On the record of 'corals' from the Late Triassic Arden Sandstone Formation, Western Park, Leicester

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Abstract: In 1849, John Plant reported "polypidoms of a coralline" from the "keuper sandstone" exposed in a railway cutting near Leicester. He proposed the name *Gorgonia Keuperi* for these structures, but this is a *nomen nudum*. Subsequent authors have consistently questioned the organic origin of '*Gorgonia Keuperi*', or considered it to be an ichnofossil, but it has never been illustrated. Museum specimens labelled '*Gorgonia Keuperi*' have been found to contain a number of ichnofossils, amongst which the commonly occurring *Planolites montanus* is considered most likely to be the inspiration for what John Plant termed '*Gorgonia*'.

Following the review of the distribution of corals in British Jurassic deposits from the *planorbis* Zone (Hettangian, Lias) upwards (Negus, 1983), the first author has been compiling records of corals from British Triassic deposits to complement that account. Swift (1999) reviewed occurrences of corals in the Penarth Group, of latest Triassic (Rhaetian) age. However, structures interpreted as "polypidoms of a coralline" had been reported from an older unit by John Plant at the Birmingham meeting of the British Association for the Advancement of Science in September 1849 (Plant, 1850). Plant proposed the name *Gorgonia Keuperi* for these remains which he recovered from the "keuper sandstone" near Leicester. This is, however, a *nomen nudum*, a name that is unacceptable; a holotype was not designated, formal diagnosis and description were not given, and no illustration was provided. Subsequent workers have consistently questioned the nature of '*Gorgonia Keuperi*', with many doubting that it had an organic origin, but none has described or illustrated the material. The purpose of this contribution is to rectify these shortcomings and formally establish the nature and origin of this material.

Location and stratigraphy

John Plant obtained his specimens from the "keuper sandstone" exposed in a cutting on the "Leicester and Swannington" railway, at Shoulder of Mutton Hill (SK556042) in the western suburbs of Leicester (Fig. 1). This unit was subsequently termed 'Upper Keuper Sandstone' (James Plant, 1856; Bosworth, 1912), 'Dane Hills Sandstone Group' (Horwood, 1913) and 'Dane Hills Sandstone Member' (Warrington et al., 1980); it is now the Arden Sandstone Formation, within the Mercia Mudstone Group (Howard *et al*., 2008). Carney *et al*. (2009) stated, incorrectly, that it was named the 'Hollygate Skerry Member' by Warrington *et al*. (1980), and used 'Hollygate Sandstone Member', a modification of that term proposed by Charsley *et al*. (1990). The main outcrops of this formation are in Warwickshire, Worcestershire and Gloucestershire, where Murchison and Strickland (1840) recognised it as a sandstone unit within the 'Red or Saliferous Marls'. James Plant (brother of John) considered this to be "the same formation" as that at Leicester, described by him (Plant, 1856), and later by Browne (1893), Fox-Strangways (1903), Bosworth (1912), Horwood (1913), and Carney *et al*. (2009). The formation also includes the units formerly known as the North Curry Sandstone and Weston Mouth Sandstone members that crop out in Somerset and on the southeast Devon coast respectively (Howard *et al*., 2008).

The Arden Sandstone Formation is a unique and widespread facies within the Mercia Mudstone Group (Warrington and Ivimey-Cook, 1992; Hounslow and Ruffell, 2006) and is relatively fossiliferous. At Leicester it has yielded ichnofossils of invertebrate and vertebrate origin, poorly preserved plant remains, and a macrofauna that includes conchostracan crustaceans and remains of fish and other vertebrates (Plant 1856; Browne, 1893; Horwood, 1908, 1913, 1916; Carney *et al*., 2009). Elsewhere in England, ichnofossils of invertebrate and vertebrate origin, miospores, a macroflora dominated by remains of conifers, and a macrofauna that includes bivalves, conchostracans and remains of fish and other vertebrates, have been recorded (Horwood, 1909; Clarke, 1965; Warrington, 1970, 1971, 1985; Fisher, 1972, 1985; Williams and Whittaker, 1974; Jeans, 1978; Warrington and Williams, 1984; Ruffell and Warrington, 1988; Old *et al*., 1991; Warrington and Ivimey-Cook, 1992; Barclay *et al*., 1997; Powell *et al*., 2000; Benton *et al*., 2002;

