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A revision of sponges from the Faringdon Sponge Gravel Member and Atherfield Clay Formation, Lower Greensand Group of England

Consuelo Sendino [a,b,*], Stephen Kershaw [b,c]

[a] Collections Department, National Museum of Natural Sciences, Jose Gutierrez Abascal 2, 28006 Madrid, Spain
[b] Science Group, Natural History Museum, Cromwell Road, London SW7 5BD, UK
[c] Department of Life Sciences, Brunel University London, Uxbridge UB8 3PH, UK

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ABSTRACT

Sponges of the Lower Greensand Group (LGS) are well preserved and occur in sediments of a sandy matrix. Abundant in the Faringdon Sponge Gravel Member (FSG), these sponges, mostly Calcareans, are found in Oxfordshire, with notable preservation at Little Coxwell quarries. This study provides descriptions of common species following the updated Porifera classification and recent sponge taxonomy research, illustrated with specimens from the Natural History Museum, London (NHM), British Geological Survey (BGS), and Natural History Museum Basel (NMB) collections. The following taxa are recorded and described: 1) Calcareans: *Barroisia anastomosans* (Parkinson, 1822), *Barroisia clavata* (Keeping, 1883), *Barroisia irregularis* (Hinde, 1884), *Dehukia crassa* (de Fromentel, 1861), *[Elasmoierea] faringdonensis* (Mantell, 1854), *[Elasmoierea] mantelli* (Hinde, 1884), *Peronidella gillieroni* (de Loriol, 1869), *Peronidella prolifera* (Hinde, 1884), *Peronidella ramosa* (Roemer, 1839), *Oculospongia dilatate* (Roemer, 1864), *Tremospongia pulvinaria* (Goldfuss, 1826), *Raphidonema contortum* (Hinde, 1884), *Raphidonema porcatum* (Sharpe, 1854), *Raphidonema farringdonensis* (Sharpe, 1854), *Raphidonema macropora* (Sharpe, 1854), *Raphidonema pustulatum* (Hinde, 1884), *Endostoma foraminosa* (Goldfuss, 1826); and 2) Hexactinellids: *Lonsda contortuplicata* (Lonsdale, 1849). Key findings include the identification of Tethyan biogeographic affinities and ecological adaptations that highlight the role of these sponges in early reef-like systems. By refining species descriptions and linking them to broader Cretaceous ecosystems, this work enhances understanding of sponge biodiversity, evolutionary strategies, and their contributions to carbonate platform development during periods of environmental change.

1. Introduction

Sponges with other organic remains, mostly marine, from the Lower Greensand Group (LGS) have been described from the beginning of 19th century. In most cases they are well-preserved, presumably as a result of their hypercalcified nature (the sponges secreted a skeleton of calcium carbonate, as a secondary skeleton as they grew). The sponges are found mainly in poorly consolidated sandy sediment. Amorphozoae, the name that sponges were given at the beginning of their study, can be found abundantly in the Faringdon Sponge Gravel Member (FSG, Hopson et al., 2008, table 5), within the Faringdon Sand Formation (FDNS). The FSG is thus stratigraphically positioned in the upper part of Lower Cretaceous strata. Sponges are abundant in Oxfordshire (in sites that were formerly part of Berkshire, as cited in classic bibliographical references), at the Faringdon outcrop, where they can be found in coarse pebbly and cross-stratified sands 10 m thick (Krantz, 1972; Hesselbo et al., 1990) and also at Little Coxwell quarries, with sponge assemblages with spectacular preservation. This member comprises predominately calcareous sponges of littoral facies.

The first researcher to pay attention to sponges from the FSG was Lhuyd (1699), who noted the Coxwell Sponge-Gravel pits and the Faringdon outcrop, publishing the first recorded illustrations of sponges from the LGS, including '*Endostoma foraminosa*' (Lhuyd, 1699: pl. 18: fig. 1522). Following him, Sowerby (1811) mentioned sponges and sponge spicules from the FSG, whilst Parkinson (1822) and Mantell (1839, 1844, 1848, 1854) described new species from this stratum. Sharpe (1854) was one of the first palaeontologists to describe sponges from this member, and Hinde (1884) conducted a taxonomic study of the sponges of this group deposited at the British Museum (Natural History) [now Natural History Museum].

Other formations in this group which also contain sponges are the Folkestone (FF), Hythe (HF) and Atherfield Clay (AC) formations. The FF sponges are normally represented by spicules (Casey, 1961), but at Coxbridge Pit they have a standard high quality of preservation. Spicules have been found in siliceous rocks of the FF in an excavation at Baker's Gap (East Cliff), and Cop Point in the third and fourth divisions respectively of the FF by Price (1874). Casey (1961) also reported sponge

* Corresponding author at: Collections Department, National Museum of Natural Sciences, Jose Gutierrez Abascal 2, 28006 Madrid, Spain.
E-mail addresses: consuelo.sendino@mncn.csic.es, c.sendino-lara@nhm.ac.uk (C. Sendino), Stephen.Kershaw@brunel.ac.uk (S. Kershaw).

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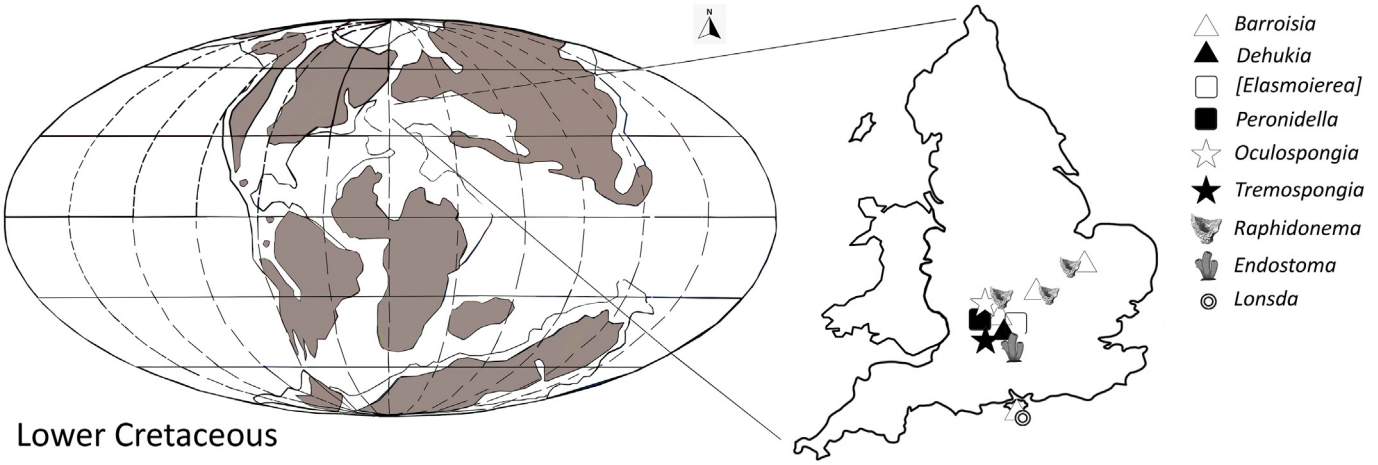

Fig. 1. Continent and oceanic distribution during LGS, Lower Cretaceous, along with genera occurrences of the British LGS porifera forms continental reconstruction redrawn from Scotese (2015).

spicules at Sandling Junction Sandpit and the Iguanodon Quarry in the same formation as well. HF contains numerous sponge spicules at the Godstone area of Surrey, in the chert beds of Tilburstow and Haslemere in which Hinde (1885) found spicules belonging to 28 taxa. Finally, spicules and a few sponges have been reported from AC in Atherfield and Sandown, on the Isle of Wight.

The LGS sponges, mostly FSG, lived in warm shallow waters at a latitude of around 40 degrees north (*e.g.,* Scotese, 2015, see Fig. 1) and are characterised by mostly irregular shapes, typical of shallow waters, containing robust spicules and having a short base to attach to the seabed, or they are encrusted on rocks or other sponges. Most of these are sponges of the class Calcarea, but there are a few hexactinellids and demosponges of deeper waters that have not been studied here. This article includes the description of the most common British species (17 Calcarean sponges and one hexactinellid) of the Lower Greensand and may be regarded as characteristic. For this we have followed the most updated Porifera classification (Finks et al., 2004), the current sponge taxonomy (de Laubenfels, 1955; Hurcewicz, 1975; Vacelet, 1979; Delamette et al., 1986; Masse and Termier, 1992; Finks, 2004; Senowbari-Daryan et al., 2011) and illustrated the species with specimens housed at the Natural History Museum, London (NHM) and the British Geological Survey (BGS).

2. Material and methods

We have studied mainly British specimens housed in the Natural History Museum, London (NHM) and the British Geological Survey (BGS), and consulted other institutions regarding type specimens. These include the Natural History Museum Basel [Naturhistorische Museum Basel] (NMB); the Goldfuss-Museum, University of Bonn; and the Roemer-Pelizaeus Museum, in Hildesheim, Germany. Once the specimens were located, they provided us with images of the type series. In order to understand the sponge descriptions, below are defined the most used morphological terms in this study, using the taxon *Barroisia irregularis* (Hinde, 1884), that has a sphinctozoan (chambered) architecture, to emphasise some key terms (Fig. 2; also shown in Fig. 3J).

Apopore: Exhalant pore.

Clavate: Form gradually thickening towards the distal end, club-shaped.

Cloaca: Large, central exhalant cavity, without digestive function. Also termed *e.g.,* spongocoel or paragaster.

Dermal layer (*skeletal*): Differentiated peripherical top layer, specialised or not.

Diactine: Spicule with two rays.

Ectosome: Cortical part, directly beneath the exopinacodenn or outer layer of a sponge, characterised by the absence of choanocyte chambers and extending across the outer ends of inhalant canals.

Endopore: Pore that pierces the inner wall of a chamber (Fig. 2).

Endowall: Wall of a central exhalant tube or cloaca (Fig. 2).

Equiradiate: Equal rays.

Exowall: External skeleton of a chamber (Fig. 2).

Exopores: Pore that pierces the outer wall of a chamber (Fig. 2).

Filiform: Thread or filament-like shape.

Interpore: Pore that pierces the wall between chambers (Fig. 2).

Nodose excrescence: Knotty distinct outgrowth.

Osculum: Large aperture of the exhalant canal or paragaster.

Paragaster: Large internal, central exhalant cavity (Fig. 2).

Paratangential dermal spicule: Dermal spicule near to being tangent.

Parenchymal: Regarding endosome or inner part, in middle layer of body wall, between dermal and atrial layers; where the spicules are located.

Tetraradiate: Spicule with four rays.

Trabecular (network): Microstructure pillar-like filling skeleton.

Triradiates: Spicule with three rays.

