Abh. Geol. B.-A.	ISSN 0378-0864 ISBN 3-900312-54-0	Band **39**	S. 51–55	Wien, März 1987

Concerning Dimorphism in Early Jurassic Coccoliths and the Origin of the Genus *Discorhabdus* NOËL 1965

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With 1 Figure and 1 Plate

Calcareous nannofossils
Jurassic
Evolution

Contents

Zusammenfassung

Eine Entwicklungsreihe von der Gattung *Biscutum* BLACK 1959 über die Gattungen *Sollasites* BLACK 1967 und *Calyculus* NOËL 1973 zu der Gattung *Discorhabdus* NOËL 1965 wird vorgeschlagen. Dimorphismus in den Coccolithen der Gattung *Calyculus* kompliziert diese Reihe. Dieser Dimorphismus ist dem Beispiel der jüngeren Gattungen *Pontosphaera* LOHMANN 1902 und *Scyphosphaera* LOHMANN 1902 ähnlich.

Abstract

I propose an evolutionary lineage from the genus *Biscutum* BLACK 1959, through the genera *Sollasites* BLACK 1967 and *Calyculus* NOËL 1973 to the genus *Discorhabdus* NOËL 1965. This evolutionary lineage is complicated by dimorphism in the coccoliths of the genus *Calyculus*. This dimorphism is similar to the more recent example seen in the genera *Pontosphaera* LOHMANN 1902 and *Scyphosphaera* LOHMANN 1902.

1. Introduction

Recent studies by GOY et al. (1979) and GOY (1981) of Early Toarcian nannofossils from the "Schistes Carton" of the Paris Basin, have reported dimorphism amongst the coccoliths of *Vikosphaera noelae* GOY in GOY, NOËL & BUSSON (1979). This dimorphism is shown by the two forms of coccolith *V. noelae* ssp. *depressa* and *V. noelae* ssp. *recondita*. The two forms are identical except for a vertical elongation of the distal rim elements in the sub-species *recondita*. GOY (1981) reports finding the two sub-species closely associated with one another in what he considered to be disaggregated coccospheres. These coccospheres were examined, using a scanning electron microscope, on the surface of rock samples. GOY argued that the "Schistes Carton" were deposited in very calm water and that groups of coccoliths belonging to the same species represented disaggregated coccospheres, as no subsequent transportation would have occurred after initial deposition. It can also be argued that the high organic content of "Schistes Carton" would be associated with anoxic sea floor conditions and thus minimal bioturbation.

In the present study a similar example of dimorphism to that of *V. noelae* is postulated amongst the genus *Calyculus*, and compared with more recent cases. The dimorphic species of *Calyculus* reveal possible evolutionary links between the genera *Biscutum* BLACK 1967 and *Discorhabdus* NOËL 1965. This evolutionary trend from *Biscutum* to *Discorhabdus* is illustrated in Fig. 1.

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2. Evolution and Dimorphism in the Family Biscutaceae BLACK 1971

A member of the family Biscutaceae BLACK 1971 has been reported from strata as old as Rhaetian (JAFAR, 1983); however, this report is of a single broken specimen of *Paleopontosphaera repleta* PRINS 1969 (invalid), which was not illustrated. More reliable reports of this family begin with the inception of *Biscutum dubium* (NOËL 1965) GRÜN in GRÜN, PRINS & ZWEILI (1974) in the Late Sinemurian (BARNARD & HAY, 1974; HAMILTON, 1977 and 1979) and the Early Pliensbachian (PRINS, 1969; MEDD, 1982; CRUX, 1984). No intermediate forms between *B. dubium* and the already existing coccolith species have been reported, although PRINS (1969) postulated an evolutionary link with *Crucirhabdus primulus* PRINS in ROOD, HAY & BARNARD 1973. Ancestral species to *B. dubium* may have existed in the relatively unstudied Tethyan realm, and have yet to be disco-