Figure 1. *Arden Sandstone Formation in the railway cutting at Shoulder of Mutton Hill, Western Park, Leicester (for other illustrations of the unit in this area, see Browne, 1893, pl.1; Bosworth, 1912, fig.38; Carney et al., 2009, pl.12).*

Hounslow and Ruffell, 2006; Radley, 2006; Radley and Pollard, 2006; Porter and Gallois, 2008; and references cited therein). The miospores consist largely of pollen and are indicative of a Tuvalian (late Carnian, early Late Triassic) age (Fisher, 1985; Warrington, in Old *et al.*, 1991, Barclay *et al*., 1997, and Powell *et al*., 2000).

Previous work

The fossils first reported from the "keuper sandstone" in Leicester by John Plant (1850) included, in "bands of fine marl" between "gray shaly sandstones", bodies that he interpreted as "the polypidoms of a coralline" and described as occurring "in great profusion on the surfaces of nearly every band….. The polypidoms lie confusedly and in all instances occur as siliceous casts, the delicate organization of the cells being obliterated.". John Plant suggested the name *Gorgonia Keuperi* for these "fossil markings". His brother, James, made a contribution on the same beds, without reference to '*Gorgonia Keuperi*' but noted the presence of "Cololitic remains of Annelids, and casts of their tubes." (Plant, 1856: 373).

Browne (1893) noted that some of John Plant's specimens had been purchased by the Leicester Museum but that it was "exceedingly doubtful if they are organic.". However, he listed (on p.223), under Cœlenterata, Actinozoa, "*Gorgonia Keuperi*" (Plant) and "Polypidoms of coralline" from the "Upper Keuper Sandstones", citing Plant (1850) and Plant (1856).

Fox-Strangways (1903, 15) noted, with regard to possible plant remains from the "Upper Keuper" or "Dane Hills" Sandstone, that "…it is doubtful if some of them are organic. The same may be said of the doubtful coral *Gorgonia keuperi*, discovered by Mr John Plant, which Mr Browne does not consider to be organic.". Under Cœlenterata (Actinozoa), Fox-Strangways (1903, 96) listed "GORGONIA KEUPERI; Plant", from the "Keuper Sandstone" as "Probably not organic.".

***Figure 2**. Upper (LEICT G154.1893.1):* Planolites montanus *(fine, criss-crossing burrows),* Treptichnus *isp. (ziz-zag or 'feather stitch' burrows) and* Ancorichnus [Biformites] insolutus *(short, straight, horizontal burrows with 'beading' or transverse packed infill in one or two rows, i.e. median groove). Lower (LEICT G154.1893.2):* Treptichnus pollardi *(large zig-zag burrow of three elements with enlargement at one end; also smaller examples); some small* Planolites montanus *burrows.*

Horwood (1908) tabulated the flora and fauna of the 'Keuper' in Leicestershire. With regard to *Gorgonia*, he noted (p.307) that "This *nomen nudum* was invented in 1849 for specimens which are probably nothing more than inorganic casts of tracks and galleries, the work of Worms or Crustacea.", and made the following observations on specimens in the Leicester Museum:

PLANTAE

Incertae sedis:

1893/155 - "Stem fragments" – "labelled casts of *Gorgonia* or Fucoids, but certainly neither."

1893/156 - "(Under *Echinostachys oblongus* Brong.)" – "The specimen …. exhibits no definite characters, and is associated with worm-tracks."

INVERTEBRATA

Annelida or Crustacea - "Cololitic remains of Annelida …. and casts of their tubes"

1893/154 – "(labelled *Gorgonia keuperi*."

1893/156 – "('casts of *Gorgonia* or *Echinostachys oblongus*')"… the latter "in so far as *Echinostachys* is concerned, may be partly referable to some plant; but the *Gorgonia* is only, like the other specimens, the work of worms or crustacea. No.1893/155, *supra*, may also be partly referable to the same agency."

1893/161 – "casts of probable worm-tracks or Fucoids."

