Zeitschrift: Eclogae Geologicae Helvetiae

Herausgeber: Schweizerische Geologische Gesellschaft

Band: 65 (1972)

Heft: 2

Artikel: On Jurassic coccoliths : Stephanolithion, Diadozygus and related genera

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DOI: https://doi.org/10.5169/seals-164097

Eclogae geol. Helv.	Vol. 65/2	Pages 327–342	2 figures in the text and 2 plates (I–II)	Basle, Aug. 1972

On Jurassic Coccoliths: *Stephanolithion, Diadozygus* and Related Genera

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ABSTRACT

Firstly, this paper presents the stratigraphical development of the genus *Stephanolithion* through the Jurassic and Lower Cretaceous. Several of the main taxonomic problems concerned with the species are dealt with. A change in the number of the central bars is of importance stratigraphically.

Secondly, the first detailed account of the genus *Diadozygus* and its development throughout the Jurassic, together with affinities between related genera is given. Six species of *Diadozygus* are described, two of which are new. One species of *Truncatoscaphus* and four species of *Diadorhombus* (three of which are new) are also described.

Stratigraphy

The coccoliths were obtained from numerous samples from a wide range of the Jurassic and Lower Cretaceous outcrops, and boreholes from a number of localities. The material was collected from both England and Northern France (Calvados). Details of stratigraphical age and location are listed below:

a) Upper Lias: levesquei zone
Locality: Eype (Dorsetshire)

b) Bathonian: zigzag zone, circumdata zone, discus zone
Localities: Dyrham (Gloucestershire)
Port-en-Bessin (Normandy)

c) Lower Callovian: macrocephalites zone, calloviense zone
Locality: 2 km East of Escoville (Normandy)

d) Upper Callovian and Oxfordian: jason zone, coronatum zone, athleta zone, lamberti zone, mariae zone, cordatum zone, plicatilis zone
Localities: Mesnil-de-Breville (Normandy)
Whittlesey (Cambridgeshire)
Exposures along the Dorset Coast of England
Millbrook (Bedfordshire)

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[1]) The arrangement of the authors does not indicate any seniority.

e) Kimmeridgian: eudoxus zone to epipallasiceras zone, see notes included in ARKELL (1947), and TORRENS (1969)
Localities: Kimmeridge Bay to Hounstout Cliff (Dorsetshire)

f) Valanginian–Hauterivian–Barremian–Albian: Beds D6, D2, D1, C10, C9, C5, C1, B Cement Beds, A4, A3, & A2 (LAMPLUGH 1889)
Locality: Speeton (Yorkshire)

Part A: The genus *Stephanolithion*

Introduction

The genus *Stephanolithion* was first designated by DEFLANDRE (1939), the genotype *S. bigoti* was the only species described. The description was based on Oxfordian material from Calvados (N. France). The original work by DEFLANDRE was based on an optical examination of this species, and a detailed study of the spines, bars and the shape of the coccolith was given. Electron micrographs have subsequently confirmed much of his work on the structure of *S. bigoti.* A second species, *S. speciosum*, also from the Oxfordian of Calvados, was designated by DEFLANDRE (1954). STRADNER (1963) realised the stratigraphical importance of *S. bigoti* in the Callovian–Oxfordian and set up the "Bigoti" Zone; his figures, however, add nothing to those of DEFLANDRE's first paper (1939). NOEL (1965) in her pioneer monograph on Jurassic coccoliths (based on electron microscope research), restudied *S. bigoti* and designated a new species *S. laffittei* with a range from Portlandian to Maestrichtian. DEFLANDRE's second species *S. speciosum* is not mentioned. More recently, MEDD (1971) mentions both *S. bigoti* and *S. speciosum*, the latter occurring "in the Bathonian material and is found with *S. bigoti* in the Callovian as high as the coronatum zone". A third species, *S. laffittei* NOEL, was also found in Jurassic samples, but MEDD (p. 827) points out the likelihood of Cretaceous contaminents. Two further forms of *Stephanolithion* have been found by the present authors, *S. hexum* sp. nov. and *S. speciosum* var. *octum* var. nov. Major structure differences between the Jurassic species and the Lower Cretaceous *S. laffittei* NOEL, are evident from electron micrographs.

SYSTEMATIC PALAEONTOLOGY

Kingdom PLANTAE

Division CHRYSOPHYTA

Class COCCOLITHOPHYCEAE ROTHMALER 1951

Order EIFFELLITHALES ROOD, HAY, BARNARD 1971

Family Stephanolithionacea BLACK 1968 emended

Subfamily Stephanolithionoideae VEKSHINA 1959

Genus *Stephanolithion* DEFLANDRE 1939

Type *Stephanolithion bigoti* DEFLANDRE 1939

Stephanolithion bigoti DEFLANDRE

Plate I, Fig. 5, 11

1939 *S. bigoti* DEFLANDRE, Fig. 1–9, p. 1332
1954 *S. bigoti* DEFLANDRE, DEFLANDRE and FERT, Pl. *XV*, Fig. 1–6
1954 *S. bigoti* DEFLANDRE, STRADNER, Pl. IV, Fig. 2a–c
1965a *S. bigoti* DEFLANDRE, NOEL, Fig. 9–14, p. 5
1965b *S. bigoti* DEFLANDRE, NOEL, Fig. 9–14, Pl. 5, Fig. 1–10, Pl. 6, Fig. 1–2, p. 78–83
1968 *S. bigoti* DEFLANDRE, BLACK, Pl. 152, Fig. 1, p. 807–808
1971 *S. bigoti* DEFLANDRE, in ROOD, HAY and BARNARD, Pl. II, Fig. 8, p. 259–260
1971 *S. bigoti* DEFLANDRE, MEDD, Pl. II, Fig. 6, Pl. 3, Fig. 5–6, p. 827

Remarks

Although the structure of this species has been fully dealt with by DEFLANDRE, and NOEL two factors are worthy of emphasis. Firstly, there are four radial bars supporting a central spine the angles between the bars varying; and secondly, lateral spines numbering from 6–10 vary in length, in the angle and plane in which they lie, and in the general shape (usually they are long, being broadest about mid-length). Although this species is usually described as elliptical, it is often almost hexagonal in outline.

Hypotype: 28.12.1

Dimensions: Diameter across spines, 9.5μm

Stephanolithion hexum new species

Plate 1, Fig. 3, 4, 9 and 10

Diagnosis

A species of *Stephanolithion* with six radial bars supporting a central spine.

Description

Hexagonal to elliptical coccoliths with one cycle of thin tabular elements and a much thicker cycle of slightly intricate prismatic elements. Six bars radiate asymmetrically from a platform supporting a central spine. This asymmetry is characterised such that rotation, by 180°, of one half of the central area repeats the other half.

Six to ten lateral spines arranged irregularly around the periphery vary in shape from a short cone to a long spine expanding to its broadest point at about mid-length, and then tapering to a blunt conical end.

