite a dissimilarity to any serpulids known from elsewhere in the Lias or the few known extant colonial serpulids. However, local preservation of fine detail reveals evidence, in the form of corallites, septa and tabulae, that they are scleractinian corals of the Suborder Faviina, Family Stylophyllidae. These coral specimens occur in close association with barite–galena veins in the underlying Carboniferous Limestone and adjacent Lias marginal facies. Their widespread misindentification as 'serpulid reefs' is a consequence of coarse replacive mineralization by barite, which has largely obscured the diagnostic characters.

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1. INTRODUCTION

The spectacular unconformity which exists between Lower Carboniferous limestones and Lower Jurassic carbonates exposed near Southerndown, South Wales [Great Britain Ordnance Survey, Grid ref. SS 871741 to 890726], has formed the subject of discussion for more than a century and been the destination of countless field trips. Details of the site, its stratigraphy and its sedimentology, have been described in many papers (e.g. Trueman, 1922; Arkell, 1933; Hallam, 1960; Wobber, 1965; Ager, 1986a, b; Fletcher *et al.*, 1986; Wilson *et al.*, 1990; Warrington & Ivimey-Cook, 1995).The facies exposed here are unusual for the British Lower Jurassic, being dominated by bioclastic calcarenites and calcirudites. These sediments are accompanied by a correspondingly unusual fauna in which corals, thick-shelled bivalves and gastropods, indicative of a high-energy environment, are relatively abundant while ammonites are extremely rare (Hodges, 1986).

There is now a general consensus that this unusual succession developed as a marginal or 'near-shore' facies, banked unconformably against a pre-existing topography developed on the Carboniferous Limestone, although the actual depth of deposition remains unclear (Hesselbo & Jenkyns, 1998). The marginal facies are superbly exposed in the cliffs between Pant y Slade and Dunraven Bay [Grid ref. SS 871741 to 890726], some 2 km to the east. They show a clear transition, both laterally and vertically, from 'marginal' facies unconformable on Carboniferous Limestone in the west through to more 'offshore' Blue Lias facies of the Porthkerry Member (Wilson *et al.*, 1990) in the east. The marginal facies traditionally have been subdivided into two distinct named units. Both comprise litharenites and gravel-grade conglomerates but the upper unit contains a lower proportion of limestone lithoclasts, a higher clay content and is more thinly bedded. The lower unit, resting on an irregular surface of the underlying Carboniferous Limestone, was termed the Sutton Stone by Henry de la Beche (1846) and passes up gradationally into strata which were termed the Southerndown Beds by Tawney (1866). They, in turn, pass upwards, and laterally, into the more 'offshore' facies of alternating mudstones and argillaceous limestones typical of the Blue Lias Formation. However, the boundary between the two marginal facies units is gradational and it can be impossible to identify a distinct boundary in some sections.

Despite the rarity of ammonites, it has long been recognized that the boundaries between the two marginal facies and the 'offshore' facies are strongly diachronous (Hodges, 1986). On the coast the marginal facies extend through much of the Hettangian Stage, ranging in age from at least the *johnstoni* Subzone to the *angulata* Zone, while at inland sites nearby, such as at Brocastle (Duncan, 1867), they apparently extend into the *semicostatum* Zone of the lower Sinemurian Stage. Consequently, no biostratigraphical significance can be attached to the two named marginal facies,

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which merely reflect relative distance, vertically or laterally, from the underlying unconformity.

The exposures at Southerndown are unusual not only for their marginal facies development but also in showing significant penecontemporaneous mineralization of the early Jurassic sediments. This was described in some detail by Fletcher (1988), who found evidence for cavity fill and replacive mineralization of both the Jurassic sediments and the underlying Carboniferous Limestone by barite, calcite and minor galena. The precise age of the mineralization is uncertain. Fletcher (1988) suggested a late Triassic to early Jurassic age, contemporaneous with the various Mesozoic breccias along this stretch of coast, but there is no conclusive evidence to discount the possibility that it entirely post-dates the Lower Jurassic succession preserved here. We have observed conspicuous galena and barite mineralization in association with fossil driftwood well up into the normal Blue Lias facies of the Porthkerry Member at Dunraven Bay, to the east; hence it must be no earlier than Sinemurian. Indeed, by analogy with the lead–zinc mineralization of the Mendip Hills (Haggerty *et al.*, 1996; Simms, 1997), and several of the other major carbonate-hosted orefields in England and Wales, it is more likely to be mid-Jurassic in age.