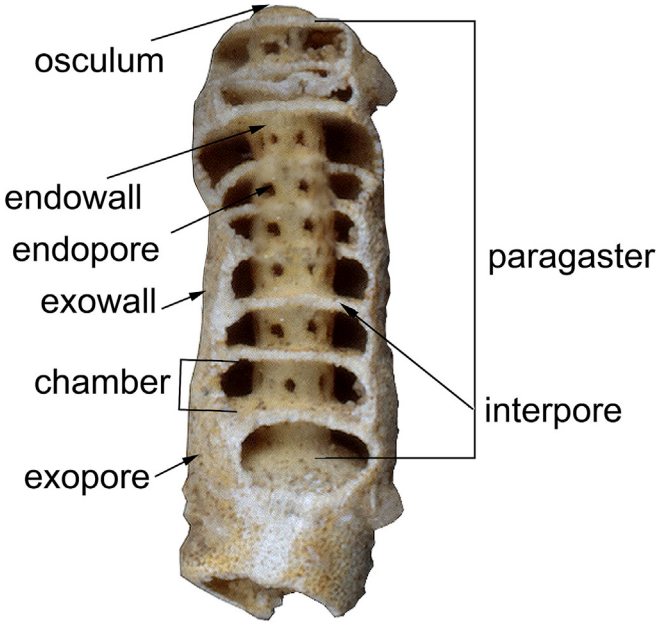

Fig. 2. Sphinctozoan-grade sponge with main morphological elements, *Barroisia irregularis* (NHMUK PI S 4619).

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Tylostyle: Monaxon, or spicule in which ray grow along a single growth axis, knobbed at one end, sharply pointed at the other.

Tylote: Monaxon, or spicule in which ray grow along a single growth axis, knobbed at both ends.

3. Systematic palaeontology

The classification here follows the Treatise on Invertebrate Palaeontology (Finks et al., 2004).

Phylum Porifera Grant, 1836

Class Calcarea Bowerbank, 1864 [=class Calcispongea de Blainville, 1834; *ex* order Calcispongiae de Blainville, 1834; Calcarosa Haeckel, 1872; Megamastictora Sollas, 1887]

Subclass Calcaronea Bidder, 1898

Order Sphaerocoeliida Vacelet, 1979

Family Sphaerocoeliidae Steinmann, 1882

Genus ***Barroisia*** Munier-Chalmas, 1882

Type species. *Tubipora anastomosans* Parkinson, 1822, 70–71, pl. 9: fig. 10.

Diagnosis. Erect, conicocylindrical branching tubes formed of irregular chambers which may be segmented only internally. Conical paragaster occupies one-third of the sponge diameter. Exowall netlike with subpolygonal, substellate exopores. Partitions between chambers gently arched, mostly upwards distally, chambers low, with polygonal interpores. Endowall continuous, with horizontal whorl of large, circular endopores in each chamber. Exowall made of equiradiate triradiates on the inner layer parallel to wall and penicillately arranged tylostyles, tylotes on the outer layer, both embedded in finely fibrous groundmass.

Remarks. Provisionally included in the Sphaerocoeliidae due to the existence of triradiates.

Barroisia anastomosans (Parkinson, 1822)

Figs 3A–D

1822 *Tubipora anastomosans* Parkinson, 70–71, pl. 9: fig. 10.

1839 *Tubipora anastomosans sensu* Mantell, 560: fig. 105.3.

1843 *Verticillipora anastomosans* (Mantell) in Morris, 46.

1844 *Verticillipora anastomosans* (Mantell), 289–290, fig. 55.4.

1848 *Verticillipora anastomosans* (Mantell), p. 636, fig. 139.3.

1848 *Verticillipora anastomosans* (Mantell) in Bronn, 1364.

1854 *Verticillipora anastomosans* (Mantell), 273, figs 70.4, 72.3.

1854 *Verticillipora anastomosans* (Mantell) in Sharpe, 195, pl 5: figs 1a–1e.

1874 *Verticillites anastomosans* (Mantell) in Davey, 13–14. pl. 7: fig. middle; pl. 8: fig upper.

1882 *Barroisia anastomosans* (Mantell) in Munier-Chalmas, 425.

1882 *Barroisia anastomans* (Mantell) in Steinmann, 164, pl. 8: figs 1–1a.

1883 *Verticellites anastomosans* (Mantell) in Keeping, 145.

1883 *Verticillites anastomans* (Mantell) in Carter, 27.

pars 1884 *Tremacystia anastomans* (Mantell) in Hinde, 175, pl. 34: fig. 4a–c.

1890 *Barroisia anastomosans* (Mantell) in Steinmann and Döderlein, 72–73, fig. 68A–C.

1905 *Tremacystia anastomans* (Mantell) *sensu* Hinde in Davey, 17–18, pl. 1: fig. 2; pl. 2: fig. 1.

1914 *Barroisia anastomans* (Mantell) in Rauff, 84–103, pl. 1: figs 1–5; pl. 2: 6–11.

1914 *Barroisia anastomosans* (Mantell) in Douville, 399, pl. 12: figs 4–5.

pars 1986 *Barroisia anastomosans* (Mantell) in Delamette, Termier and Termier, 314, pl. 2: figs 1–6, 9–12, text fig. 4.

1992 *Barroisia anastomosans* (Mantell) in Masse and Termier, 96, pl. 6: figs 1–4.

Type specimens: *Tubipora anastomosans* Parkinson, 1822, pp. 70–71, pl. 9: fig. 10 is the holotype (also type species of the genus *Barroisia* Munier-Chalmas, 1882), from FSG, Aptian age, of Oxfordshire. This specimen has not been found in the Parkinson Collection at the NHM. As many of the fossil sponges from the Parkinson Collection were bought by an American and taken to the USA, they may have been destroyed during the fire that consumed these specimens in the USA (Cleevely, 1983). We designate NHMUK PI P 3264, formerly published by Hinde (1884), as neotype of *Barroisia anastomosans* (Parkinson, 1822).

Description. Bush-like colony with cylindrical tubes composed of superposed chambers. The cylindrical forms are *ca.* 30–60 mm high with approximate diameter of 5–7 mm. The width of the conical paragaster is less than one-third of this diameter. These merge at their base, but are usually free distally (Fig. 3B). Lack of paragaster at the proximal area (Fig. 3D). Outer surface may be slightly constricted at the chamber partition level, but without external segmentation (Fig. 3A). Chamber height with an average of 2.3 mm. Endowall continuous with horizontal whorl of large, coarse, circular endopores in each chamber, 0.4 mm thick. This whorl extends downwards and upwards making the wall firm. Exowall with subpolygonal exopores and triradiate on the inner layer, thickness approximately 0.4 mm. With radial canals perpendicular to exowall (Fig. 3C). Subcircular apopores arranged at the whorl. Chambers with weak crenulations on their floor and roof (Fig. 3C). Internal segmentations with almost 1 mm thick.

This species is relatively common in the upper Aptian. It has been reported from the following localities in England: Faringdon (FSG, LGS) in Oxfordshire (Parkinson, 1822; Mantell, 1839, 1844, 1854; Morris, 1843; Sharpe, 1854; Davey, 1874, 1905; Keeping, 1883; Hinde, 1884; Steinmann and Döderlein, 1890), Upware in Cambridgeshire (Davey, 1874, 1905; Keeping, 1883; Hinde, 1884; Rauff, 1914), Little Brickhill in Buckinghamshire (Keeping, 1883), Godalming in Surrey (Keeping, 1883), and Atherfield on the Isle of Wight (Keeping, 1883). Additionally, it is known from the Aptian of Blangy (Normandy) (Steinmann, 1882; Keeping, 1883), Bize (Hautes-Pyrénées) (Rauff, 1914), La Presta and Boveresse, in Val de Travers (Switzerland) (Davey, 1905); Vormy, in Haute-Savoie, and Ardennes (France) (Keeping, 1883; Delamette et al., 1986; Masse and Termier, 1992); and Cenomanian of Essen (Germany) (Rauff, 1914). It may also occur in the French Provence region, in the Barremian of Vallon du Pêcheur, in Orgon, and Aptian (Bedoulian) of the Gorges de la Nesque, at Les Fayols (France) (Masse and Termier, 1992).

Remarks: Although Parkinson was the first to describe and figure this species (Parkinson, 1822, 70–71, pl. 9: fig. 10), Mantell has been credited as the species' author (*e.g.,* in the Treatise by Finks et al., 2004). It has been written that the original designation was published by Mantell (1838) in the Wonders of Geology, but the first time that Mantell figured this species is in the second volume of Wonders of Geology, 4th edition (Mantell, 1839, and not 1838) without crediting Parkinson's (1822) authorship. Nevertheless, Sherborn (1902) acknowledged this species to Parkinson (1822). Following the Article 23 of the ICZN, Principle of Priority, we credit Parkinson as the species' author of *Barroisia anastomosans*.

Sphinctozoan hypercalcified skeleton morphology. Low growth gradient with cylindrical forms giving new cylinders that grew in close proximity to the previous ones. Exopores most often slightly elongated, parallel to the cylindrical forms at their fixed base. The chamber segmentation produced a zone of weakness that after the death of the individual is often separated allowing the new osculum to have a crenulate border. Forms inhabiting shallow water.

This species resembles the French-Swiss species *Barroisia helvetica* (de Loriol, 1869), but tubular paragaster formation starts with short ridges on the wall next to the osculum. Several segment sequences, in most cases simple, start from a common basis and rapidly increase in width; whilst *B. anastomosans*, on the other hand, the segment sequences form irregular, intergrown, bushy masses, and the segments have the same thickness almost everywhere. It also differs from the coeval *B. clavata* because of the lack clavate forms and transverse constrictions.