Remarks:

The species was named *hexum* because of the diagnostic six internal radial bars.

Holotype: 55.8.1

Paratype: 56.11.2

Dimensions: Diameter across spines, 9 μm

Type locality: 2 km East of Escoville (Normandy)

Type level: macrocephalites zone

Stephanolithion speciosum DEFLANDRE

Plate 1, Fig. 1, 7

1954 *S. speciosum* DEFLANDRE in DEFLANDRE and FERT, Pl. *XV*, Fig. 7, 8, text-fig. 56, p. 146
1971 *S. speciosum* DEFLANDRE, MEDD. p. 827

Remarks

This elliptical coccolith with eight bars supporting a central spine has 8–10 short lateral spines. The original figures of DEFLANDRE are difficult to interpret, particularly regarding the central portion. Electron-micrographs show that the central asymmetry associated with *S. hexum* is again a feature of the central area of *S. speciosum*. The major problem concerning the occurrence of this species, recorded by DEFLANDRE from the Oxfordian of Villers-sur-Mer, Calvados, is that in the present work it has not been recorded higher than Lower Callovian (Cornbrash). MEDD (p. 827) records it from the Bathonian to Callovian coronatum Zone. NOEL (1965) does not record it at all; and as most of her work is from Upper Callovian and Oxfordian it is surprising that she did not find this form during her research.

Hypotype: 56.1.1

Dimensions: length 6 μm, width 4.4 μm

Locality: Port-en-Bessin (Normandy)

Level: circumdata zone

Stephanolithion speciosum DEFLANDRE var. *octum* new variety

Plate I, Fig. 2, 8

Remarks

The variety differs from the species, which has 8–12 short lateral spines, in having 8–12 (usually 8–10) long lateral spines. These are broadest at the mid-point. In *speciosum* sensu stricto, the lateral spines are short blunt prolongations from the rim; whereas in *speciosum* var. *octum* the spines resemble those usual in *S. bigoti* DEFLANDRE.

Holotype: 57.4.2

Dimensions: Diameter across spines, 8.5 μm

Type locality: 2 km East of Escoville (Normandy)

Type level: macrocephalites zone

Stephanolithion laffittei NOEL 1956

Plate I, Fig. 6, 12

1956 *S. laffittei* NOEL, Pl. 2, Fig. 5 (non 6), p. 318
1958 *S. laffittei* NOEL, NOEL, Pl. 1, Fig. 1–2, p. 161
1963 *S. laffittei* NOEL, BOOCHÉ, p. 6
1963 *S. laffittei* NOEL, STRADNER, Pl. 1, Fig. 14, a, b, p. 9
1964 *S. laffittei* NOEL, BRAMLETTE and MARTINI, Pl. 6, Fig. 12–15, p. 230
1971 *S. laffittei* NOEL, MEDD, p. 827

Remarks

The crown of the coccolith is much deeper than other species of *Stephanolithion* and it is possible that *S. laffittei* NOEL should be referred to a different (or new) genus.

This circular coccolith consists of two cycles of elements much larger than in *S. bigoti*, *hexum* and *speciosum*, and vertically or slightly inclined. Eight regularly arranged bars radiate from the centre of the coccolith. No central spine has been observed. The lateral spines are short, and thick. Apart from NOEL's recording of this species in the Portlandian (haut) of Algeria, all records come from the Cretaceous.

The species is long ranged throughout the Cretaceous and deserves further study.

In our comprehensive studies of the Jurassic we have not discovered this species, but it occurs in abundance and is diagnostic element of the Lower Cretaceous (Valanginian–Barremian) of Speeton (Yorkshire).

Stratigraphical History of *Stephanolithion*

Extensive investigation into all ammonite zones in the Lias has not revealed the presence of *Stephanolithion* or any genus from which it has clearly arisen. The first occurrence in any samples investigated was in the Zigzagiceras zigzag Bed at the base of the Bathonian at Port-en-Bessin (Normandy), where the short-spined, eight barred *S. speciosum* DEFLANDRE, occurred abundantly.

This species continued as the sole representative of the genus throughout the Fullers Earth and Forest Marble Beds (Lower and Middle Bathonian). It occurs abundantly in most clay beds, unless extensive weathering has taken place.

A major change appears in the Lower Cornbrash (Clydoniceras discus Zone) where *S. speciosum* DEFLANDRE is still present but accompanied by *S. speciosum* DEFLANDRE var. *octum* var. nov. (a long-spined, eight-barred form) and *S. hexum* sp. nov. (a long-spined, six barred form).

It is possible that *S. speciosum* var. *octum* may have arisen directly from *S. speciosum* sensu stricto, but the change in the length of the spines is abrupt and intermediate transions have not been found.

Approximately half-way through the succession of Cornbrash Clays exposed near Escoville (N. France), at a marked lithological change, possibly the junction between the Lower and Upper Cornbrash, the three previous species are reduced to two, *S. speciosum* sensu stricto becomes extinct and *S. speciosum* var. *octum* occurs with *S. hexum* the latter dominating the species.

Throughout the Callovian *S. bigoti* occurs in abundance, and continues through the Oxfordian, where it becomes extinct. Intensive study of the Kimmeridgian has not yielded any species of *Stephanolithion*. *S. speciosum* var. *octum* occurs through most of the Callovian but becomes sporadic and does not extend into the Oxfordian. *S. hexum* occurs through almost to the top of the Callovian where it becomes extinct. Only the one species *S. bigoti* occurs in the Oxfordian. There is then a large break in the occurrence of species of *Stephanolithion* beginning at the extinction point at the top of the Oxfordian of *S. bigoti* to the occurrence of *S. laffittei* at the base of the Valanginian (on the assumption that *S. laffittei* is a true *Stephanolithion*).

This deep crown-like, circular coccolith with usually eight very short but broad spines occurs unchanged through the Valanginian, Hauterivian, Barremian and still occurs in the Albian. The present study did not include the rest of the range to Maestrichtian given by NOEL.