One of the most conspicuous elements of the 'marginal facies' fauna is a number of fairly large, discrete masses of small, closely packed, tubular structures. These mineralized, creamy-orange tubes contrast strikingly with the colour of the surrounding calcarenite and invariably are pointed out on field trips, as well as having been cited in several descriptions of the site. However, the identity of these mineralized 'colonies' of tubular organisms has been rather enigmatic. Cope (1971, p. 118) was the first to identify them as serpulids. Fifteen years later Ager (1986a, p. 30) stated, more cautiously, that they were 'worm colonies' but categorically refuted that they might be corals. Fletcher (1988, p. 7) stated that the tubes were colonial corals, but did not figure or describe them further. The most recent publication concerning the fossils in question (Johnson & McKerrow, 1995) reiterated the earlier claims for their serpulid affinity. At least one of us (MJS) is also guilty of referring to them as 'serpulid reefs' on several student field trips in the past!

2. OBSERVATIONS

The supposed 'serpulid reefs' are confined to a small area of the Lower Jurassic marginal facies on the western margin of the Slade Trough of Fletcher (1988) and lie very close to the unconformity surface beneath (Fig. 1). Johnson & McKerrow (1995) identified seven 'colonies' over a 2.5 m long section in this area, while we have found further examples near the base of the marginal facies further east, within the Slade Trough itself. In all cases they are closely associated with narrow veins of barite–galena mineralization in the Carboniferous Limestone beneath, and with more disseminated mineralization in the rather open framework sediments present near the base of the Lias marginal facies.

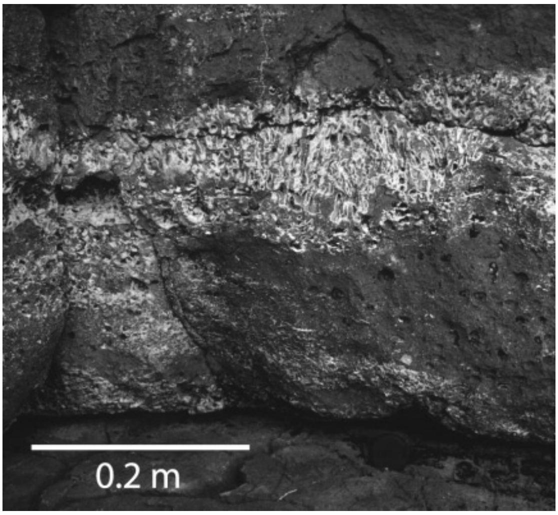

Fig. 1. General view of mineralized coral colonies and their relationship to the unconformity at the base of the Lias marginal facies. The conspicuous break near the base of the picture is the unconformity surface between the Lias marginal facies and the Carboniferous Limestone.

Each discrete mass measures up to about 300 mm across and 200 mm high, consisting of a radiating fan-like mass of fairly closely packed, creamy-orange tubular structures, which occasionally bifurcate (Fig. 2). Each tube is about 10 mm in diameter with walls about 1–2 mm thick and composed of barite. Typically the central cavity of each is lined with small drusy calcite crystals (Fig. 3). The interstices between adjacent tubes are filled largely with pale-brown bioclastic calcarenite. Small (1–2 mm) euhedral crystals of galena are fairly common, both within the barite of the tube walls and in the interstitial sediment. A close examination of these colonies, particularly the examples described by Johnson & McKerrow (1995), reveals that the barite mineralization is coarse and irregular, generally preserving only the gross morphology of the organisms. However, locally the mineralization has preserved finer details and it is these which have proved critical for interpreting the taxonomic affinities of these structures.

The most widespread of these finer structures takes the form of thin, regularly spaced plates, less than 1 mm thick, extending horizontally across the open tubes (Fig. 4). A second type of structure is seen at the upper end of some of the tubes, where a deeply concave plate extends across the tube and bears at least two size orders of vertical plates extending radially inwards from the walls of the tube (Fig. 3). Finally, in a few places detail of the external tube wall

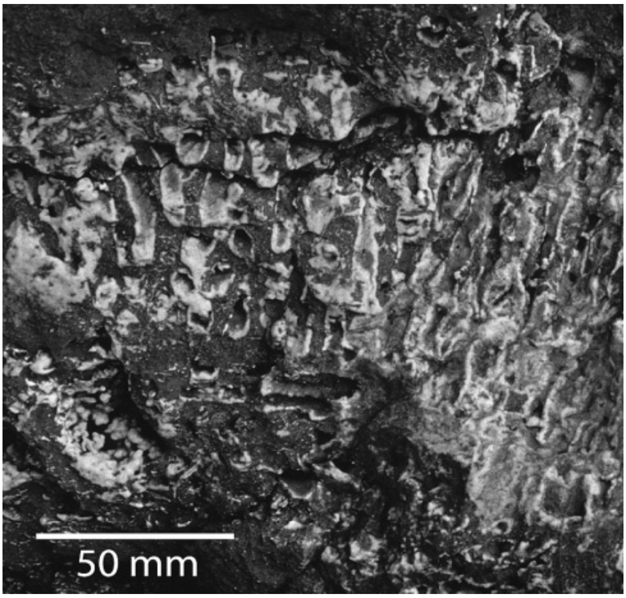

Fig. 2. Colony of radiating phaceloid corallites showing the hollow, tubular form of these extensively mineralized examples. Detail of Figure 1.