Barroisia clavata (Keeping, 1883)

Figs 3E, F

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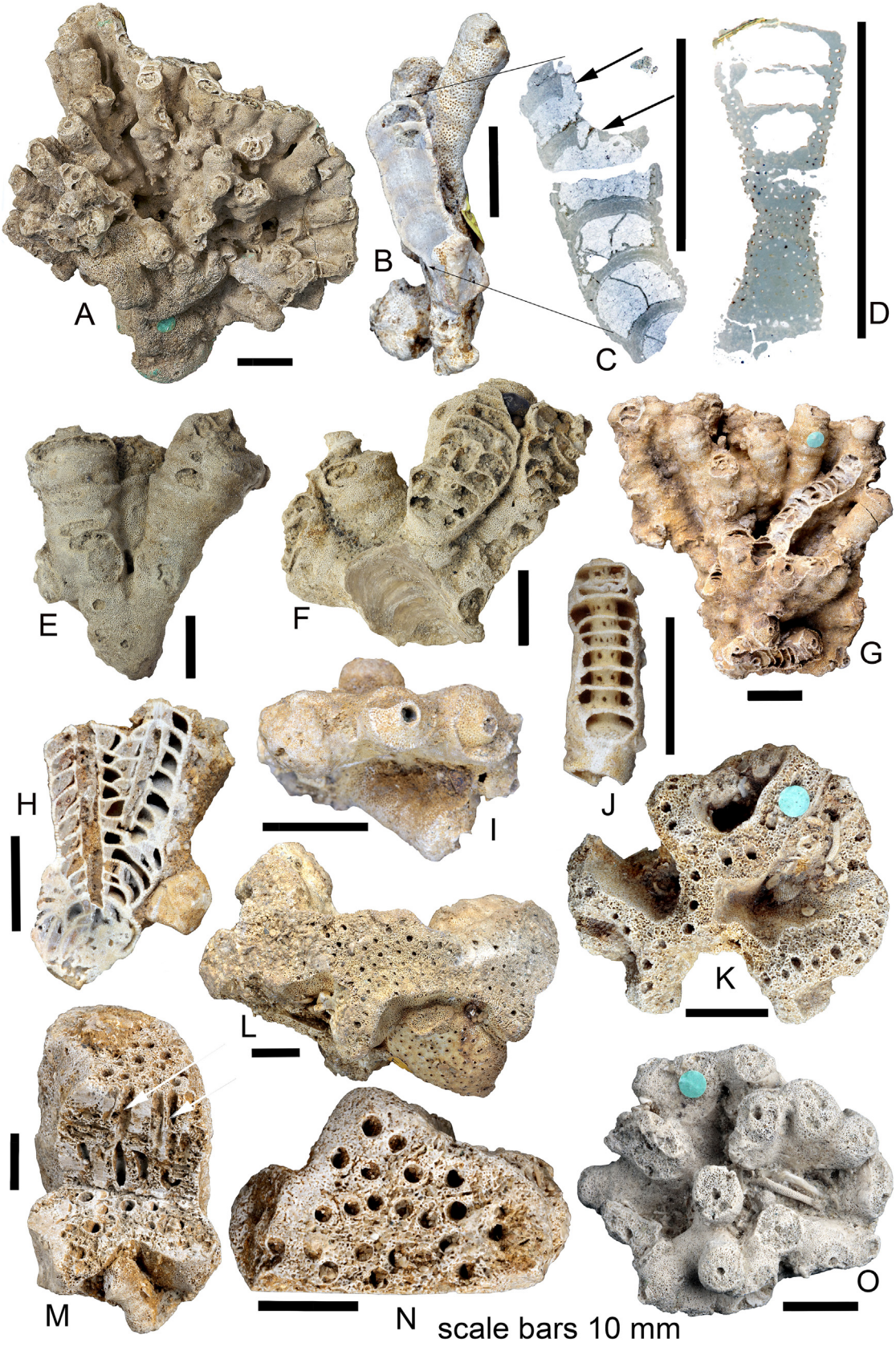
pars 1869 *Discoelia helvetica* de Loriol in de Loriol and Gilliéron, 65, pl. 5: figs 9–10.

pars 1879 *Verticillites anastomans* (Mantell) in Zittel, p. 28.

1882 *Barroisia helvetica* (de Loriol) in Steinmann, 165, pl. 6: figs 5–6; pl. 9: fig. 1.

1883 *Verticellites clavatus* Keeping, 146, pl. 8: fig. 3.



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pars 1884 *Tremacystia clavata* (Keeping) in Hinde, p. 176, pl. 34: fig. 6.

Type specimens: *Verticellites clavatus* Keeping, 1883, p. 146, pl. 8: fig. 3, BGS SM B 26236, is the holotype; and BGS SM B 26237 and BGS SM B 26238 are the paratypes. All of them are from FSG, Aptian, of Upware, Cambridgeshire.

Description. Sponge with cylindrical-clavate forms merged at their base (Fig. 3E). These forms are composed of superposed chambers that increase in width and have about 25–40 mm height and an approximate diameter of 8–9 mm when they emerge from the proximal base and a diameter of about 15–16 mm distally. The members of the colony may be in contact along its length. Conical paragaster. This occupies one-third of the chamber diameter (Fig. 3F). Outer surface with irregular transverse constrictions moderately developed at the chamber partition level throughout its length, but without external segmentation (Fig. 3E, F). Chamber height varies, approximately from 1.5 to 3 mm. Osculum may protrude at the upper end (Fig. 3E). Endowall continuous with coarse, circular endopores in each chamber, as the previous described species. Exowall with subpolygonal exopores and triradiate on the inner layer, thickness of approximately 0.4 mm. Internal segmentations almost 0.5 mm thick.

This species is relatively common in the upper Aptian of England. It has been recorded from FSG, LGS, also at Upware in Cambridgeshire (Keeping, 1883; Hinde, 1884), Faringdon in Oxfordshire (Keeping, 1883; Hinde, 1884), and Little Brickhill in Buckinghamshire (Keeping, 1883). Also reported from the Aptian of La Presta, in the Val de Travers (Switzerland) (Steinmann, 1882).

Remarks: Although this species includes specimens described under *Barroisia helvetica*, it is possible to discern them from *B. clavata* for the clavate forms culminating in subglobular endings and the regular distribution of the constrictions in "*B.*" *helvetica*. We did not have the opportunity to study any specimen of the latter cited species microstructurally, but it seems to belong to *Tremacystia* Hinde, 1884. The constrictions of *B. clavata* seen do not follow a periodic pattern. The chambers increase in width distally, but there are zones where this is not so obvious, affecting the irregular growing of the constrictions. These data could be combined with temperature, depth and surrounding fauna to help with reconstructions of Cretaceous shallow water palaeoenvironments.

Barroisia clavata resembles *B. anastomosans*, but with cylindrical-clavate forms that increase in width from base to distal end and transverse constrictions moderately developed at the chamber partition level throughout its length.

Barroisia irregularis (Hinde, 1884)

Figs 3G–J

1884 *Tremacystia irregularis* Hinde, 175–176, pl. 34: fig. 5.

1905 *Tremacystia irregularis* Hinde in Davey, 19.

1962 *Tremacystia irregularis* Hinde in British Museum (Natural History), pl. 48: fig. 1.

Type specimens: *Tremacystia irregularis* Hinde, 1884, pp. 175–176, pl. 34: fig. 5, NHMUK PI P 3271, is the holotype. Other specimens from the Hinde Collection, as paratypes, are NHMUK PI P 2188 and NHMUK PI S 4619. All of them are from FSG, Aptian, Faringdon, in Oxfordshire.

Description. Colony with straight or curved cylindrical forms composed of superposed chambers of about 40 mm high and a diameter from 5 to 9 mm. Colony individuals are mostly connected (Figs 3G, H). Conical paragaster usually takes less than one-third of the chamber diameter (Fig. 3H). Outer surface mostly regularly constricted at the chamber partition level (Fig. 3G). Chamber height with an average of 1.75 mm. Osculum protrudes at the upper end (Fig. 3I, J). Endowall continuous with circular endopores in each chamber (Fig. 3J), almost 0.2 mm thick (Fig. 3H, J). Exowall with subpolygonal exopores and triradiate on the inner layer, thickness approximately 0.4 mm. Internal segmentations approximately 0.2 mm thick.

It has been recorded in the upper Aptian of England: from FSG, LGS, at Upware in Cambridgeshire, and Faringdon in Oxfordshire (Hinde, 1884).

Remarks: Chambers have a regular distribution except at the flexion area in curved conical forms.

This species resembles *Barroisia anastomosans*, but with noticeably constricted individuals that are mostly merged and may be curved, and considerable thinner walls and chamber partitions than *B. anastomosans*. Protrusion of the osculum differs also from the previous species.

Order Stellispongiida Finks and Rigby, 2004

Family Stellispongiidae de Laubenfels, 1955

Genus ***Dehukia*** Senowbari-Daryan, Fürsich and Rashidi, 2011

Type species. *Dehukia maxima* Senowbari-Daryan, Fürsich and Rashidi, 2011, p. 435, pl. 7, figs A–D

Diagnosis. Irregular forms with uneven folded walls which include deep grooves of different shapes. The upper part of the wall bears numerous oscula. The wall between these oscula is composed of reticulate fibre skeleton and interfibre openings.

Remarks. This genus includes mainly Jurassic species described from Iran, except the described species below that was previously included in *Elasmoierea* de Fromentel, 1860 (= *Elasmocoelia* Roemer, 1864, *nom. van.*). See Senowbari-Daryan et al. (2011) for discussion.

Dehukia crassa (de Fromentel, 1861)

Fig. 3K

1861a *Elasmojerea crassa* de Fromentel, 10, pl. 2: fig. 10.

1861b *Elasmoierea crassa* de Fromentel, 363.

non 1861 *Elasmoierea crassa* de Fromentel in de Loriol in de Loriol and Gilliéron, 70–71, pl. 5: fig. 12.

1884 *Elasmocoelia crassa* (de Fromentel) in Hinde, 176, pl. 33: fig. 11.

non 1905 *Elasmocoelia crassa* (de Fromentel) *sensu* Hinde in Davey, 22.

2011 *Dehukia crassa* (de Fromentel) in Senowbari-Daryan, Fürsich and Rashidi, 435.

Type specimen: *Elasmojerea crassa* de Fromentel, 1861: p. 10, pl. 2: fig. 10 is the holotype from Hauterivian-Barremian, Urgonian facies, of France, Germigney in Haute-Saône. We contacted the Muséum National d'Histoire Naturelle, France, and it appears that this specimen is missing. We recommend studying topotypes of this species to designate a neotype.

Description. Anastomosing forms with roughly 20 mm high and 40 mm wide, the walls of which have an approximate thickness of 4–6 mm. Circular oscula or exhalant canals arranged in rows (Fig. 3K). Oscula with an average width of 1 mm and the same distance apart each other along the crest of the walls. External fibres with trabecular microstructure, subcircular exopores, triradiate and filiform spicules.

Fig. 3. A–D. *Barroisia anastomosans* (Parkinson, 1822) (A. Topotype NHMUK PI P 3280 from Faringdon, Oxfordshire. B–D. Neotype NHMUK PI P 3264 from Upware, Cambridgeshire). A. Typical bush colony. B. Longitudinal section through chambers. C, D. Cross sections of a cylindrical form seen on B with visible internal partitions. C. Radial canals seen with vesicular internal filling, beginning of the paragaster partially seen at the last two partitions on the figure (black arrows). D. Base and first chambers of an individual. Wall detail with exopores and endopores. E, F. *Barroisia clavata* (Keeping, 1883) (E. Holotype BGS SM B 26236. F. Paratype BGS SM B 26237 from Upware, Cambridgeshire). E. Lateral view of colony with three forms in contact. F. Longitudinal section through chambers. G–J. *Barroisia irregularis* (Hinde, 1884) (G. Holotype NHMUK PI P 3271. Paratypes: H, I. NHMUK PI P 2188 and J. NHMUK PI S 4619. All from Faringdon, in Oxfordshire). G. General view of the holotype with typical branching form. H. Longitudinal section of two attached tubes with interconnected chambers. I. View from above, with protruding oscula. J. Endowall seen (as shown in Fig. 2). K. *Dehukia crassa* (de Fromentel, 1861), NHMUK PI P 3273 from Faringdon, in Oxfordshire, seen from the upper part with the typical anastoming wall and oscula arrangement. L. *[Elasmoierea] faringdonensis* (Mantell, 1854), topotype NHMUK PI S 4459, from Faringdon, Oxfordshire, fan-shape on the upper part, oscula with irregular arrangement, and attached to *Raphidonema pustulatum* Hinde, 1884. M, N. *[Elasmoierea] mantelli* (Hinde, 1884), paratype NHMUK PI P 3491, from Faringdon, in Oxfordshire. M. Longitudinal section with cylindrical exhalant canals exposed. N. View from the upper part with oscula seen. O. *Peronidella gillieroni* (de Loriol, 1869), NHMUK PI OR 10202, from Faringdon, Oxfordshire, general view. Scale bar 10 mm.