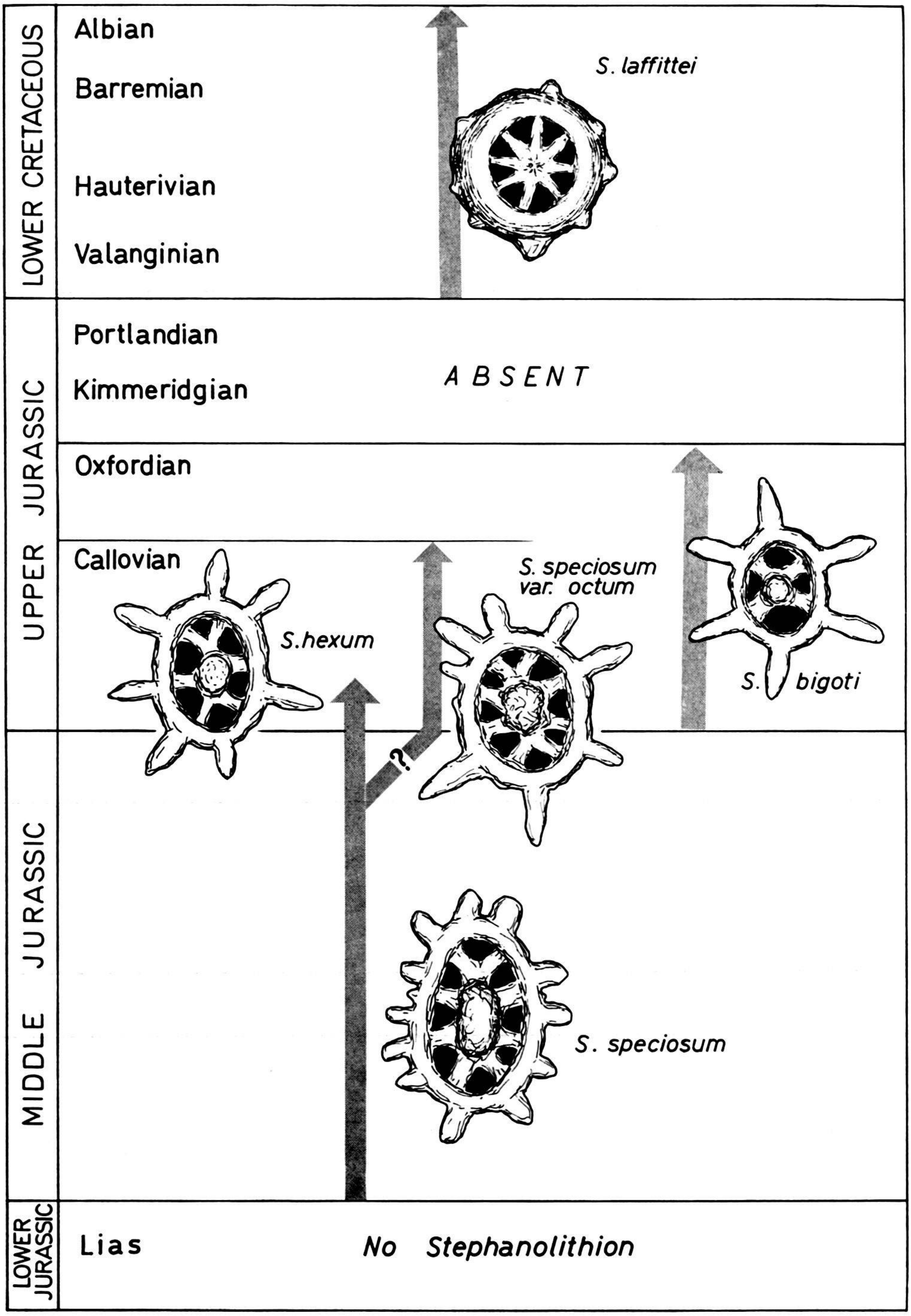


Fig. 1. The evolution of *Stephanolithion* through the Jurassic.

Part B: The genus *Diadozygus* and closely related genera *Diadorhombus*, *Actinozygus* and *Truncatoscaphus*

Introduction

In an earlier paper (ROOD, HAY, BARNARD 1971) intimated that further papers would deal with the stratigraphical ranges and evolution of certain of the Jurassic coccoliths. This paper deals with a group species belonging to the Family Actinozygaceae, coccoliths of minute size which have been largely overlooked by previous authors. Optical work is almost impossible on these diminutive coccoliths, but electron microscope studies have revealed changes in their structure which are of stratigraphical importance. Generally, these coccoliths occur frequently throughout the Jurassic extending into the Cretaceous, and are not rare or new recordings as stated by BLACK (1971). The family Actinozygaceae and sub-families Actinozygoideae and Diadozygoidea were proposed by ROOD, HAY and BARNARD 1971 and several suggestions were made as to the affinities between the various genera. Some of these have been substantiated by definite evidence and the development of the group is clarified.

SYSTEMATIC PALAEONTOLOGY

Family ACTINOZYGACEAE ROOD, HAY, BARNARD 1971

Subfamily Actinozygoideae ROOD, HAY, BARNARD 1971

Genus *Actinozygus* GARTNER 1968

Type: *Tremalithus* regularis GORKA 1957

Actinozygus geometricus

Plate II, Fig. 8

1957 *Discolithus geometricus* GORKA, Pl. 4, Fig. 8, p. 259, 279
1968 *Zygolithus geometricus* (GORKA) STRADNER, ADAMIKER et MARESCH, Pl. 36–37, Fig. 1–4, p.40
1971 *Actinozygus geometricus* (GORKA) ROOD, HAY et BARNARD, Pl. 1, Fig. 6, p. 254
1971 *Zygolithus* of *geometricus* (GORKA) MEDD, Pl. 1, Fig. 6, Pl. 3, Fig. 3–4, p. 825
1971 *Corollithion ellipticum* BUKRY, THIERSTEIN, Pl. 7, Fig. 6, p. 480

Remarks

This species is clearly recognized by its strict symmetry (ROOD, HAY and BARNARD 1971), a factor which separates it from species of *Diadozygus*. MEDD's (1971) cf. *geometricus* occurring commonly in the Oxfordian is similar to the present authors' form. THIERSTEIN (1971) assigns a form from the Aptian to Albian to *Corollithion ellipticum* BUKRY which appears similar to our species.

Hypotype: 59.3.1

Dimensions: length 5.0 μm; width 3.4 μm

Locality: Speeton Cliffs (Yorkshire)

Level: D6 Beds, Speeton Clay

Actinozygus fragilis new species

Pl. II, Fig. 9

Diagnosis

A species with a thin biconvex rim composed of lathe-like plates, a much reduced central disc, with a spine, connected by eight long parallel-sided bars to the rim. Very slight asymmetry occurs.

Description

A biconvex to elliptical rim composed of thin lathe-like plates. Long thin bars connect to the centrally placed disc which is reduced in size.

Remarks

This form is similar in many respects to both the genera *Actinozygus* and *Diadozygus* have the rim of the former and the asymmetry of the latter.

This is a rare form in the Oxford Clay and is clearly intermediate between two genera.

Holotype: 28.2.2

Dimensions: length 3.0 μm; width 2.2 μm

Type level: mariae zone

Type locality: Millbrook (Bedfordshire)

Subfamily *Diadozygoideae* Rood, Hay, Barnard 1971

Genus *Diadozygus* Rood, Hay, Barnard 1971

Type *Diadozygus rotatus* Rood, Hay, Barnard 1971

Diadozygus langi new species

Plate II, Fig. 1

Diagnosis

An elliptical species of *Diadozygus* with six asymmetrically disposed bars.