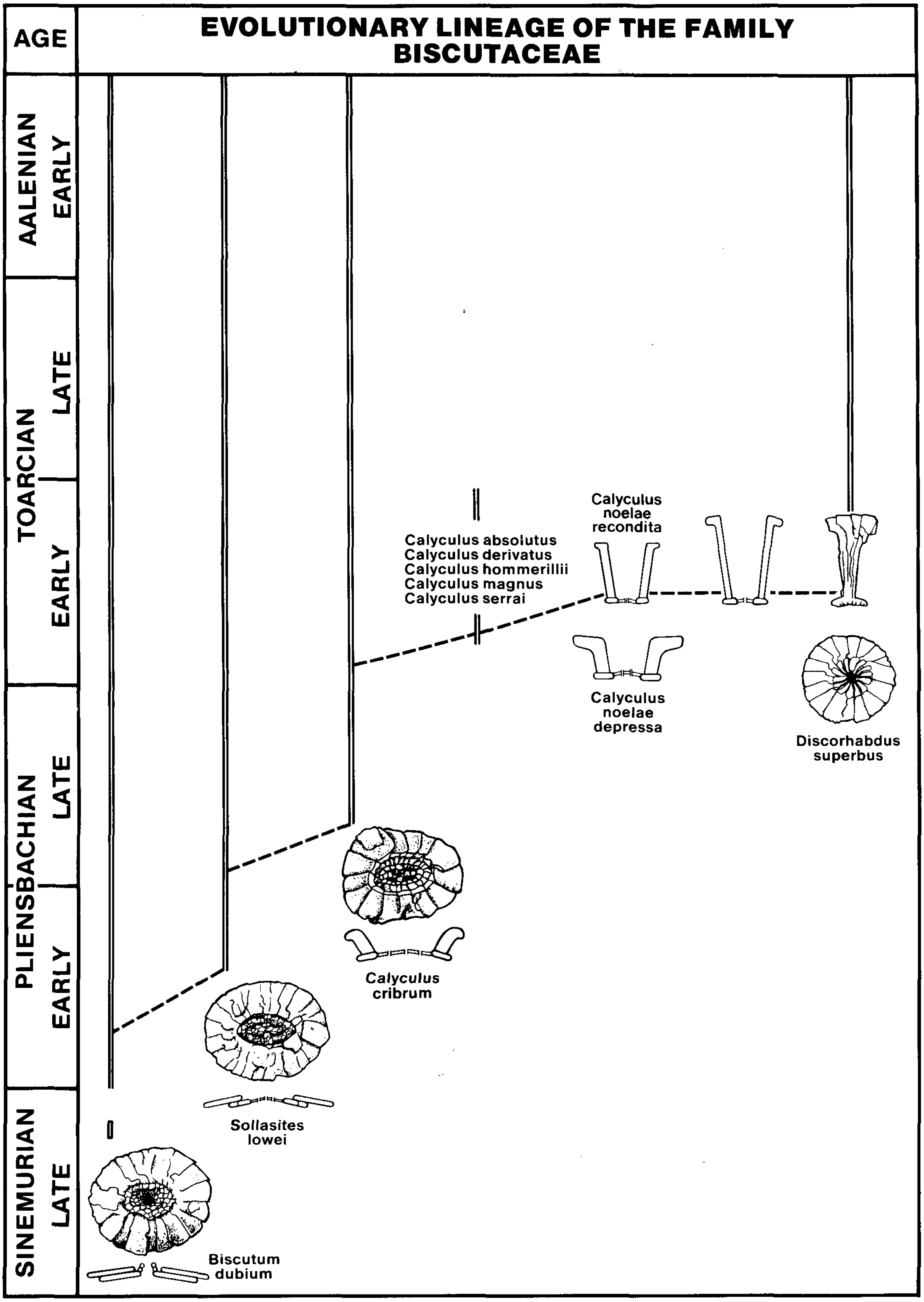

Fig. 1: Evolutionary lineage from *Biscutum* to *Discorhabdus*.

vered. A second member of the family Biscutaceae, *Sollasites lowei* (BUKRY 1969) ROOD, HAY & BARNARD 1971, evolved in the Early Pliensbachian (CRUX, 1984; and this study). *Sollasites lowei* (Pl. 1, Figs. 3 and 4) is similar to *B. dubium* (Pl. 1, Figs. 1 and 2), but has an enlarged central area filled with a grid comprising a cross and one or two cycles of blocky elements. It is probable that *S. lowei* evolved from *B. dubium*, as no other known placolith with a radial structure had evolved by the Early Pliensbachian; however, no intermediate forms have been observed.