According to Horwood (1908: 312), Seward (1904: 8) compared a specimen "named *Gorgonia keuperi*, but exhibited in the Fossil Plant Gallery" (in the Natural History Museum, London), with others, "to probably remains of *Voltzia.*". Seward had noted this specimen (BM 24, 190; Horwood, 1908: 307) under the heading of 'Indeterminable Remains', some of which he considered "are no doubt fragments of Coniferous plants (*Voltzia*?)" but had described it as "Half-relief tracks or castings, labelled "*Gorgonia Keuperi"*, from the Keuper Sandstone of Leicester. Presented by James Plant, Esq., 1849.". This specimen (NHM PB OR 24190; Fig. 6) is reviewed below.

Despite their suggestions regarding the nature of these specimens, none of the above authors provided an illustration or adequate description. The opportunity is therefore taken to rectify this situation and to clarify the nature of the material.

Description of the specimens

The authors have undertaken a review of John Plant's material, curated in the Leicester Museum and in the Natural History Museum, London, and confirm that none is of coralline origin. The following interpretations and identifications are by the second author.

Figure 3*. (LEICT G161.1893):* Planolites montanus *(dominant; two size groups, short irregular horizontal burrows c.1-2mm and <1mm diameter);* Treptichnus pollardi *? (rare; zig-zag burrows with short straight elements);* Ancorichnus [Biformites] insolutus *? (rare; sand-filled burrows with a faint median groove and single or double beaded infill). There may also be a drag mark (?) crossing the specimen.*

New Walk Museum, Leicester

Specimens LEICT G154.1893.1, G154.1893.2 and G161.1893 are curated as "'reference' specimens of Triassic ichnofossils *Gorgonia keuperi*, possibly annelid castings or trails".

LEICT G154.1893.1 (Fig. 2, upper). Lower surface: curved channel-like form with *Planolites montanus* Richter 1937 (background of fine, criss-crossing burrows of several sizes), *Treptichnus* isp. (several clear zig-zag or 'feather stitch' burrows), *Ancorichnus* [*Biformites*] *insolutus* (Linck) 1949 (short, straight, horizontal burrows with 'beading' or transverse packed infill in one or two rows, i.e. median groove). Upper surface shows mud-draped interference ripples.

LEICT G154.1893.2 (Fig. 2, lower). Small slab of grey sandstone. *Treptichnus pollardi* Buatois and Mangano 1993 (large zig-zag burrow of three elements with enlargement at one end; also smaller examples); *Planolites montanus* – a few small burrows.

LEICT G161.1893 (Fig. 3). Fine, grey-green sandstone with mud-coated upper and lower surfaces; diverse small sand-filled burrows on the latter. *Planolites montanus* (dominant; two size groups, short irregular, horizontal burrows c.1-2mm and <1mm diameter); *Treptichnus pollardi* ? (rare; zig-zag burrows with alternating short straight elements); *Ancorichnus* [*Biformites*] *insolutus* ? [rare; sand-filled burrows with a faint median groove and single or double beaded infill, described as *Biformites* from the German Schilfsandstein by Linck (1949) and reassigned by Seilacher (2007, 94, pl. 32)]. There may also be a drag mark (?) crossing the specimen.

Figure 4*. (LEICT G149.1893):* Planolites montanus*, and a drag mark (?), possibly produced by a broken* Equisetites*.*

LEICT G149.1893 (Fig. 4). Appears to show *Planolites montanus* and what might be interpreted as a cast of a drag mark, perhaps produced by a broken *Equisetites*, that predates the burrows.

LEICT G155.1893 (not illustrated)**.** Small triangular specimen with a few *Planolites montanus* burrows and two divergent lobed moulds (arthropod resting traces?).

LEICT G156.1893 (Fig. 5). "*Gorgonia* or *Echinostachys oblongus*". Burrows predominantly *Planolites montanus* but also a larger cylindrical sand-filled burrow, 14mm in diameter and possibly with a short lateral branch and faint lateral scratch marks; if correct, this could be *Spongeliomorpha* [*Steinichnus*] *carlsbergi* Bromley and Asgaard 1979 which is also known from late Triassic fluvial sandstones of East Greenland (Bromley and Asgaard, 1979).