Description

This extremely small elliptical of *Diadozygus* has a very narrow margin, and only six bars disposed according to the asymmetric mode characteristic for the genus. A vestigial central island is present. The junctions between the radial bars and the rim are flattened. The plates in the rim are narrow lathe-like.

Remarks

The species is named after the late Dr. W. D. Lang for his contributions to Jurassic stratigraphy.

Holotype: 48.8.1

Dimensions: length 1.6 μm; width 1.1 μm

Type locality: Eype Cliff, Dorset

Type level: U. Lias Downcliffe Clay, levesquei zone

Diadozygus asymmetricus ROOD, HAY, BARNARD 1971

Plate I, Fig. 2, 3

1971 *Diadozygus asymmetricus* ROOD, HAY, BARNARD, Pl. 1, Fig. 7, p. 255

Remarks

The *eight* asymmetrically placed bars often have flattened triangular plates where they joined the rim, or sometimes show a tendency towards bifurcation almost at the junction. This does not lead to a doubling of the number of the bars, bifurcation is irregular and occurs only near the rim not extending towards the centre. The central spine is often 10μ long.

Hypotype: 57.6.1

Dimensions: length 4.1 μm; width 2.1 μm

Level: macrocephalites zone

Locality: Escoville (France)

Diadozygus escovillensis new species

Pl. II, Fig. 4

Diagnosis

Elliptical species of *Diadozygus* with eight bars, six arranged asymmetrically in the mode of the genus, but two in the long axis of the ellipse.

Description

Short plates form the thin rim. Eight radial bars occur sometimes bifurcating near the rim, not all do this in each specimen, and the resulting double bars are extremely short. A broad central platform occurs.

Holotype: 55.5.2

Dimensions: length 3.2 μm; width 2.3 μm

Type Level: Lower Callovian (Cornbrash)

Type Locality: Escoville (Normandy)

Remarks

The species seems to be restricted to the Cornbrash.

Diadozygus callomoni ROOD, HAY, BARNARD

See text-fig. 2

1971 *Diadozygus callomoni* ROOD, HAY, BARNARD, Pl. 1, Fig. 8, p. 256

Remarks

An elliptical ten barred species of *Diadozygus* limited to the Oxford Clay.

Diadozygus rotatus Rood, Hay, Barnard
Plate II, Fig. 6

1971 *Diadozygus rotatus* Rood, Hay, Barnard, Pl. 1, Fig. 9, Pl. 11, Fig. 1, p. 256

Remarks

A ten barred species of *Diadozygus* differing from *D. callomoni* by being rhombic not elliptical.

Hypotype: 30.7.2

Dimensions: length 3.4 μm; widht 1.9 μm

Level: lamberti zone

Locality: Millbrook (Bedfordshire)

Diadozygus dorsetense Rood, Hay, Barnard
Plate II, Fig. 5

1971 *Diadozygus dorsetense* Rood, Hay, Barnard, Pl. II, Fig. 2, 3, p. 257
?1971 *Stradnolithus comptus* Black, Pl. 31, Fig. 31, Fig. 10, p. 415

Remarks

A species of *Diadozygus* with fourteen asymmetrically arranged bars. Ranges from Callovian to Valanginian. While the earlier paper (Rood, Hay, Barnard) was in press, Black published on Lower Cretaceous forms, including a fragmented specimen assigned to a new genus *Stradnolithus* and a new species *comptus*. The broken specimen, although not showing the typical asymmetry, may be similar to *Diadozygus dorsetense*.

Hypotype: 36.8.1

Dimensions: length 2.2 μm; width 1.4 μm

Level: mariae zone

Locality: Millbrook (Bedfordshire)

Genus *Diadorhombus* Worsley 1971

Type *Diadorhombus rectus* Worsley 1971

As suggested by Rood, Hay and Barnard (1971, p. 258) a close affinity to *Diadozygus* possibly existed, but intermediate forms were not published. These inter mediate forms have now been found to exist and are described. The name *Diadorhombus* was given by Rood, Hay and Barnard 1971, but Worsley was given priority to use it in his paper, no note of which was made. When describing species of *Diadozygus* and *Diadorhombus* the authors Rood, Hay and Barnard were aware of the possible link between the two genera.

Diadorhombus minutus ROOD, HAY, BARNARD

Pl. II, Fig. 10

1971 *Diadorhombus minutus* ROOD, HAY, BARNARD, Pl. II, Fig. 6, p. 258
1971 *Zygolithus scutulatus* MEDD, Pl. 3, Fig. 1, 2, p. 826

Remarks

The coccolith is equilateral rhombic in shape with distinct asymmetrical arrangement of the bars, not regularly arranged as suggested by MEDD whose figures 1 and 2 (particularly 1) show this irregular asymmetric arrangement.

Hypotype: 26.11.1

Dimensions: width 1.4 μm

Level: mariae zone

Locality: Millbrook (Bedfordshire)

Diadorhombus octocostata new species

Pl. II, Fig. 11

Diagnosis

Equilateral rhombic rim with 8 bars disposed asymmetrically almost similar to the character of *Diadozygus*.

Description

The species has an equilateral rhombic rim composed of small equidimensional plates. Usually the junction between the plates are indented giving a crenulate rim. The eight bars are arranged asymmetrically, not along the diagonals of the rhomb. Four bars radiate from the central platform and bifurcate half way across the coccolith so that eight bars result.

Remarks

A bifurcation of the bars in *Diadorhombus minutus* would result in *Diadorhombus octocostata*, and still maintain the basic asymmetry.

Holotype: 50.1.1

Dimension: length 2.5 μm; width 1.9 μm

Type level: athleta zone

Type locality: Whittlesey (Cambridgeshire)

Diadorhombus horrelli new species

Pl. II, Fig. 12

Diagnosis

Equilateral rhombic rimmed coccolith connecting a central platform with spine to the rim.

Description

An equilateral rhombic rim, with a relatively large central disc with a spine, joined to the rim by ten thick bars asymmetrically placed.

Remarks

The species is named after Mr. J. Horrell, Geologist with the London Brick Company for his help in collecting the material of Callovian and Oxfordian age.

Holotype: 34.3.2

Dimensions: length 2.4 μm; width 1.8 μm

Type level: athleta zone

Type locality: Millbrook (Bedfordshire)

Diadorhombus rhombiscus (STRADNER et ADAMIKER)
Pl. II, Fig. 7

1966 *Zygolithus rhombicus* STRADNER et ADAMIKER, Pl. 2, Fig. 1, p. 338, text-fig. 5–7
1968 *Zygolithus rhombicus* STRADNER, ADAMIKER et MARESCH, Pl. 3, 7, Fig. 5–7; Pl. 38, p. 40

Remarks

Equilateral rhombic rimmed coccolith with eight bars in the central area, arranged with marked asymmetry. A *Diadorhombus* with *Diadozygus* arrangement of the bars in the central area. The hollow spine is again evident (although fractured in nearly all specimens). The rim has a large number of over-lapping prismatic elements typical of *Diadorhombus*. Forms from the Speeton Clay are similar to those from the Albian described by STRADNER et al.