In the Late Pliensbachian forms similar to *S. lowei* but with a vertical elongation of their distal rim elements first appear. These forms were placed in a new family

Calyculaceae and genus *Calyculus* by NOËL (1973), and given a different specific name, that of *C. cribrum* (Pl. 1, Figs. 5–7). It is possible that *C. cribrum* was one of two types of coccolith on the same coccosphere, since forms with less elongate distal rims have been observed (BOWN, personal communication). During the latest Pliensbachian and earliest Toarcian more members of *Calyculus* evolved. GOY (1981) divided these into four genera by the character of their proximal grids. The four genera which are all placed within *Calyculus* in the present study are:

Incerniculum GOY in GOY, NOËL & BUSSON 1979
Vikosphaera GOY in GOY, NOËL & BUSSON 1979
Calyculus NOËL 1973
and
Catillus GOY in GOY, NOËL & BUSSON 1979.

Evolution continued in the Biscutaceae, with

1) progressive elongation of the distal rim elements, and
2) appearance of more circular shape and a reduction in the size of the central area of a species of *Calyculus* sensu this study; finally resulting in the evolution of *Discorhabdus superbus* (DEFLANDRE in DEFLANDRE & FERT 1954) CRUX 1984.

This evolutionary trend was first noted by PRINS (1969), although he considered these forms to originally evolve from *Crepidolithus crassus* (DEFLANDRE in DEFLANDRE & FERT 1954) NOËL 1965. It is probable that *D. superbus* evolved from *V. noelae*, as this species has the most elongate distal rim of all the species of *Calyculus* yet described. The evolutionary trend from *Calyculus* to *Discorhabdus* is shown in Pl. 1, Figs. 13–16.

It is not yet known if the coccospheres of *D. superbus* show dimorphism similar to that described by GOY (1981) for *V. noelae*. Separate *Discorhabdus* placoliths are commonly found, but these are easily detached from the distal rim which in *D. superbus* is so reduced in diameter that it appears as a central spine. It has been noted, however, that some of these separate placoliths have 3 rims, while those specimens with the attached distal rim/spine only have two rims. Examples of the two forms are shown in Pl. 1, Figs. 9–12.

It is thus postulated that *S. lowei* gave rise to the dimorphic genus *Calyculus* in the Late Pliensbachian. The distal rim of *Calyculus* became more elongate, the central area narrower, and the coccolith shape more circular, until the genus *Discorhabdus* evolved. It is likely that this genus was also dimorphic.

3. The Evolution of the Genus *Scyphosphaera* LOHMANN 1902

A possible parallel to the evolutionary trend of *Biscutum* to *Discorhabdus* may be the evolution of the structurally more complex and much younger *Pontosphaera* LOHMANN 1902 and *Scyphosphaera* LOHMANN 1902. This latter trend occurred in the Eocene to Recent, when the flat disk-like *Pontosphaera* began to show dimorphism, with the appearance of barrel-shaped lopadoliths of *Scyphosphaera*. This dimorphism has been observed on coccospheres (see GAARDER, 1970, fig. 4, a–f), and provides a clue to how the as yet undiscovered complete Jurassic dimorphic coccospheres may have been constructed.

It is possible that a detailed study of the distribution in time and space, environmental preferences and mode of life of the *Scyphosphaera/Pontosphaera* coccolithoporid, would give us an insight into the environmental preferences and causes for the evolution of the genus *Calyculus*.

4. Taxonomy

Family Biscutaceae BLACK 1971

Genus *Biscutum* BLACK in BLACK & BARNES 1959

Biscutum dubium (NOËL 1965) GRÜN in GRÜN, PRINS & ZWEILI 1974
(Pl. 1, figs. 1–2)

Genus *Calyculus* NOËL 1973 emend. this study

Diagnosis: A genus of coccolithoporids which can bear two forms of coccolith, a flat form with an open centre placolith structure consisting of radiating elements, and a second similar form but with elongated distal elements which can make a high outer wall to the coccolith. Both types of coccolith have an identical central grill. Differences in the character of the central grill allow different species to be recognised within the genus *Calyculus*.

Calyculus absolutus (GOY in GOY, NOËL & BUSSON 1979) nov. comb.

1979 *Incerniculum absolutum* GOY in GOY, NOËL & BUSSON, p. 42, pl. 4, fig. 6

Remarks: This species was assigned to the genus *Incerniculum* by GOY in GOY et al. (1979). That genus is not considered useful, as the main difference between it and *Calyculus* NOËL 1973, is the character of the proximal grill, a feature much less significant than the similarity of the rim type(s) of the forms concerned.