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This species appears in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884); and Hauterivian-Barremian, Urgonian facies, of Germigney in Haute-Saône (France) (de Fromentel, 1861).

Remarks: The specimen NHMUK PI P 3273 (Fig. 3K) is the only one described (Hinde, 1884: pl. 33: fig. 11) of this species from the LGS Group.

Hinde (1884) included this species under the genus *Elasmocoelia* de Fromentel, 1860, but its irregular form, non-tubular, distinguishes this species from other species of the genus *Elasmocoelia* (synonymised with *Elasmoierea*), which embraces erect laminae, mostly branching forms. On the other hand, another species included in '*Elasmocoelia*' and which resembles the described species is '*E.*' *tortuosa* (de Loriol, 1869). According to Davey (1905), both forms belong to the same species, but the latter has less thickness between walls and oscula are arranged in two rows abreast and not one as in *D. crassa*.

Genus ***Elasmoierea*** de Fromentel, 1860

Type species. *Elasmoierea sequana*, de Fromentel, 1860, p. 34, pl. 2: fig. 3.

Diagnosis. Erect, plicate, sometimes branching laminae with many vertical, exhalant canals opening mainly in single row or occasionally several abreast on upper edge. Sides of laminae may bulge around each subcircular osculum; sides of laminae covered with small, closely spaced pores. Trabecular microstructure.

Remarks. Some species attributed to this genus currently belong to other. Those species that remain under this taxonomic name should be revised.

[Elasmoierea] faringdonensis (Mantell, 1854).

Fig. 3L

1854 *Tragos faringdoniensis* Mantell, 229, pl. 72: fig. 5.

pars 1874 *Tragos faringdoniensis* Mantell in Davey, 14.

1884 *Elasmocoelia farringdonensis* (Mantell) in Hinde, 177, pl. 34: figs 7–7a.

1905 *Elasmocoelia faringdonensis* (Mantell) *sensu* Hinde in Davey, 21, pl. 2: fig. 2.

Type specimens: *Tragos faringdoniensis* Mantell, 1854, p. 229, pl. 72: fig. 5 is the holotype from FSG of Faringdon, Oxfordshire. This specimen is missing in the Mantell Collection at the NHM and is not in BGS. We designate NHMUK PI OR 10293 as the neotype of *[Elasmoierea] faringdonensis*, from FSG of Faringdon, Oxfordshire, figured by Hinde (1884: p. 177, pl. 34: figs 7–7a).

Description. Erect forms with usually fan-shaped walls. These forms are about 30 mm high and between 40 and 70 mm wide with numerous subcircular oscula without any arrangement (Fig. 3L). These are approximately 1 mm in diameter (maximum 1.5 mm) with external borders well defined, and are connected with vertical exhalant canals, that are *ca.* 2 mm apart. Trabecular microstructure, with tri- and tetraradiates and slender filiform spicules. Lateral polygonal exospores.

This species appears in the upper Aptian of England: from FSG, LGS, at Faringdon, in Oxfordshire (Mantell, 1854; Davey, 1874; Hinde, 1884).

Remarks: *Elasmocoelia* has been synonymised with *Elasmoierea*, the latter being the senior synonym. The specific name of this taxon, *[Elasmoierea] faringdonensis*, is assigned to the genus with doubt, thus is currently in open nomenclature, which is why we have used square parentheses indicating informal identification.

This species is frequently attached to another sponge species (Fig. 3L).

[E.] faringdonensis could be compared to *[E.] mantelli* Hinde, 1884, but this one has smaller dimensions, upper surface slightly convex, and larger osculum diameter, about 1.75–2.25 mm.

[Elasmoierea] mantelli (Hinde, 1884)

Figs 3M, N

1884 *Elasmocoelia mantelli* Hinde, 177, pl. 34: fig. 8.

1905 *Elasmocoelia mantelli* Hinde in Davey, 20, pl. 2: fig. 3.

Type specimens: *Elasmocoelia mantelli* Hinde, 1884: p. 177, pl. 34: fig. 8, NHMUK PI P 3253, is the holotype; NHMUK PI P 3491 is a paratype. All of them are from FSG of Faringdon, Oxfordshire.

Description. Polygonal forms with expanded base, about 50 mm high and 30 mm wide. Upper surface is normally flattened, or slightly convex. With numerous circular oscula irregularly distributed (Fig. 3N). These are approximately 1.75–2.25 mm of diameter and have external borders well defined with annular membrane. The oscula communicate with cylindrical exhalant canals (arrows on Fig. 3M) which go through the sponge vertically. They do not seem to keep a pattern in their distribution on the external surface. Trabecular microstructure with tri- and tetraradiates. Fibres of about 0.15–0.30 mm thick.

This species appears in the upper Aptian of England: from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884).

Remarks: *Elasmocoelia* has been synonymised with *Elasmoierea*, the latter being the senior synonym. The specific name of this taxon, *[Elasmoierea] mantelli*, is assigned to the genus with doubt in open nomenclature, reason why we have used square parentheses indicating informal identification.

[E.] mantelli could be compared to *[E.] faringdonensis* (Mantell, 1854), but this has larger dimensions, upper surface flattened, smaller osculum diameter, about 1–1.5 mm and fan-shaped walls.

Genus ***Peronidella*** Zittel in Hinde, 1893

Type species. *Spongia pistilliformis* Lamouroux, 1821, p. 88, pl. 84: figs 5–6.

Diagnosis. Normally bush-like colony with cylindrical forms that arise from a common base, being later partly merged laterally. May be also solitary forms. The distal cylindrical end is usually rounded with central osculum connected with a deep central paragaster that runs through the form to near the base. Surface pores only regular, intertrabecular spaces. Imperforate, dermal layer present on the basal part of each branch. Trabecular microstructure with triradites, and possibly tetradiates, including tuning-fork spicules closely intermingled. Fibres may be covered concentrically by thin layer of filiform, sinuous spicules which could line the paragaster.

Remarks. This genus was described by Zittel (1879: pp. 30–31) as *Peronella*, taxonomic name already proposed by Gray in 1855 and adopted by Agassiz in 1872 for echinoderms (Hinde, 1893), therefore it was not available. Hinde (1893: p. 213) published the proposed name that Zittel offered instead of *Peronella*.

Many of the specimens belonging to this taxon have epifauna associated such as bryozoans (Fig. 3O) confirming that the parenchymal skeleton was rigid during the life.

Peronidella gillieroni (de Loriol, 1869)

Fig. 3O

1869 *Discoelia gillieroni* de Loriol, 66–67, pl. 4: figs 16–18.

1879 *Peronella gillieroni* (de Loriol) in Zittel, 33.

1884 *Peronella gillieroni* (de Loriol) in Hinde, 169, pl. 33: fig. 10.

1905 *Peronella gillieroni* (de Loriol) *sensu* Hinde in Davey, 17, pl. 1: fig. 3.

Type specimens: *Discoelia gillieroni* de Loriol, 1869: pp. 66–67, pl. 4: figs 16–17. We designate as lectotype the specimen NMB D6633 (de Loriol, 1869: pl. 4: fig. 16) and the paralectotype as NMB D6634 (de Loriol, 1869: pl. 4: fig. 18), from late Hauterivien of Le Landeron (Neuchâtel, Switzerland).

Description. Bush-like colony with short cylindrical forms of about 15–30 mm high that arise from a common base reaching a colony height of 25–40 mm and a width of approximately 40–50 mm. The cylindrical forms are mostly connected (Fig. 3O). Each form has a diameter from 5 to 7 mm that ends in rounded or truncate summits. Conical paragaster with almost constant diameter that protrudes in central circular osculum of 1 mm diameter, approximately one-sixth of the diameter. Some individuals with imperforate, dermal layer at the basal part. Trabecular microstructure with triradites, and possibly tetradiates.

This species appears in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884); late Hauterivien of Le Landeron, Neuchâtel (Switzerland) (de Loriol, 1869); and Valanginian-Hauterivian of Berklingen, Lower Saxony (Germany) (Hinde, 1884).

Remarks: It is characteristic that the short forms are mostly bifurcated and exceptionally trifurcous. Closely intermingled spicules are normally observed in the longitudinal direction of the fibre.

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P. gillieroni resembles *P. ramosa* (Roemer, 1839) and *P. prolifera* (Hinde, 1884). The former with smaller dimensions regarding the cylindrical forms and osculum. The latter with bifurcating forms, wider stems and oscula.

Peronidella prolifera (Hinde, 1884)

Figs 4A–C

1884 *Peronella prolifera* Hinde, 169–170, pl. 33: figs 8–8a.

1885 ?*Peronella prolifera* Hinde in Počta, 19.

Type specimen: *Peronella prolifera* Hinde, 1884: pp. 169–170, pl. 33: figs 8–8a is the holotype (NHMUK PI P 3277) from FSG of Faringdon, Oxfordshire.

Description. Bush-like colony (Fig. 4A) with cylindrical forms, straight or winding, on an average of 40 mm high that may bifurcate and also merge distally (Figs 4A, B) with other. These forms have a diameter of about 9–10 mm, having a central circular osculum that takes one-fifth of the total diameter (Fig. 4C), around 2 mm, connected with a deep paragaster. The distal part of the forms ends normally in a rounded, and in some cases an inflated, summit. Thick fibres from 0.2 to 0.3 mm with small triradites and tetradiates. Spicular ray length from 0.1 to 0.04 mm.

This species is common in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884); and Cenomanian Korytzaner Schichten, Zbyslav, in Vrdy-Čáslav (Bohemia) (Počta, 1885).

Remarks: The two Bohemian specimens described by Počta (1885) coincide with Hinde's (1884) description except the fibre thickness that is 10 times thicker. This must be a typographic mistake because the fibres cannot be thicker than the osculum.

P. prolifera resembles *P. gillieroni* (de Loriol, 1869) and *P. ramosa* (Roemer, 1839). Both with smaller dimensions regarding the cylindrical forms, osculum and fibres. The latter with spicular structure mostly obliterated and may have the lower part covered by a compact or showing irregular apertures between the fibres.

Peronidella ramosa (Roemer, 1839)

Figs 4D, E

1839 *Scyphia ramosa* Roemer, 11, pl. 17: fig. 27.