Holotype: 58.11.1

Dimensions: length 3.8 μm; width 2.4 μm

Type level: D6 Speeton Clay

Type locality: Speeton Cliffs, Yorkshire

Genus *Truncatoscaphus* ROOD, HAY, BARNARD 1971

Type *Zygolithus delftensis* STRADNER et ADAMIKER 1966

Truncatoscaphus delftensis (STRADNER et ADAMIKER)
See text-fig. 2

1966 *Zygolithus delftensis* STRADNER et ADAMIKER, Fig. 8–11, Pl. 2, Fig. 3, p. 338
1968 *Zygolithus delftensis* STRADNER et ADAMIKER, STRADNER, ADAMIKER et MARESCH, Pl. 39, p. 41
1971 *Stradnerlithus delftensis* (STRADNER et ADAMIKER) BLACK, Pl. 1, 31, Fig. 11, p. 415
1971 *Truncatoscaphus delftensis* (STRADNER et ADAMIKER) ROOD, HAY, BARNARD, Pl. 11, Fig, 4, 5, p. 257

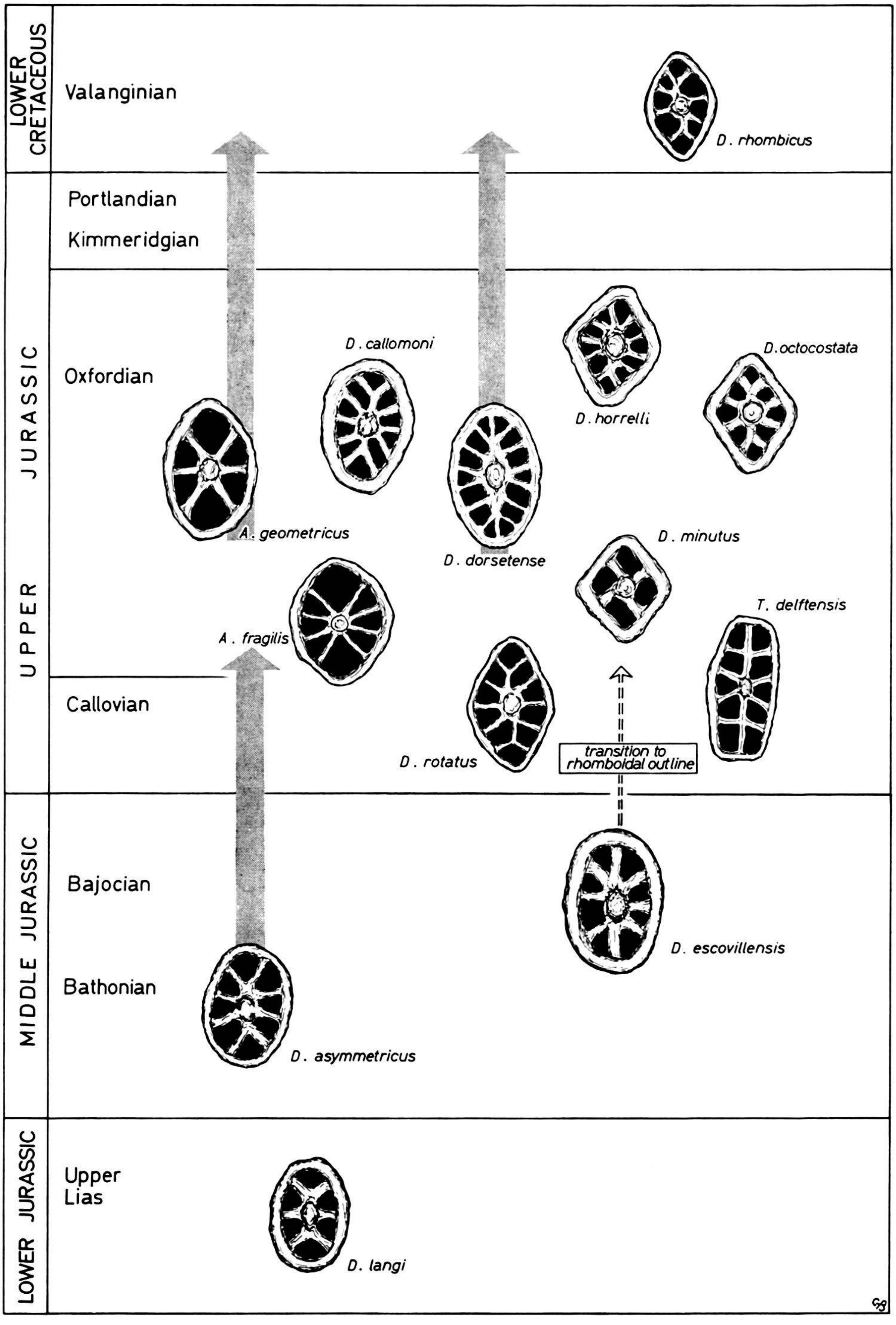


Fig. 2. The development of *Diadozygus*, *Diadorhombus*, *Actinozygus* and *Truncatoscaphus* through the Jurassic.

Remarks

Ranges from Upper Callovian through the Speeton Clay (Lower Cretaceous – a fragment figured by BLACK as Plate 31, Fig. 11 may belong to this species) to the Albian.

This form is almost rectangular, except the long sides of the rectangle are curved, convex outwards.

Development through the Jurassic and Lower Cretaceous

Rim

The elliptical rim varies considerably in the length of the long axis, so that almost circular to elongate ellipses occur. The earliest forms, *Diadozygus langi*, *Diadozygus asymmetricus* have elongate rims. Two modifications could occur: First a tendency for the ellipse to become rhombic with curved sides till finally an equilateral straight sided rhombic shape is formed.

Diadozygus langi ⟶ *D. rotatus* ⟶ *Diadorhombus minutus* and

D. langi ⟶ *Actinozygus geometricus*

Second, a quadrate rim could occur developed from an ellipse.

Diadozygus asymmetricus ⟶ *Truncatoscaphus delftensis*

Number of central-bars

The earlier forms, *Diadozygus langi*, *D. asymmetricus* and *D. escovillensis*, have six developing to eight in its latter two species. This change is also seen in *Actinozygus geometricus* (6) to *A. fragilis* (8); also in *Diadorhombus minutus* (4) to *D. Rhombicus* (8) and *D. octocostata* (8).

With all the species groups there is a progressive increase from fewer bars in the earlier occurrences to up to double at later stratigraphical horizons. The size of the coccolith does not show an increase to accommodate its central bars.

Symmetry of central bars

Although some of the earliest forms *Diadozygus langi* show an almost symmetrical arrangement of the central bars, there is no progressive change to asymmetry. The most important factor is the general asymmetric arrangement of the central bars in most species.