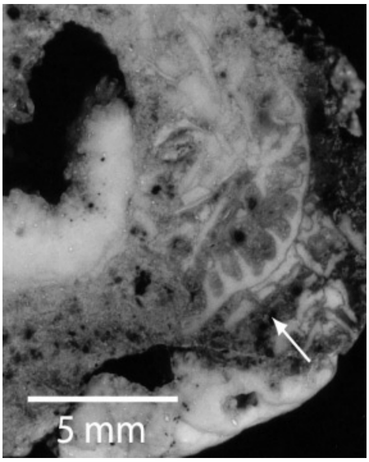

Fig. 3. Polished section of mineralized corallite, showing pale barite mineralization of corallite wall with radially disposed vertical septa (arrowed) and drusy calcite infill of cavities. Specimen collected from small colony within Slade Trough of Fletcher (1988).

is preserved, revealing fine horizontal growth lines together with equally fine vertical striations (Fig. 5).

3. INTERPRETATION

The morphology of the mineralized tubes precludes a serpulid affinity. Bifurcation of tubes is known in a few recent serpulids which reproduce asexually, including *Filogranula gracilis* Langerhans, *Filograna* sp., and *Josephella marenzelleri* Caullery & Mesnil (ten Hove, 1979), but it is far from typical for this group. Furthermore, these asexually reproducing taxa are characteristically small, no more than a few millimetres long and less than 1 mm in diameter; quite a different scale from the early Jurassic structures described here. Although the outer surface of serpulid tubes frequently bears fine striations, internally they lack horizontal or vertical septa. The presence of internal vertical septa in the Pant y Slade specimens and their bifurcation also precludes them being vermetid gastropods (see Burchette & Riding, 1977 for a thorough discussion of the morphology of this group).

The close association between these tubes and the zones of mineralization in the surrounding Jurassic sediment and underlying Carboniferous Limestone might suggest that they are elements of a ‘cold-seep’ fauna, and indeed this is the possibility which first prompted us to investigate them further. However, it is clear that they are unlikely to represent vestimentiferan worm tubes. Although bifurcation and horizontal internal septa have been reported recently from a vestimentiferan (Gaill *et al.*, 1997), none are known to possess vertical septa and most are significantly smaller than these mineralized tubes. It is improbable that vestimentiferans could flourish or be preserved in the high-energy oxidizing environments represented by the early Jurassic marginal facies at Southerndown, and none are known today from water less than 80 m deep, with most occurring at much greater depths.

The features described; the horizontal tabulae and radial septa within the tubes, the growth lines and

Fig. 4. Details of corallites in Figure 2 showing horizontal tabulae (examples arrowed). Photographed in situ.

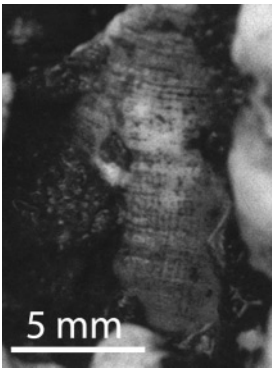

Fig. 5. Epithecal wall showing horizontal growth lines and longitudinal striations. Detail of Figure 1. Photographed in situ.

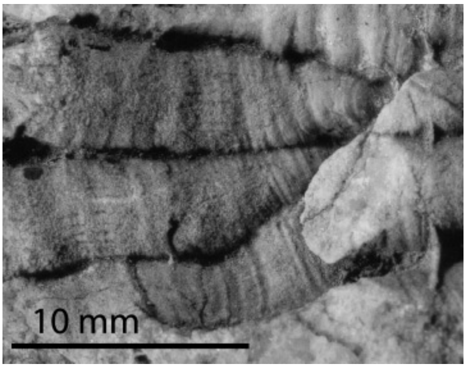

Fig. 6. *Phacelepismilia suttonensis* (Duncan), BMNH R37234. From Lower Lias marginal facies at Brocastle. South Wales. Lateral view of colony, showing longitudinal striations and horizontal growth lines; these are not discernibly different from those in the closely related genus *Phacelostylophyllum*.