1844 *Scyphia ramosa* Roemer in Mantell, 256: pl. 55: fig. 5.

1861a *Discoelia ramosa* (Roemer) in de Fromentel, 9, pl. 1: fig. 5.

1861b *Discoelia ramosa* (Roemer) in de Fromentel, 362.

pars 1864 *Polycoelia ramosa* (Roemer) in Roemer, 31.

1884 *Peronella ramosa* (Roemer) in Hinde, 169, pl. 33: fig. 5.

Type specimen: *Scyphia ramosa* Roemer, 1839: p. 11, pl. 17: fig. 27 is the holotype. We contacted the Roemer-Pelizaeus Museum to locate this specimen, but without success. Therefore, we designate as neotype of *Peronella ramosa* (Roemer, 1839) the specimen NHMUK PI P 2174 from FSG of Faringdon, Oxfordshire.

Description. Bush-like colony with short cylindrical forms of 15–20 mm high and a width of approximately 35–40 mm. The cylindrical forms are mostly connected (Fig. 4D). Each form has a diameter from 4 to 6 mm that normally ends in rounded summits. Conical paragaster with almost constant diameter and central circular osculum of 1–1.5 mm diameter, approximately one-fourth of the diameter. In some cases with a compact dermal layer wrapping the lower part of the stems. If this layer is not seen, the fossil shows irregular apertures between fibres. Microstructure of bounded fibres (Fig. 4E) of about 0.15 mm thick and triradites rarely seen.

This species is common in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Mantell, 1844); Hauterivian-Barremian, Urgonian facies, from Germigney in Haute-Saône (France) (de Fromentel, 1861b), and Le Landeron, in Neuchâtel (Switzerland); Valanginian-Hauterivian of Censeau, in Jura, and Hauterivian-Albian of Saint-Dizier, in Haute-Marne (France) (de Fromentel, 1861b) and Schöppenstedt, Berklingen and Schandelah, in Lower Saxony (Germany) (Roemer, 1864).

Remarks: Characteristic dense parenchymal skeleton with thin bounded fibres (Fig. 4E) of homogeneous thickness and triradites normally not seen.

P. ramosa resembles *P. tenuis* (Hinde, 1884), differing in larger dimensions, shorter forms and more regular stem shape. On the other hand, this one *P. tenuis* is from the Inferior Oolite.

Genus ***Oculospongia*** de Fromentel, 1860

Type species. *Oculospongia neocomiensia* de Fromentel, 1860: p. 37, pl. 2: fig. 8.

Diagnosis. Sponge massive, encrusting, rounded to conical shapes with extensive, convex top. Few small, isolated circular oscula, which may be labiate, dispersed over top surface and connected with tubular canals in the interior of the skeleton, remaining surface covered with coarse pores, normally irregular, representing intertrabecular spaces. Such pores may be vertically elongated on sides. Periodic growth. Base, and in some cases sides as well, covered with an imperforate dermal layer. Microstructure trabecular, sheetlike and curve trabeculae minutely spinose at tubular interspaces, including sagittal triactines almost uniform in size; ectosome comprising sagittal and regular triactines and accompanying diactines; and sinuous filiform spicules.

Remarks. Triactines and diactines found in Polish Jurassic species described by Hurcewicz (1975). Hinde (1893) described the sinuous filiform spicules in ectosome and triactines in central portions in a Jurassic species from South of England.

Oculospongia dilatata (Roemer, 1864)

Figs 4F–H

1864 *Tremospongia dilatata* Roemer, 40, pl. 1: figs 24a–24b.

1884 *Oculospongia dilatata* (Roemer) in Hinde, 192, pl. 36: fig. 3.

pars 1905 *Oculospongia dilatata* (Roemer) *sensu* Hinde in Davey, 23, pl. 4: fig. 1.

Type specimen: *Tremospongia dilatata* Roemer, 1864: p. 40, pl. 1: figs 24a–24b is the holotype. We have contacted the Roemer-Pelizaeus Museum to locate this specimen, but without success. Therefore we designate as neotype of *Oculospongia dilatata* (Roemer, 1864) the specimen NHMUK PI P 3252, figured by Hinde (1884: pl. 36: fig. 3) from FSG of Faringdon, Oxfordshire.

Description. Low inverted cone-shape with 15–20 mm high and about 19–29 mm wide. Base covered concentrically, with an imperforate dermal layer (Fig. 4G with an arrow), can be concave or flattened. Top arched convexly with subcircular oscula irregularly dispersed over surface (Fig. 4F) and connected with tubular canals in the interior of the skeleton. Oscula usually less abundant on the superior top; approximately 1 mm diameter; slightly labiate. Exhalant canals can reach the base or only reach a short distance from the surface. Radiating fibres (Fig. 4H) connected transversally in vertical section; thickness of 0.1–0.3 mm.

This species is common in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884; Davey, 1905); and from Valanginian-Hauterivian of Berklingen, Lower Saxony (Germany) (Roemer, 1864; Hinde, 1884). It has been reported from "Hils-Conglomerat" (Hinde, 1884), an obsolete term that, in strict and regional sense, is synonymous with the Grenzlerburg Member of the Salzgitter Formation, Minden-Braunschweig Group, uppermost Valanginian to lowermost Hauterivian (Erbacher et al., 2014).

Remarks: Spicular structure in the specimens from Faringdon was not observed, but Hinde (1884) described the existence of triactines covered by sinuous filiform spicules in ectosome in the German specimens.

Although Davey (1905) wrongly synonymised this species with *Tremospongia pulvinaria* (Goldfuss, 1826), it differs mainly in having oscula in clusters (4–6 openings per exhalant canal), these are distributed regularly, and with smaller diameter than the *O. dilatata*.

Genus ***Tremospongia*** d'Orbigny, 1849

Type species. *Lymnorea sphaerica* Michelin, 1845: p. 216, pl. 52: fig. 16a–b.

Diagnosis. Sponge massive, mushroom-shaped or hemispherical, with inverted conical shape at the base that is covered by concentrically wrinkled, imperforate, dermal layer and spheroidal upper side with numerous small oscula arranged in clusters. With trabeculae and intertrabecular spaces.

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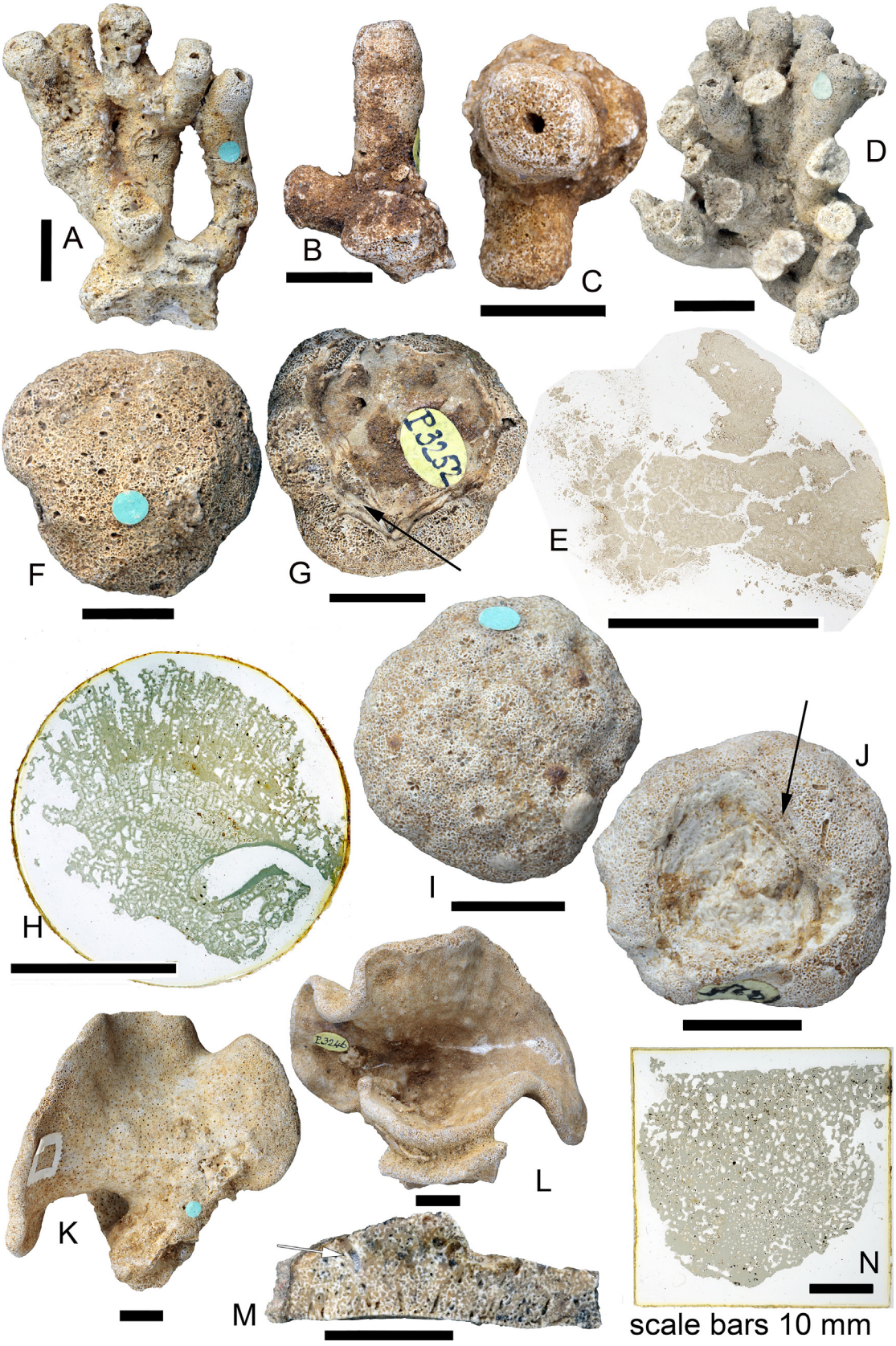
Remarks. d'Orbigny (1849) designed *Lymnorea sphaerica* as type species of *Tremospongia*, but Geinitz (1871) synonymised *L. sphaerica* with *Manon pulvinarium* (Geinitz, 1871: p. 27; Senowbari-Daryan et al., 2011: p. 431). This synonymisation is not supported here. For further details, refer to the synonym list of *Tremospongia pulvinaria* (Goldfuss, 1826) and accompanying remarks. As Geinitz (1871) noted, both genera differ in their base, and in *Tremospongia*, osculum clusters may be on a higher position than the rest of the surface.



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Tremospongia pulvinaria (Goldfuss, 1826)

Figs 4I, J

pars 1826 *Manon pulvinarium* Goldfuss, 2–3, pl. 29: figs 7a–7b.

non 1845 *Lymnorea sphaerica* Michelin, 216, pl. 52: figs 16a–16b.

non 1850 *Tremospongia sphaerica* (Michelin) in d'Orbigny, 187.