"Evolution"

The elliptical 6-barred *Diadozygus langi*, almost symmetrical species from the Upper Lias is the earliest recorded by the authors, being followed by two elliptical 8-barred species, *Diadozygus asymmetricus* and *D. escovillensis*, both with an asymmetrical arrangement of the bars.

D. escovillensis, however, shows a basic bilateral symmetry, so that two bars extend along the long axis of the ellipse, the remainder are slightly asymmetric.

No direct derivation of either of the forms which have their origin in the Middle-Jurassic is seen from its Upper Lias *D. langi*. Tendency for the bars to bifurcate near the rim occurs sporadically in time and irregularly in each specimen.

It seems likely that *D. escovillensis* was an offshoot from the main group of coccoliths and that *D. asymmetricus*, which becomes abundant in Upper Callovian times, gave rise to many of the diverse species which occur in the Callovian and Oxfordian where this species group appears to reach its acme.

In the Upper Callovian and Oxfordian numerous species occur. The 8-barred *Diadozygus asymmetricus* occurs together with 10-barred *D. callomoni*, *D. rotatus*, and *A. fragilis*. 14-barred species are represented by *D. dorsetense*. All these forms have elliptical to almost curved rhombic rims and asymmetric arrangements of its bars.

Truncatoscaphus delftensis, a 10-barred quadrate form, could easily have been derived from a 10-barred *Diadozygus* or may be a direct descendent of *Diadozygus escovillensis*, for both have the twin symmetry (the long axis bar giving bilateral symmetry and the remaining asymmetry of the genera).

It is more difficult to establish that *Diadorhombus*, with its early Upper Callovian 4-barred species *D. minutus*, was derived from *Diadozygus*, although its basic symmetry is present. The Kimmeridgian has very poor floras of this type, but (8, 10, and 14-barred) species are long-ranged and extend into the Lower Cretaceous, even up to the Albian.

Conclusions

Both the genera *Stephanolithion* and *Diadozygus* are important stratigraphically, showing distinct evolutionary changes throughout the Jurassic, the number of the central bars changing in a "programmed" manner.

Acknowledgments

The authors appreciate the help given by Mr. Horrell, Geologist to London Brick Company for arranging access to the various quarries and helping with the collecting of material. Thanks are due to Miss V. Russell for help in collecting the Bathonian material from Calvados; also Dr. M. K. Curtis, Bristol Museum, for supplying material from Dyrham. Financial support by the Esso Petroleum Company, during the collecting of material in N. France, is gratefully acknowledged.

REFERENCES

ARKELL, W. J. (1947): *The Geology of the Country around Weymouth, Swanage, Corfe and Lulworth.* Mem. Geol. Surv. Great Britain, p. 1-386 (1947).

BLACK, M. (1968): *Taxonomic Problems in the Study of Coccoliths.* Palaentology *11*, 793-813.

– (1971): *Coccoliths of the Speeton Clay and Sutterby Marl.* Proc. Yorks. Geol. Soc. *28*, 381-424.

BRAMLETTE, M. N., and MARTINI, E. (1964): *The Great Change in Caleareous Nannoplankton Fossils Between the Maestrichtian and Danian.* Micropaleaontology *10*, 291-322.

CALLOMON, J. H. (1962): *Notes on the Callovian and Oxfordian Stages.* Colloque du Jurassique, Luxembourg 1962.

DEFLANDRE, G. (1939): *Les stephanlithes, représentants d'un type nouveau de coccolithes du Jurassique supérieur.* C. r. Acad. Sci. Paris *208*, 1331-1333.

DEFLANDRE, G., and FERT, C. (1954): *Observations sur les Coccolithophorides actuels et fossiles en microscopie ordinaire et électronique.* Ann. Paleont. *40*, 115-176.

LAMPLUGH, G. W. (1889): *On the Subdivisions of the Speeton Clay.* Quart. J. Soc. Lond. *45*, 575-618.

MEDD, A. W. (1971): *Some Middle and Upper Jurassic Coccolithophoridae from England and France.* II[nd] Planktonic Conference, Rome, p. 821-845.

Noel, D. (1965a): *Note préliminaire sur des coccolithes jurassiques*. Centre National de la Recherche Scientifique, Cahiers de Micropaléontol. [I] *1*, 1-12.

– (1965b): *Sur les coccolithes du Jurassique Européen et d'Afrique du Nord, Essai de classification des coccolithes fossiles*. P. 1-209.

Rood, A. P., Hay, W. W., and Barnard, T. (1971): *Electron Microscope Studies of Oxford Clay Coccoliths*. Eclogae geol. Helv. *64*/2, 245-272.

Stradner, H. (1963): *New Contributions to Mesozoic Stratigraphy by Means of Nannofossils*. Proc. Sixth World Petrol. Congr., Sec. 1, p. 167-83.

Stradner, H., and Adamiker, D. (1966): *Nannofossilien aus Bohrkernen und ihre elektronenmikroskopische Bearbeitung*. Erdöl-Erdgas-Zeitschrift *8*, 330-341.

Thierstein, H. R. (1971): *Tentative Lower Cretaceous Calcareous Nannoplankton Zonation*. Eclogae geol Helv. *64*/3, 459-488.

Torrens, H. S. (1969): Editor of the International Field Symposium on the British Jurassic.

Worsley, T. R. (1971): *Calcareous Nannofossil Zonation of Upper Jurassic and Lower Cretaceous Sediments from the Western Atlantic*. II[nd] Planktonic Conference, Rome.

Plate I

Figures 1-6 are electron-micrographs of platinum-shadowed carbon replicas, and figures 7-12 are photo-micrographs taken with phase-contrast.

Fig. 1 *Stephanolithion speciosum* Deflandre, distal side Hypotype 56.1.1
Port-en-Bessin (Normandy); circumdata zone 7500 ×

Fig. 2 *Stephanolithion speciosum* Deflandre var. *octum*, n. var., distal side
Holotype 57.4.2
Escoville (Normandy); macrocephalites zone, 5300 ×

Fig. 3 *Stephanolithion hexum* n. sp., distal side
Holotype 55.8.1
Escoville (Normandy); macrocephalites zone, 5000 ×

Fig. 4 *Stephanolithion hexum* n. sp., distal side
Holotype 56.11.2
Escoville (Normandy); macrocephalites zone, 4900 ×

Fig. 5 *Stephanolithion bigoti* Deflandre, distal side
Hypotype 28.12.1
Millbrook (Bedfordshire); mariae zone (4941), 6100 ×

Fig. 6 *Stephanolithion laffittei* Noel, proximal side
Hypotype 58.11.2
Speeton (Yorkshire); D2 Beds, 6200 ×