longitudinal striations on the exterior surface, and the bifurcating pattern of the tubes occasionally seen, are clear evidence for a coral affinity for these colonial fossils. Fine longitudinal striations and growth lines are common on the epitheca of many corals (Fig. 6), while the deeply concave terminal plate, with its two, or more, orders of radially disposed vertical plates, clearly represent the floor of the calice in which the polyp rested (Fig. 7). The internal horizontal plates represent tabulae and are a particularly diagnostic feature of the scleractinian Suborder Faviina, and more specifically the Family Styllophylidae. Johnson & McKerrow (1995) did recognize some scleractinian corals among the contemporaneous Sutton Stone fauna, but a more comprehensive review was given by Beauvais (1976) who figured several phaceloid stylophyllid corals from the Sutton Stone as part of a revision of the much earlier study by Duncan (1867). Some of these corals closely resemble the Pant y Slade specimens in particular. Six species of this group, originally all placed in *Thecosmilia* by Duncan (1867), were listed in two genera; *Phacelostylophyllum dentatum* (Duncan), *P. irregularis* (Duncan), *P. rugosum* (Laube), *P. affinis* (Duncan), *P. michelini* (Terquem and Piette), and *Phacelepismilia suttonensis* (Duncan). Duncan (1867) described many other species from Lias marginal facies exposed on the coast and also in quarries inland at Brocastle and Ewenny, a few kilometres to the northeast, where the material tended to be better preserved. Collections from these sites are held by the Natural History Museum in London. Based on our examination of the mineralized Pant y Slade corals and comparison with better preserved material in the Natural History Museum (Figs 6 and 7), we tentatively assign the Pant y Slade specimens described here to *Phacelostylophyllum* on the basis of the corallites being more deeply concave than in *Phacelepismilia*. Our material has corallites of similar diameter to all of the five species listed above but its poor preservation precludes any specific identification.

The close association between the corals we describe and the mineralized zones in the Carboniferous Limestone and basal part of the marginal facies is very significant for understanding their style of preservation. Mineralization appears to be concentrated along minor faults associated with the Slade Trough. These faults may have been active during early Jurassic times, particularly considering their proximity to the

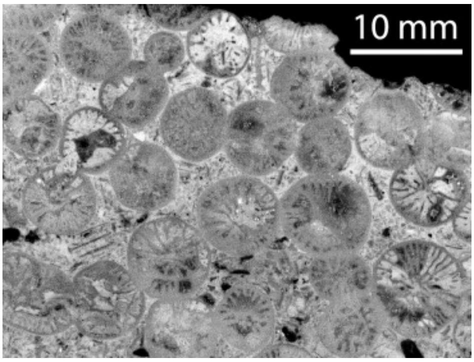

Fig. 7. *Phacelepismilia suttonensis* (Duncan), BMNH R37234. From Lower Lias marginal facies at Brocastle, South Wales. Polished transverse section through calcitized colony, showing arrangement of vertical septa in corallites; these are not discernably different from those in the closely related genus *Phacelostylophyllum*.

northwestward extension of the Watchet–Cothelstone–Hatch Fault. The latter was a major active transfer fault throughout the Mesozoic (Miliorizos & Ruffell, 1998) and runs just offshore, parallel to the Southerndown coast.

It is the open framework of certain units within the basal part of the marginal Lias, and also the supposedly Triassic breccias a little further west at Ogmore by Sea (Thomas, 1968), that appears to have played host to the mineralization. Replacive mineralization of shells and corals in open-framework coquinas is a conspicuous feature of the marginal Lias at several locations along this stretch of coast, notably just a short distance east of the mineralized corals (Fletcher, 1988). Barite mineralization is also conspicuous as infills of borings in the underside of boulders in the basal breccia on the western side of the Slade Trough. It would seem that mineralization was favoured by the presence of open cavities within the sediment and, perhaps, also by the presumed originally aragonitic composition of the corals and some of the shell material. The style of replacement was rather coarse, and hence much fine detail has been lost, obscuring the coral affinities of some of these fossils. Elsewhere, away from the main zones of mineralization, both this and other species of coral are preserved mostly in rather coarsely crystalline calcite and are more readily recognizable, though still often lacking fine detail.

4. CONCLUSION

Large radiating masses of colonial tube-like organisms occur locally near the base of the Lower Jurassic marginal facies exposed on the coast at Southerndown, South Wales. Formerly interpreted as serpulid reefs, the morphological evidence does not support this. The presence of large (*c.* 10 mm) diameter, occasionally bifurcating tubes with horizontal internal plates (tabulae), external growth lines, and longitudinal striations, together with corallites bearing at least two orders of radially disposed vertical plates (septa), provides unequivocal evidence that these fossil colonies are scleractinian corals of the suborder Faviina. Comparison with better preserved material from adjacent localities suggests that they are phaceloid stylophyllids referable to *Phacelostylophyllum* sp. indet. The open framework, and presumed originally aragonitic skeleton of these corals, acted as a locus for subsequent barite–galena mineralization where they lay close to the route of mineralizing fluids. In this way a rather coarse replacement of the coral colonies was formed in which generally only gross morphology is discernable.

The reinterpretation of these conspicuous and well-documented fossils demonstrates the need for careful observation and a consideration of the effects of different preservational styles when investigating fossil faunas. As such they represent an invaluable teaching resource on this remarkable and much visited coastline.

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