1851–2 *Tragos pulvinarium* (Goldfuss) in Bronn, 61, pl. 29: fig. 1.

non 1860 *Tremospongia sphaerica* (Michelin) in de Fromentel, 37, pl. 2: fig. 13.

1864 *Tremospongia pulvinaria* (Goldfuss) in Roemer, 40, pl. 14: fig. 8.

pars 1871 *Tremospongia pulvinaria* (Goldfuss) in Geinitz, 27–28.

pars 1878 *Manon pulvinarium* Goldfuss in Quenstedt, 355–356, pl. 132: figs 18, 20–21.

pars 1884 *Synopella pulvinaria* (Goldfuss) in Hinde, 190–191, pl. 36: fig. 1.

pars 1905 *Synopella pulvinaria* (Goldfuss) *sensu* Hinde in Davey, 23.

2011 *Tremospongia pulvinaria* (Goldfuss) in Senowbari-Daryan, Fürsich and Rashidi, 431, pl. 4: figs G–H; pl. 5: figs A–F; pl. 13: figs A–G.

Type specimen: *Manon pulvinarium* Goldfuss, 1826: pp. 2–3, pl. 29: figs 7a–7b, from Cenomanian of Essen is the holotype. This specimen seems to be missing at the Goldfuss-Museum. We designate as neotype of *Tremospongia pulvinaria* (Goldfuss, 1826) the specimen NHMUK PI OR 10215, figured by Hinde (1884: pl. 36: fig. 1) from FSG of Faringdon, Oxfordshire.

Description. Semihemispherical shape of about 26 mm high and 25–42 mm wide, maximum 30 and 60 mm respectively; upper surface convex with subcircular openings, from 3 to 6 units, arranged in slightly raised clusters and connected with exhalant canals (Fig. 4I). Cluster diameter of 1–2 mm and exhalant canal diameter of 0.3 mm. Openings separated from each other by 0.2 mm of fibre and separation between neighbouring clusters approximately between 5 and 10 mm depending on the specimen. Also, small irregular pores spread erratically between the fibres with 0.2 to 0.4 mm of diameter. Other parts of the skeleton with fibres between 0.15 and 0.30 mm wide. Base covered by concentrically wrinkled and imperforate dermal layer.

This species is common in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884); from Cenomanian of Essen (Germany) (Goldfuss, 1826; Roemer, 1864; Geinitz, 1871; Quenstedt, 1878), Le Mans (France) (Geinitz, 1871); and from Callovian–Oxfordian of Tabas (east-central Iran) (Senowbari-Daryan et al., 2011).

Remarks: Senowbari-Daryan et al. (2011) stated that the clusters are not located on protuberances or nipple-like elevations as in *Mammillopora* Bronn, 1825. *T. pulvinaria* (Goldfuss, 1826) has its oscula in slightly raised clusters as Goldfuss (1826: pl. 29: figs 7a–b) and Senowbari-Daryan et al. (2011: pl. 5: fig. A) figured hemispherical specimens with unequivocally slightly elevated clusters. This differs from *Lymnorea sphaerica* Michelin, 1845, whose oscula are at the same level as the rest of the surface and have a mushroom shape. It is obvious that this species does not belong to *Mammillopora* as there are no knoblike proper protuberances. The Faringdon specimens are smaller than the German ones (Hinde, 1884). Senowbari-Daryan et al. (2011) compared this species to *T. pellisfera* Senowbari-Daryan, Fürsich and Rashidi, 2011. The latter differs in exhalant canals surrounded by thin imperforated dermal layer.

Family Endostomatidae Finks, 2004

Genus ***Raphidonema*** Hinde, 1884

Type species. *Raphidonema contortum* Hinde, 1884: pp. 197–198, pl. 37: figs 2, a-b.

Diagnosis. Sponge cup or funnel-shaped with irregular or convolute outline, and relatively thin walls. Wall formed by anastomosing, tubular spaces of narrow bore, disconnected by trabeculae. Larger and straighter tubes, probably exhalant canals, pass through most of the internal wall where they run obliquely close to the wall, and open as pores with the same diameter. These tubes are arranged quincuncially. Intertrabecular spaces open as small, circular pores on both surfaces of the wall. In cases where the inferior part of the internal surface is very thickened, it may obliterate the small pores. Microstructure with trabeculae of sinuous sheetlike or filiform forms subparallel to fibre surface made of triactines of which the basal part is slightly developed resembling uniaxial forms in thin sections (Fig. 4M).

Remarks. Hinde (1884) compared this genus to *Elasmostoma* de Fromentel, 1860 and *Corynella* Zittel, 1879 (younger synonym of *Endostoma* Roemer, 1864); but it differs from them in different spicular fibres and triactines, and in their basal ray that is poorly developed.

Raphidonema contortum Hinde, 1884

Figs 4K–N

pars 1874 *Manon peziza* Goldfuss *sensu* Davey, 10.

1884 *Raphidonema contortum* Hinde, 197–198, pl. 37: figs 2, 2a–2b.

1905 *Raphidonema contortum* Hinde in Davey, 25.

Type specimens: *Raphidonema contortum* Hinde, 1884: pp. 197–198, pl. 37: figs 2, a–b, NHMUK PI P 3246, is the holotype, from FSG of Faringdon, Oxfordshire. Some topotypes included are the following: NHMUK PI OR 10258, P 2178, P 2179, P 7802 and S 8575.

Description. Sponge grew in convolute expansions with a general cup or funnel shape that has an undulose wall (Figs 4K, L). Specimens are normally between 30 and 60 mm high and between 50 and 90 mm wide; wall from 4 to 8 mm thick (Fig. 4M). Internal and external surfaces, smooth in fair preserved specimens, are covered with a dermal layer of very closely arranged fibres, thinner than those of the internal part of the wall. One of these wall surfaces has circular oscula with a diameter from 0.3 to 0.8 mm, with an irregular distance from each other between 0.5 and 2 mm, and associated to sinuous canals (Fig. 4M with an arrow) that normally extend at right angles into the wall. Microstructure with wall interior fibres of 0.2–0.4 mm thick, slender filiform spicules that are parallel to each other in direction of the fibre and round the limits of the canals (Fig. 4N).

This species is common in the upper Aptian, from FSG, LGS, at Faringdon, in Oxfordshire (Davey, 1874; Hinde, 1884).

Remarks. This sponge species is frequently attached to other sponge species.

Hinde (1884) created this species with what Davey (1874: p. 10) believed to be *Manon peziza* Goldfuss, 1826, but it seems that Davey's (1874: pl. 2 and figure on page with 'Additional Note' -not numbered-) illustrations refer to a different species, probably *Raphidonema pustulatum* Hinde, 1884 in case of the pl. 2. It is clear that it does not correspond with *M. peziza*, but neither with *Raphidonema contortum*.

R. contortum is a very distinctive species, but Hinde (1884) compared to *Elasmostoma consobrinum* d'Orbigny, 1850 with which coincides in oscula diameter size and growth mode, but differs in spicular structure, thicker walls and normally larger size. Its structural fibres could also be compared to *Raphidonema porcatum* (Sharpe, 1854), but this species has characteristic sinuous anastomosing ridges on the external surface.

Raphidonema porcatum (Sharpe, 1854)

Figs 5A–C

Fig. 4. A–C. *Peronidella prolifera* (Hinde, 1884) from Faringdon, Oxfordshire. A. Holotype, NHMUK PI P 3277, colony general view. B, C. Topotype NHMUK PI P 4188. B. Forms bifurcating. C. Form summit with central circular osculum. D, E. *Peronidella ramosa* (Roemer, 1839), from Faringdon, Oxfordshire. D. Topotype NHMUK PI S 4542, general view. E. Neotype, NHMUK PI P 2174, skeletal fibres in tangential section. F–H. *Oculospongia dilatata* Roemer, 1864 from Faringdon, Oxfordshire. F, G. Neotype, NHMUK PI P 3252. F. General view from the upper part, oscula irregularly distributed. G. General view from the base, with concentric imperforate dermal layer (with an arrow). H. NHMUK PI OR 10232. Vertical section with radiating fibres connected transversally. I, J. *Tremospongia pulvinaria* (Goldfuss, 1826), neotype, NHMUK PI OR 10215 from Faringdon, Oxfordshire. I. Upper view showing osculum clusters with asterisk shape, each one formed of 5 or 6 openings at a slightly higher level than the rest of the surface. J. Base showing the concentric imperforate dermal layer (with an arrow). K–N. *Raphidonema contortum* Hinde, 1884 from Faringdon, Oxfordshire. K. Holotype NHMUK PI P 3246, general view of one side of the cup shape with oscula seen. L. Same specimen as K seen from the other side with view of the cup shape. M. Topotype NHMUK PI P 2178, wall cross section. N. Topotype NHMUK PI S 8575, microstructure seen in thin section. Scale bar 10 mm.