Fig. 7 *Stephanolithion speciosum* Deflandre, 1700 ×

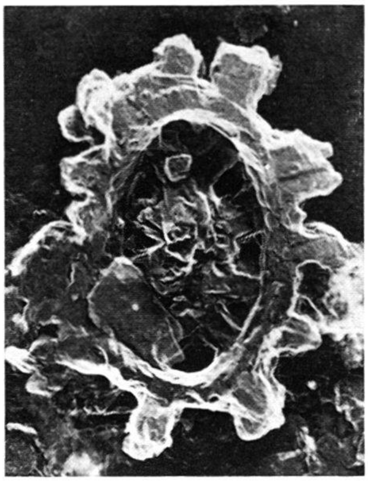
Fig. 8 *Stephanolithion speciosum* Deflandre var. *octum*, n. var., 1800 ×

Fig. 9 *Stephanolithion hexum* n. sp., 1400 ×

Fig. 10 *Stephanolithion hexum* n. sp., 1150 ×

Fig. 11 *Stephanolithion bigoti* Deflandre, 1600 ×

Fig. 12 *Stephanolithion laffittei* Noel, 1500 ×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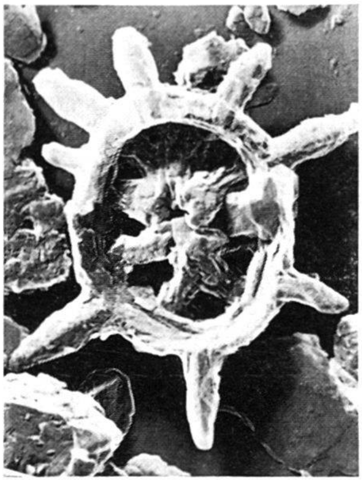
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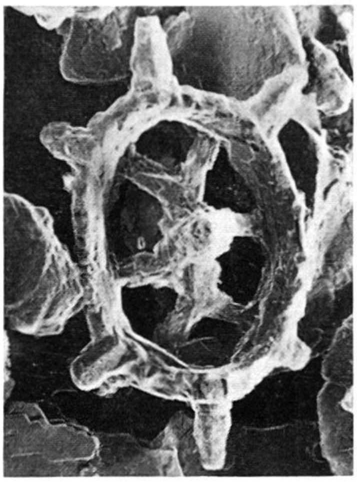
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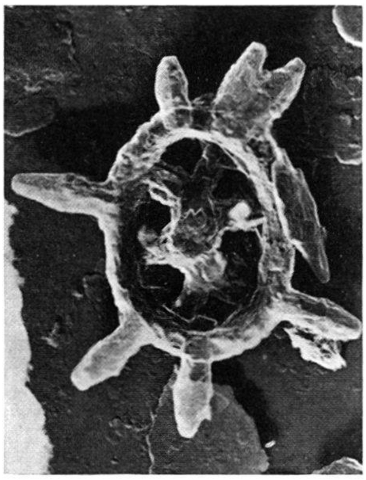
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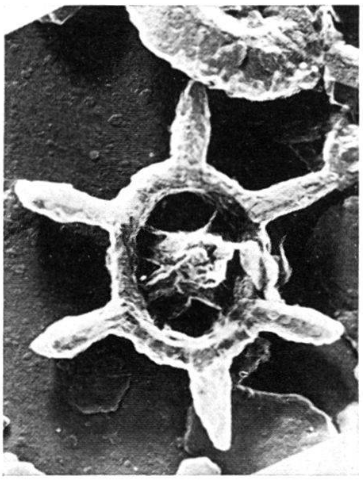
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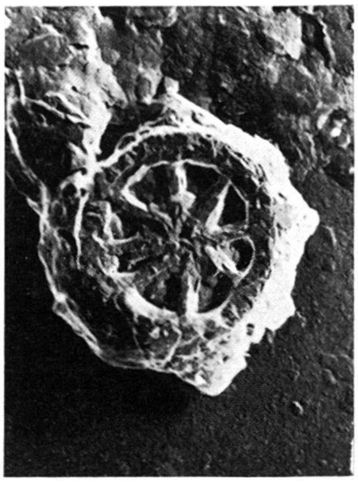
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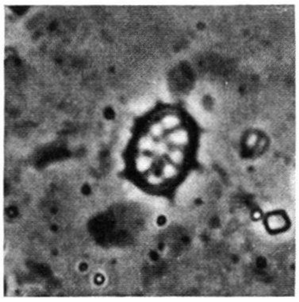
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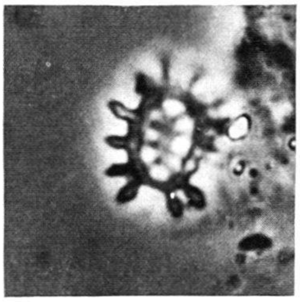
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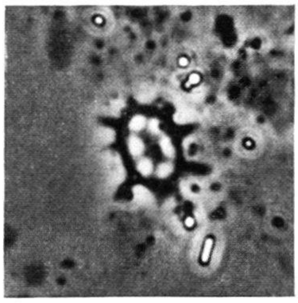
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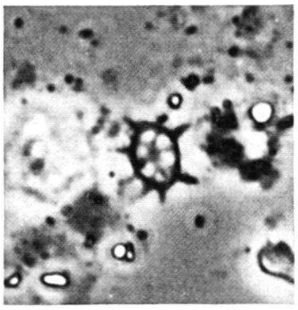
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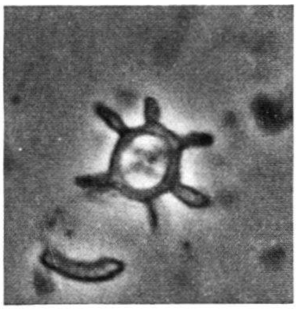
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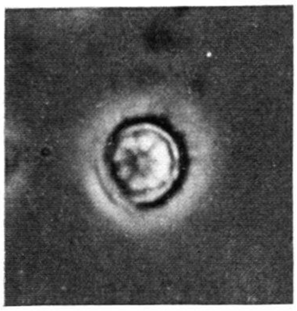
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Plate II

Figures 1–12 are electron-micrographs of platinum shadowed carbon replicas.