Calyculus cribrum NOËL 1974
(Pl. 1, figs. 5–7)

Remarks: This possibly dimorphic species was the first of the genus *Calyculus* to evolve in the Late Pliensbachian.

Calyculus derivatus (GOY 1981) nov. comb.

1981 *Incerniculum derivatum* GOY, p. 55, pl. 21, figs. 1–2

Remarks: see *Calyculus absolutus*.

Calyculus homerilii (GOY in GOY, NOËL & BUSSON 1979) nov. comb.

1979 *Catillus homerilii* GOY in GOY, NOËL & BUSSON, p. 43, pl. 65, fig. 4

Remarks: The differentiation of the genera *Calyculus* and *Catillus* GOY, in GOY et al. (1979), is considered to be unnecessary as the two genera have similar rims.

Calyculus magnus (GOY 1981) CRUX 1984

Calyculus noelae (GOY in GOY, NOËL & BUSSON 1979) nov. comb.

1979 *Vicosphaera noelae* GOY NOËL & BUSSON, p. 42, pl. 4, fig. 7; pl. 5, fig. 1

Calyculus noelae ssp. *depressa* (GOY 1981) nov. comb.

Calyculus noelae ssp. *recondita* (GOY 1981) nov. comb.

Remarks: This dimorphic species is placed in the genus *Calyculus* with other species showing a similar rim construction(s).

Calyculus serrai (GOY 1981) nov. comb.

1979 *Catillus serrai* GOY, p. 63, pl. 27, figs. 5–10

Remarks: see *Calyculus homerilii*.

Genus *Discorahbdus* NOËL 1965

Discorhabdus superbus (DEFLANDRE in DEFLANDRE & FERT 1954) CRUX 1984

(Pl. 1, figs. 8–12,17)

Genus *Sollasites* BLACK 1967

Sollasites lowei (BUKRY 1969) ROOD, HAY & BARNARD 1971

(Pl. 1, figs. 3–4)

Acknowledgements

I would like to thank the British Petroleum Company plc, for permission to publish this paper. In particular I would like to thank the following for their help: G. L. EATON, E. M. FINCH, D. I. WARTON and A. A. H. WONDERS. I would also like to thank P. BOWN and H. STOWE of University College London for their helpful suggestions.

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Plate 1

Figs. 1–12: scanning electron micrographs; Figs. 13–17: photomicrographs, + nicols.