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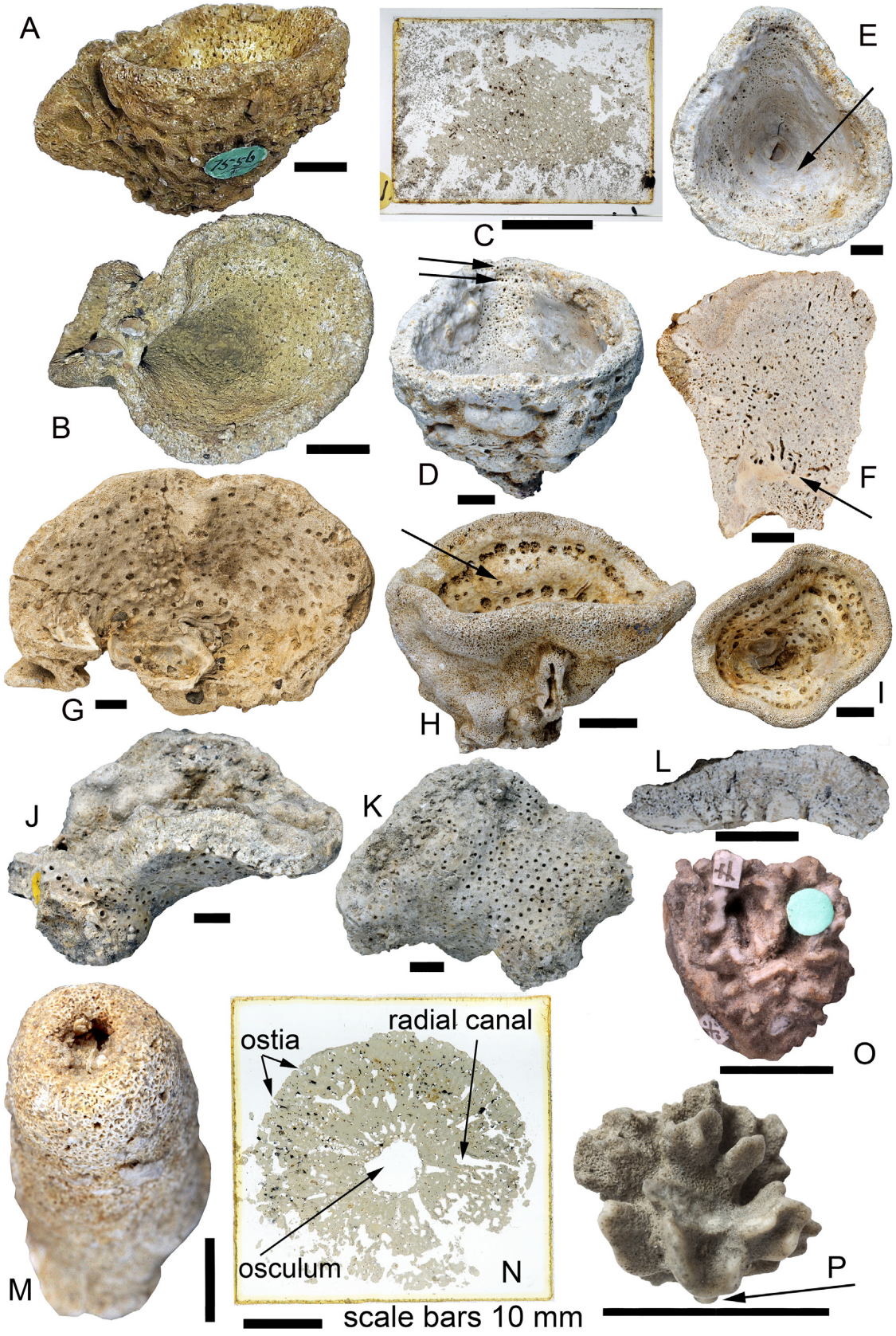
1854 *Manon porcatum* Sharpe, 196, pl. 5: fig. 2.
1874 *Manon porcatum* Sharpe in Davey, 16, pl. 10.
1878 *Catagma porcatum* (Sharpe) in Sollas, 362.
1883 *Catagma porcatum* (Sharpe) in Keeping, 147.
1884 *Raphidonema porcatum* (Sharpe) in Hinde, 198, pl. 37: fig. 3.
1905 *Raphidonema porcatum* (Sharpe) in Davey, 25.
Type specimens: *Manon porcatum* Sharpe, 1854: p. 196, pl. 5: fig. 2, BGS Geol.Soc.Coll. 7556, from Little Coxwell, Faringdon, is the holotype.



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Description. Sponge growing in convolute expansions with irregular shape or cup-shaped and sinuous anastomosing ridges on the external surface (Fig. 5A), with an average of 40 mm high, 85 mm maximum wide and 45 mm deep; wall from 4 to 5.5 mm thick. Internal surface is smooth and has numerous circular oscula of about 0.80 mm wide and irregular arrangement, apart each other between 0.2 and 1 mm; also minute pores (Fig. 5B). External surface fibres may be thinner and closer than the internal surface ones. These ones have a thickness between 0.15 and 0.3 mm (Fig. 5C). With filiform spicules.

This species appears in the upper Aptian, FSG, LGS, at Faringdon, in Oxfordshire (Sharpe, 1854; Davey, 1874; Keeping, 1883; Hinde, 1884), Upware, in Cambridgeshire (Keeping, 1883; Hinde, 1884), and Little Brickhill, in Bedforshire (Keeping, 1883).

Remarks. With well-marked oscula on well preserved specimens.

It could be compared to *R. contortum* Hinde, 1884 regarding the spicular structure but *R. porcatum* differs in sinuous anastomosing ridges on the external surface.

Raphidonema farringdonense (Sharpe, 1854)

Figs 5D–F

1854 *Manon farringdonense* Sharpe, 196, pl. 5: figs 5–6.

1878 Catagma faringdonense Sollas, 362.

1879 Pharetrospongia farringdonensis Zittel, 46.

1884 *Raphidonema farringdonense* (Sharpe) in Hinde, 200–201, pl. 37: figs 5, 5a–5b.

pars 1905 *Raphidonema farringdonense* (Sharpe) in Davey, 25, pl. 1: upper left figure.

1962 *Raphidonema farringdonense* (Sharpe) in British Museum (Natural History), pl. 48: fig. 6.

Type specimens: *Manon farringdonense* Sharpe, 1854: p. 196, pl. 5: figs 5–6. Syntypes from Little Coxwell, Faringdon. Lectotype BGS Geol. Soc.Coll.7554 (Sharpe, 1854: pl. 5: fig. 6) and paralectotype BGS Geol. Soc.Coll.7553 (Sharpe, 1854: pl. 5: fig. 5).

Description. Sponge with a cup or funnel shape (Figs 5D, E), with a height between 30 and 90 mm and a maximum width of 120 mm; wall from 7 to 17 mm thick. Internal surface varies with specimens. It is normally fibrous and with subcircular oscula about 1 mm of diameter connected with exhalant canals that descend practically perpendicularly and open downward on the external surface. These oscula mostly have a random distribution, but also with a partial horizontal arrangement (Fig. 5D with arrows), apart each other between 0.2 mm and several mm; also small pores. The sponge is partially covered by an imperforate compact dermal layer (Fig. 5E with arrow), in its most internal part and some patches close to the cup edge. External surface is covered by nodose excrescences and may have thinner and closer fibres than the internal surface and also patches of the imperforate dermal layer. This dermal layer can pass through the wall (Fig. 5F). Microstructure with wall interior fibres of 0.15–0.3 mm thick (Fig. 5F); slender filiform triactines spicules that are parallel to each other in direction of the fibre.

This species is common in the upper Aptian, FSG, LGS, at Faringdon, in Oxfordshire (Sharpe, 1854; Hinde, 1884).

Remarks. With well-marked oscula on well preserved specimens. Sponges found attached to others.

Davey (1905) illustrated of what he thought to be *R. farringdonense*, but only one of these photographs belongs to this species (Davey, 1905: pl. 1: upper left figure).

R. farringdonense could be compared to *R. contortum* Hinde, 1884 regarding the spicular structure, but *R. farringdonense* differs in lacking convolute expansions and the common existence of excrescences on the external surface. It has been reported that the most similar species is the Indian Eocene *R. indica* Rigby and Mohanti, 1990, but differs mainly in its nodose excrescences and not clustered exhalant system.

Raphidonema macropora (Sharpe, 1854)

Figs 5G–I

? 1838 *Chenendopora fungiformis sensu* Mantell (non Lamouroux), 496–497, fig. 56.

? 1839 *Chenendopora fungiformis sensu* Mantell (non Lamouroux), 561: fig. 106.

1854 *Manon macropora* Sharpe, 195, pl. 5: figs 3–4a.

1874 *Manon macropora* Sharpe in Davey, 15.

1878 *Catagma macroporus* (Sharpe) in Sollas, 356: fig. 1, 362.

1879 *Elasmostoma macropora* (Sharpe) in Zittel, 44.

1883 *Elasmostoma acutimargo sensu* Keeping (non Roemer), 147.

1884 *Raphidonema macropora* (Sharpe, 1854) in Hinde, 199–200, pl. 37: fig. 4.

1905 *Raphidonema macropora sensu* Hinde in Davey, 24, pl. 3: fig. 2.

Type specimens: *Manon macropora* Sharpe, 1854: p. 195, pl. 5: figs 3–4, syntypes, BGS GSd498 and Geol.Soc.Coll.7555, both from Little Coxwell, Faringdon. Lectotype BGS GSd498 (Sharpe, 1854: pl. 5: fig. 3) and paralectotype BGS Geol.Soc.Coll.7555 (Sharpe, 1854: pl. 5: figs 4–4a).

Description. Sponge funnel-shaped or cup-shaped (Fig. 5H), or forming convolute expansions, normally with a height of 50 mm (range 25 and 100 mm) and a width of 54 mm (between 23 and 110 mm); wall from 4 to 10 mm thick. Internal surface may be smooth (Fig. 5G) or with annular rings alternating concentric elevations and depressions (Figs 5H–J), covered by a compact dermal layer perforated by circular apertures from 1.5 to 3.5 mm in diameter. These apertures have a concentric annular disposition and are situated in the depressions in case they exist. They are approximately 3–5 mm (exceptionally 0.2 mm) apart each other at the same concentric level without any pattern, and about 5 mm between two adjacent levels. They are connected with exhalant canals. Small pores are amongst two levels of apertures (Fig. 5H with arrow), with a random distribution and with a diameter of 0.5–1 mm. External surface is irregular and may have nodose excrescences. Microstructure with fibres from 0.13 to 0.26 mm thick forming reticulated bands. With sinuous filiforme triactines.

This species is common in the upper Aptian, FSG, LGS, at Faringdon, in Oxfordshire (Mantell, 1838, 1839; Sharpe, 1854; Keeping, 1883; Hinde, 1884); Upware, in Cambridgeshire (Davey, 1874; Keeping, 1883; Hinde, 1884); and Little Brickhill, in Bedforshire (Keeping, 1883). Additionally, it is known from the Aptian of Ardennes (France) (Keeping, 1883); Valanginian-Hauterivian of Schöppenstedt, in Lower Saxony (Germany) (Keeping, 1883); Cenomanian- Turonian (Pläner Limestones) of "Dresden?" (Germany) (Keeping, 1883); and Valanginien from Arzier-Le Muids, in Vaud (Switzerland) (Keeping, 1883).

Fig. 5. A–C. *Raphidonema porcatum* (Sharpe, 1854). A, B. Holotype BGS Geol.Soc.Coll. 7556 from Little Coxwell, Faringdon, Oxfordshire. A. View of the sinuous anastomosing ridges on the external surface. B. Internal surface with oscula and pores. C. Toppotype NHMUK PI P 2181, fibres seen in a thin section. D–F. *Raphidonema farringdonense* (Sharpe, 1854). D, E. NHMUK PI OR 8296, from FSG of Faringdon, published in Hinde (1884: pl. 37: figs 5, a-b). D. General view of the cup shape, with arrow on two rows of oscula, partially covered by a dermal layer. E. Internal surface of the wall with oscula, pores and dermal layer. F. Topoptype NHMUK PI S 6655, from Little Coxwell Pit, Faringdon, Oxforshire. Longitudinal section of the wall showing imperforate dermal layer (with arrow), canals and pores. G–I. *Raphidonema macropora* (Sharpe, 1854). G. NHMUK PI P 23, from Upware, Cambridgeshire, view of the concentric disposition of the apertures in the internal surface. H, I. NHMUK PI S 8577, from Faringdon, Oxfordshire, published in Hinde (1884: pl. 37: fig. 4). H. General view with external and part of the internal surfaces with annular rings alternating concentric elevations and depressions. I. View of the internal surface with the concentric rings, apertures in depressions and small pores in elevations. J–L. *Raphidonema pustulatum* Hinde, 1884. Topoptype NHMUK PI P 2182, from Faringdon, Oxfordshire. J. General view with external and part of the internal surfaces with circular apertures. K. Specimen with apertures in the external surface. L. Wall section with canals seen. M, N. *Endostoma foraminosa* (Goldfuss, 1826). Neotype, NHMUK PI P 3272 and a thin section of the same specimen, NHMUK PI P 3272$1, from Faringdon, in Oxfordshire. M. General view. N. Cross section of the same specimen. O–P. *Lonsda contortuplicata* (Lonsdale, 1849), from Atherfield, Isle of Wight. O. Holotype NHMUK PI OR 46805(1), general view. P. BGS Geol.Soc.Coll.1968, general view with an arrow where the dermal layer is thicker, at the base. Scale bar 10 mm.