Natural History Museum, London

NHM PB OR 24190 (Fig. 6). Under-surface of a grey-green sandstone showing randomly oriented horizontal burrows preserved in semi-relief. *Planolites montanus*

Figure 5*. (LEICT G156.1893):* Planolites montanus *(dominant) and a larger sand-filled burrow that may be* Spongeliomorpha [Steinichnus] carlsbergi*.*

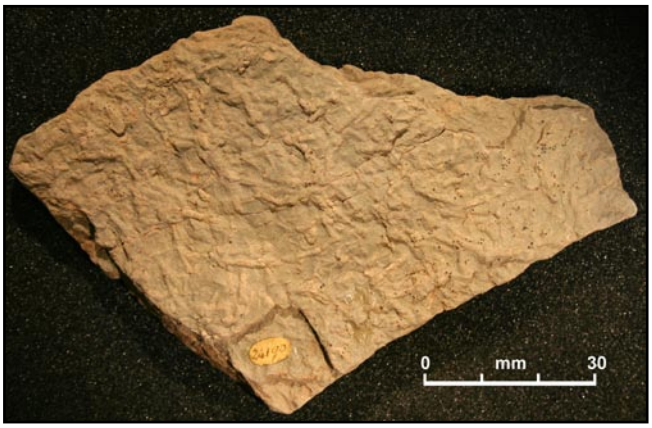

***Figure 6**. (NHM PB OR 24190):* Planolites montanus *(dominant) and rarer* Ancorichnus [Biformites] insolutus *? (photo: NHM London).*

(abundant, short sand-filled burrows) and *Ancorichnus* [*Biformites*] *insolutus* ? (rare burrows with faint central groove or beaded infill).

Discussion

The identification by John Plant, in 1849, of structures in the "keuper sandstone" near Leicester as "polypidoms of a coralline" (Plant, 1850) appears to have been conditioned by comparison with the common branching structure of a colony of polyps of a sea-fan. He therefore referred the "polypidoms" to the recent genus *Gorgonia* Linnaeus 1783, and created the invalid species '*Gorgonia Keuperi*'. Citations of fossil specimens of *Gorgonia* are erroneous (Bayer, 1956) and in the present instance clearly relate to abundant *Planolites montanus* burrows. These conclusions confirm previous workers' doubts about the nature of these specimens as body fossils.

Reference to possible plant remains (*Echinostachys oblongus*) on specimen LEICT G156.1893 (Horwood, 1908) may relate to the larger cylindrical burrow with the lateral branch on that specimen (Fig. 5*)*, identified above as possibly *Spongeliomorpha* [*Steinichnus*] *carlsbergi*. Grauvogel-Stamm (1978) noted that, up to that time, the genus *Echinostachys*, with the type species *E. oblonga*, from the Grès à Voltzia in the Bas-Rhein area of France (Brongniart, 1828), had been considered *incertae sedis*. However, Grauvogel-Stamm (1978: 70) interpreted *E. oblonga* as a male reproductive organ (with *in situ* microspores), and placed it in the new combination *Schizoneura-Echinostachys paradoxa* (Schimper & Mougeot) Grauvogel-Stamm, 1978 (Kustatscher *et al*., 2007).

Facies considerations

Units now united in the Arden Sandstone Formation in England (Howard *et al*., 2008) have been noted as containing *Planolites* at localities ranging from Devon to Warwickshire (Warrington and Williams, 1984; Ruffell and Warrington, 1988; Old *et al*., 1991; Warrington and Ivimey-Cook, 1992; Barclay *et al.*, 1997; Porter and Gallois, 2008). The association of *Planolites montanus* and *Treptichnus*, first noted by the second author in the Arden Sandstone Formation at Rowington, Warwickshire, in 1979, has been confirmed by Porter and Gallois (2008) who used it as the basis for a Planolites ichnofabric (Pl) which they interpreted as the result of short-lived opportunistic colonisation by an infaunal deposit feeding community, mostly in lacustrine environments, but also at lake margins and in minor channels and floodplains. These considerations alone would preclude the possibility of corals occurring in the Arden Sandstone Formation.

Conclusions

Specimens in Leicester Museum curated as "*Gorgonia keuperi*" (Figs 2, 3) are clearly ichnofossils, predominantly *Planolites montanus*, but including *Treptichnus pollardi* and other ichnotaxa. *Planolites montanus* is, on account of the convolute and densely intertwining nature of the tubes that constitute this ichnofossil, considered most likely to have provided the inspiration for what John Plant termed '*Gorgonia*', and his interpretation of this as a coral may reasonably be attributed to a perceived similarity with the gorgonian sea fans (Anthozoa, Octocorallia, Alcyonacea).

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