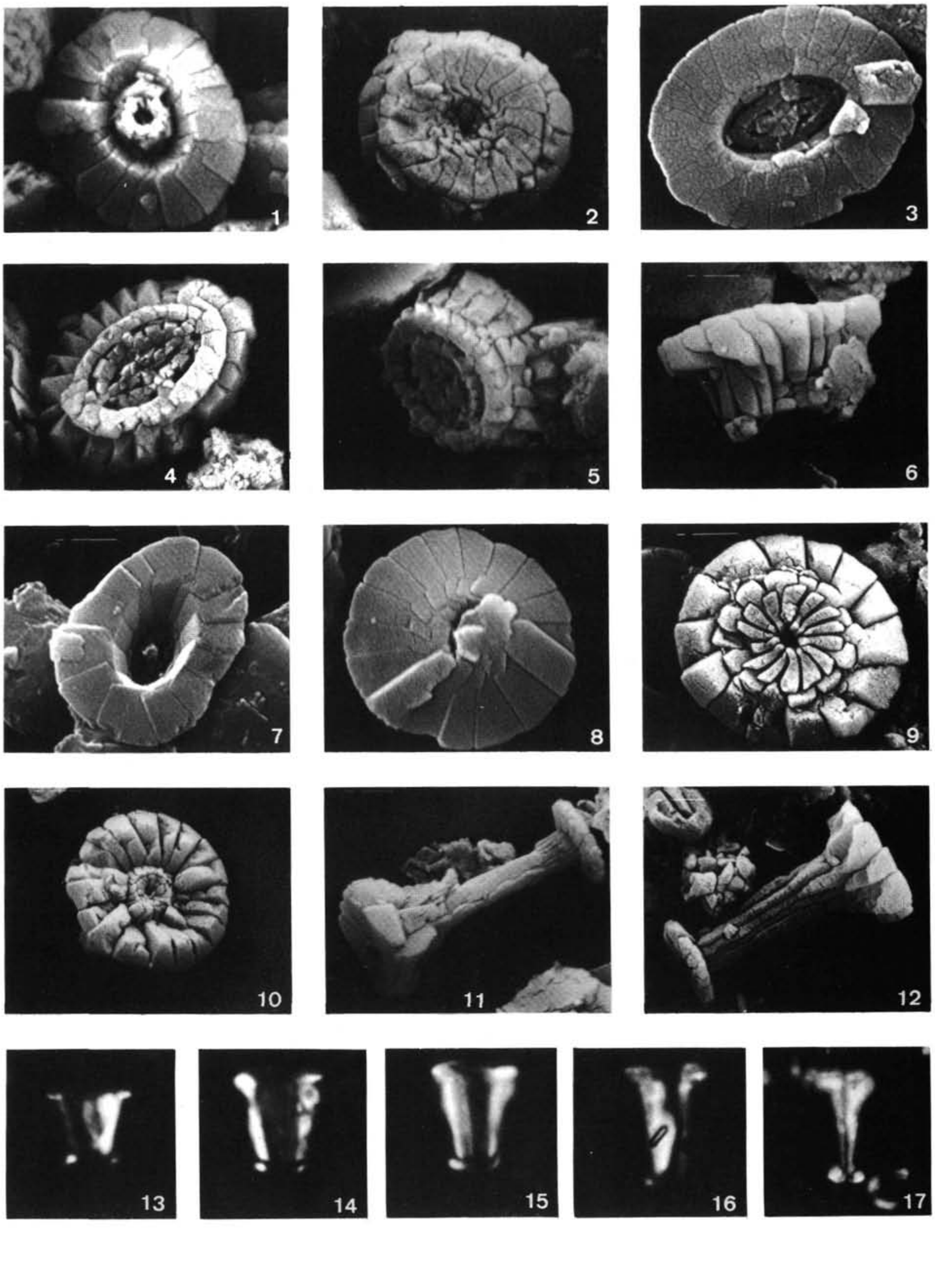
Figs. 1–2: *Biscutum dubium* (NOËL 1965) GRÜN in GRÜN, PRINS & ZWEILI 1974.
1. Distal view, ×10,800, BP-11-4, PAL 1178, Spinatum Zone, Pliensbach.
2. Proximal view, × 8,000, BP-5-30, PAL 1195, Levesquei Zone, Holzmaden.

Figs. 3–4: *Sollasites lowei* (BUKRY 1969) ROOD HAY & BARNARD 1971
3. Distal view, × 17,900, BP-3-32, PAL 1178, Spinatum Zone, Pliensbach.
4. Proximal view, × 8,950, BP-12-21, PAL 1178, Spinatum Zone, Pleinsbach.

Figs. 5–7: *Calyculus cribrum* NOËL 1973
5. Proximal view, ×7,150, BP-13-14, PAL 1178, Spinatum Zone, Pliensbach.
6. Side view, × 6,000, BP-33-29, PAL 1195, Levesquei Zone, Holzmaden.
7. Distal view, × 8,000, BP-6-32, PAL 1199, Bifrons Zone, Aalen.

Figs. 8–12 and 17: *Discorhabdus superbus* (DEFLANDRE in DEFLANDRE & FERT 1954) CRUX 1984
8. Distal view, × 8,000, BP-11-29, PAL 1194, Levesquei Zone, Holzmaden.
9. Proximal view, × 8,000, BP-7-30, PAL 1195, Levesquei Zone, Holzmaden.
10. Proximal view, × 5,450, BP-29-29, PAL 1195, Levesquei Zone, Holzmaden.
11. Side view, × 6,000, BP-22-29, PAL 1195, Levesquei Zone, Holzmaden.
12. Side view, × 6,050, BP-6-30, PAL 1195, Levesquei Zone, Holzmaden.
17. Side view, × 2,800, BP-5-28, PAL 1194, Levesquei Zone, Holzmaden.

Figs. 13–16: *Calyculus* sp.
13. Side view, × 2,800, BP-30-38, southern North Sea.
14. Side view, × 2,800, BP-33-38, southern North Sea.
15. Side view, × 2,800, BP-32-38, southern North Sea.
16. Side view, × 2,800, BP-35-38, southern North Sea.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