Fig. 1 *Diadozygus langi* n. sp., distal side
Holotype 44.8.1
Eype Cliff (Dorsetshire; levesquei zone, 23500 ×

Fig. 2 *Diadozygus asymmetricus* ROOD, HAY et BARNARD, distal side
Hypotype 57.6.1
Escoville (Normandy); macrocephalites zone, 9500 ×

Fig. 3 *Diadozygus asymmetricus* ROOD, HAY et BARNARD, proximal side
Hypotype 33.7.1
Millbrook (Bedfordshire); cordatum zone – bukowskii subzone (4945), 13000 ×

Fig. 4 *Diadozygus escovillensis* n. sp., distal side
Holotype 55.5.2
Escoville (Normandy); macrocephalites zone, 13000 ×

Fig. 5 *Diadozygus dorsetense* ROOD, HAY et BARNARD, distal side
Hypotype 36.8.1
Millbrook (Bedfordshire); mariae zone (4925), 18500 ×

Fig. 6 *Diadozygus rotatus* ROOD, HAY et BARNARD, distal side
Hypotype 30.7.2
Millbrook (Bedfordshire); lamberti zone (4771), 13000 ×

Fig. 7 *Diadorhombus speetonensis* n. sp., distal side
Holotype 58.11.1
Speeton Cliffs (Yorkshire); D6 Bed, Speeton Clay, 10600 ×

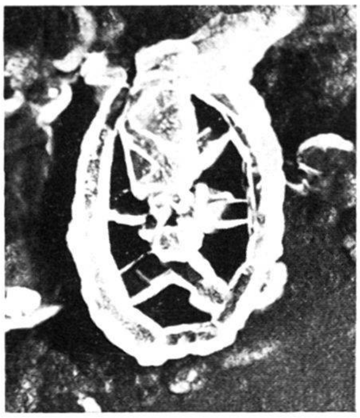
Fig. 8 *Actinozygus geometricus* (GORKA), distal side
Hypotype 59.3.1
Speeton Cliffs (Yorkshire); D6 bed, Speeton Clay, 9000 ×

Fig. 9 *Actinozygus fragilis* n. sp., distal side
Holotype 28.2.2
Millbrook (Bedfordshire); mariae zone (4932), 13400 ×

Fig. 10 *Diadorhombus minutus* ROOD, HAY et BARNARD, distal side
Hypotype 26.11.1
Millbrook (Bedfordshire); mariae zone (4932), 14500 ×

Fig. 11 *Diadorhombus octocostata* n. sp., distal side
Holotype 50.1.1
Whittlesey (Cambridgeshire); athleta zone, 15800 ×

Fig. 12 *Diadorhombus horrelli* n. sp., distal side
Holotype 34.3.2
Millbrook (Bedfordshire) athleta zone, 16500 ×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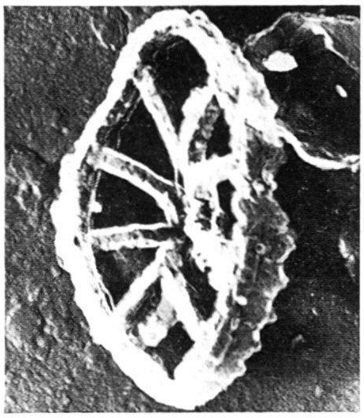
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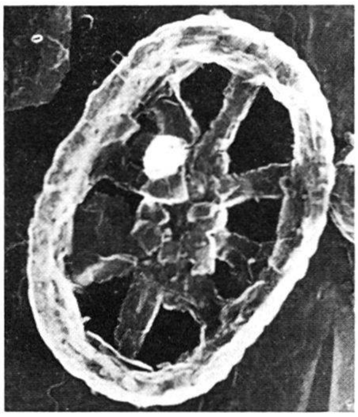
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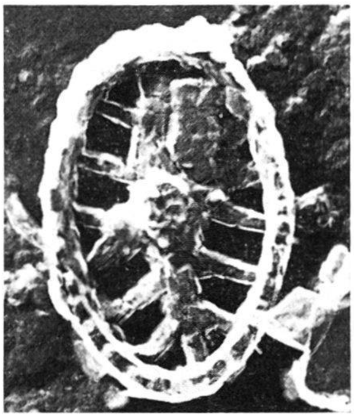
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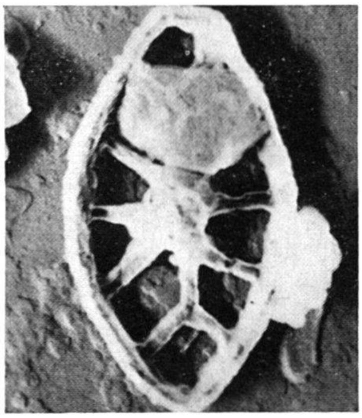
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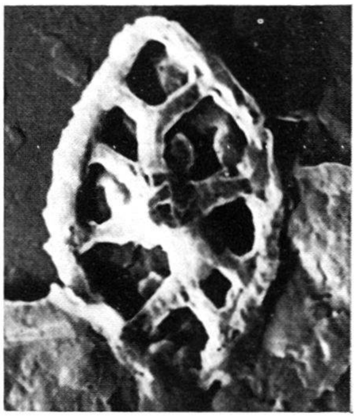
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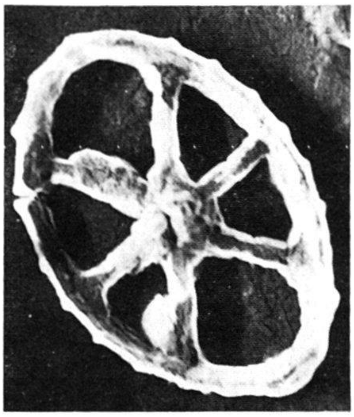
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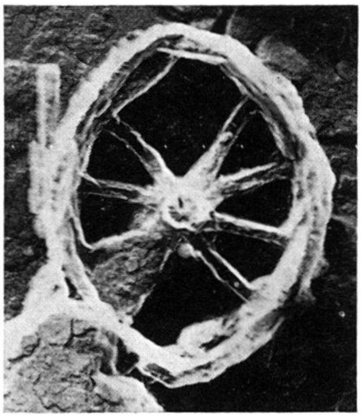
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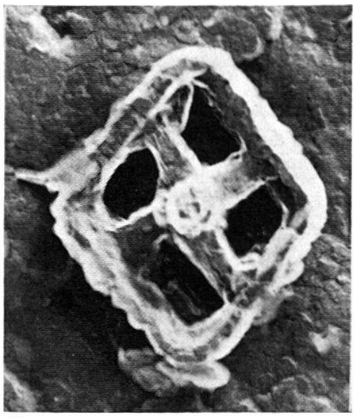
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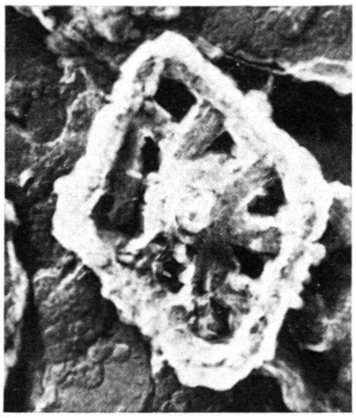
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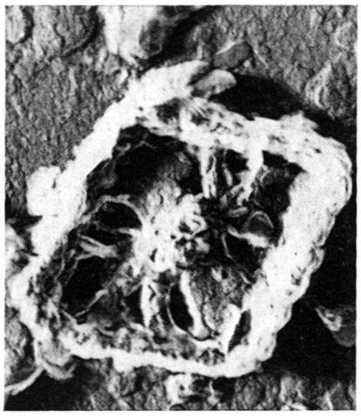
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