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Remarks. The large circular apertures arranged concentrically in the internal surface are very distinctive of this species.

R. macropora could be compared to *R. contortum* Hinde, 1884 regarding the spicular structure, but *R. macropora* differs in more robust spicules with more random distribution, with large apertures on concentric disposition on the internal surface and possibly nodose external wall surface.

Raphidonema pustulatum Hinde, 1884

Figs 5J–L

non 1829 *Spongia marginata* Phillips, 168, pl. 1: fig. 5.

non 1826 *Manon peziza* Goldfuss, 3, pl. 29: figs 8a–8c.

1884 *Raphidonema pustulatum* Hinde, 198–199, pl. 36: figs 8–8a.

1905 *Raphidonema pustulatum* Hinde in Davey, 24, pl.3: fig. 1.

Type specimens: *Raphidonema pustulatum* Hinde, 1884: pp. 198–199, pl. 36: figs 8–8a. The holotype is NHMUK PI S 8595, from FSG of Faringdon, Oxfordshire.

Description. Sponge with funnel or cup shapes (Fig. 5J), or grew with convolute expansions; normally with a height of 40 mm (between 13 and 57 mm) and width of 60 mm (between 28 and 90 mm); wall thickness from 3.5 to 13 mm (Fig. 5L). One of the wall surfaces, usually the internal one, with a compact dermal layer containing prominent circular apertures with margins normally raised, 0.5–1.20 mm diameter (Fig. 5K). These apertures connected with exhalant canals distributed regularly, equidistantly 1–3 mm. Also minute pores. The other surface is smooth with slender and closer fibres than the other surface. Fibre thickness varies from 0.1 to 0.35 mm, with filiform spicules that are parallel to each other in direction of the fibre and round the limits of the canals.

It appears in the upper Aptian, FSG, LGS, at Faringdon, in Oxfordshire (Hinde, 1884).

Remarks. A distinctive feature of this species is the large circular apertures with raised rims.

This species could be compared to *R. macropora* (Sharpe, 1854) concerning the compact dermal layer with apertures, but it differs in not having a concentric arrangement of the apertures, and these have smaller diameters.

Genus ***Endostoma*** Roemer, 1864

Type species. *Scyphia foraminosa* Goldfuss, 1826, p. 86, pl. 31: figs 4a–4b.

Diagnosis. Conicocylindrical, usually simple but sometimes several basally conjoined, characterised by deep, central cloaca; principal, exhalant canals enter cloaca subhorizontally, and on top surface occur as radial grooves converging on osculum; other canals essentially intertrabecular spaces; patches of imperforate dermal layer may cover lower parts of sponge. Fibres forming bundles of mainly subparallel, extremely slender triradiates, and paratangential dermal triad tetraradiates may be present locally.

Remarks. Mainly Hinde's (1884: p. 181) description.

Endostoma foraminosa (Goldfuss, 1826)

Figs 5M, N

1829 *Scyphia foraminosa* Goldfuss, 86, pl. 31: figs 4a–4b.

1844 *Scyphia foraminosa* Goldfuss in Mantell, 256: pl. 55: fig. 6.

1844 *Scyphia intermedia* Münster in Goldfuss, in Mantell, 256: pl. 55: fig. 2.

1864 *Endostoma foraminosum* (Goldfuss) in Roemer, 39, pl. 14: fig. 6.

1871 *Epitheles foraminosa* (Goldfuss) in Geinitz, 33–34, pl. 8: fig. 13.

pars 1878 *Scyphia foraminosa* (Goldfuss) in Quenstedt, 351–352, pl. 132: fig. 8.

pars 1883 *Corynella foraminosa* (Goldfuss) in von Dunikowski, 317.

1884 *Corynella foraminosa* (Goldfuss) in Hinde, pl. 34: figs 9, 9–9a.

1905 *Corynella foraminosa* (Goldfuss) in Davey, 16.

Type specimens: *Scyphia foraminosa* Goldfuss, 1826: p. 86, pl. 31: figs 4a–4b, from Cenomanian of Essen (Germany). It is missing at the Goldfuss-Museum. We designate NHMUK PI P 3272 as the neotype of *Endostoma foraminosa* (Goldfuss, 1826). This specimen is from FSG of Faringdon, Oxfordshire; it is probably the same that Hinde published (1884: pl. 34: figs 9, 9a).

Description. Conicocylindrical forms (Fig. 5M) that occur normally in solitary, but also in clusters of a few conjoined individuals. They usually have a height of approximately 45 mm and about 34 mm of diameter, being wider proximally. Deep and central cloaca of about 6 mm diameter (Fig. 5N), less than one-sixth of the diameter. There may be a differentiated layer covering the wall at the basal zone, otherwise it is possible to see ostia and canals. Endowall continuous with canal apertures present. Exhalant canals enter cloaca subhorizontally. Exowall with subpolygonal exopores. Fibres composed of minute three-rayed spicules parallel to each other in the direction of the fibre (Fig. 5N) that are combined with larger forms.

This species is common in the upper Aptian: FSG, LGS, at Faringdon, in Oxfordshire (Mantell, 1844; Hinde, 1884), and in the Cenomanian of Essen (Germany) (Goldfuss, 1826; Roemer, 1864; Geinitz, 1871; Hinde, 1884).

Remarks: Although in cross section (Fig. 5N) seem to have filiform uniaxial spicules, they are filiform three-rayed spicules.

E. foraminosa resembles the coeval *Pachytilodia infundibuliformis* as Goldfuss (1826) illustrated it [*Scyphia infundibuliformis*]. In this case the sponge base lacks the usual layer present in *E. foraminosa*, covering ostia and canals. On the other hand, adult individuals of *P. infundibuliformis* have been described as goblet shapes with coarse, irregular pores and monoaxons besides triradiates.

Class Hexactinellida Schmidt, 1870

Order Uncertain

Genus ***Lonsda*** de Laubenfels, 1955

Type species. *Conis contortuplicata* Lonsdale, 1849: pp. 63–66, pl. 4: figs 1–4.

Diagnosis. Irregular forms with numerous ridges that merge at the base; ridges and furrows alternate and may anastomose. Furrows can connect with each other. Patches of compact dermal layer. Minute pores in furrows. Reticulated fibres.

Remarks. Taxonomic name replacing *Conis* Lonsdale, 1849, due homonymy, which was created to identify a sponge from the southern basin LGS, AC of the Isle of Wight, that cannot be related to any other.

Lonsda contortuplicata (Lonsdale, 1849)

Figs 5O–P

pars 1849 *Conis contortuplicata* Lonsdale, 63–66, pl. 4: figs 1–4.

1955 *Lonsda contortuplicata* (Lonsdale) in de Laubenfels, E86.

1961 *Lonsda contortuplicata* (Lonsdale) in Casey, 572–573.

2004 *Lonsda contortuplicata* (Lonsdale) in Finks, Reid and Rigby, 555.

Type specimens: *Conis contortuplicata* Lonsdale, 1849: pp. 63–66, pl. 4: figs 1–4, NHMUK PI OR 46805(1), is the holotype, from AC of Atherfield, Isle of Wight. The type series contains two additional specimens.

Description. Irregular (Fig. 5O) or branch-like (Fig. 5P) forms, with alternating ridges and furrows that may anastomose. Usual height between 10 and 17 mm, width between 9 and 16 mm, and approximate depth of 8 mm. Some ridges and base covered by a dermal layer that is thicker at the base (Fig. 5P with arrow); thickness varies in the same branch-like or ridge structure or on opposite sides. Minute inhalant pores, not seen when the dermal layer is very thick at the base. Microstructure finely reticulated with irregular meshes and bent fibres.

This species appears in the Aptian: Upper Perna Member, AC, LGS, of Atherfield (Lonsdale, 1849) and Sandown, on the Isle of Wight (Casey, 1961).

Remarks: Irregular mode of growth that may be tuberculated. Furrows may have functioned as excurrent canals. This species has been the subject of great controversy. Casey (1961) argued this species is a hydrozoan, agreeing with the calcareous species found of shallow waters in the LGS. de Laubenfels (1955) placed this species with hyalospongea (heteractinellids) and more recently Finks et al. (2004) with hexactinellids in order uncertain.

Lonsdale (1849) compared this species to the Streiberg Jurassic species *Astrospongia costata* (Münster in Goldfuss, 1826) [*Achilleum costatum*]. This one is a calcareous sponge that has a hemispherical

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form with radially arranged ribs that converge distally. It differs from *L. contortuplicata* not only in form, but also in composition.

4. Conclusion

This comprehensive study documents 17 British Calcarean sponge species and one hexactinellid from the British LGS, incorporating the latest Porifera classification and recent taxonomic research. Specimens from the Natural History Museum, London, and the British Geological Survey are illustrated. These sponges are remarkable for their fine preservation, attributed to the loose sandy matrix and their own composition. Found abundantly in Oxfordshire, notably at the Faringdon outcrop and Little Coxwell quarries, these sponges are primarily calcareous and from shallow marine to littoral facies. The global significance of these taxa is underscored by their presence in other regions, such as France, Switzerland, and Germany, contributing to our understanding of Cretaceous shallow-water ecosystems. The robust spicules and irregular morphologies suggest adaptations to high-energy, shallow marine environments. Whilst some were encrusting organisms that provided substrates for epifaunal communities, others featured short attachment bases suited for sandy substrates. These features may provide insights into early reef-like systems in dynamic marine settings. The faunal assemblage predominantly exhibits Tethyan affinities, having developed in warm, shallow Cretaceous seas at approximately 40° latitude. Comparisons with Urgonian facies in France and similar deposits in Germany further support the Tethyan connection. These carbonate platforms are associated with periods of sea-level fluctuations and nutrient enrichment, conditions that promoted diverse and rich faunal assemblages.

Future research could focus on orbitolinid and rudist-dominated ecosystems within the Urgonian limestones, which offer biostratigraphic evidence consistent with studies across Europe and the Middle East, reinforcing their global correlation to Tethyan marine environments.

CRediT authorship contribution statement

Consuelo Sendino: Writing – original draft, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Stephen Kershaw:** Writing – review & editing, Formal analysis, Methodology, Investigation.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were used in the creation of this article. All content, including the writing, analysis, and conclusions, was produced by the authors without the aid of generative AI tools.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.pgeola.2024.12.006. These data include the Google map of the most important areas described in this article.

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