THREE NEW SPECIES OF HETEROHELIX EHRENBERG FROM THE UPPER SENONIAN OF DENMARK

By

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Abstract

The genus *Heterohelix* EHRENBERG, 1843 is widely distributed in the Danish Cretaceous deposits. From the Danish *Heterohelix*-material (STENESTAD, in press) three new species are described. *Heterohelix pachymarginata,* which is characterized by a strongly thickened initial margin, is present in the Upper Campanian and the Lowermost Maestrichtian. *H. dentata,* characterized by its dentate-looking adult periphery, ranges from the upper part of the Lower Maestrichtian to the lower boundary of the Danian. *H. robusta,* a large and robust form with coarse longitudinal costae, is known from the Upper Campanian and the lowermost Maestrichtian. Besides the descriptions of species, a genus diagnosis and a genus description are given, which give some new observations of morphologic details and a re-evaluation of some features of the test.

INTRODUCTION

The genus *Heterohelix* EHRENBERG is widely distributed in the Danish Cretaceous deposits. Since it is considered to be a planctonic genus, it may possibly make an interesting contribution to the biostratigraphical zonation of the Cretaceous sequence. Several Danish specimens of *Heterohelix* differ more or less from the already known species. In this paper will be described three morphologic types with rather imited stratigraphic distributions.

MONTANARO GALLITELLI (1957) discusses the synonymic status of *Gümbelina* and *Heterohelix* and finds no valid morphologic distinction between them. In consequence of this, she suppresses *Gümbelina* as a junior synonym. LOEBLICH and TAPPAN (1961) state that *Gümbelina* EGGER, 1902 (1899) is a homonym of *Gümbelina* KUNTZ, 1895, and they assume that the publication of the latter genus has been overlooked by later workers. This means that *Gümbelina* KUNTZ, 1895 should be considered as nomen oblituum, having been unused in the principal zoological literature for more than fifty years. (Int. Code. Zool. Nom. 1961 Art. 23 (b)). So, if the international commission rejects the name *Gümbelina* KUNTZ, 1895, Gümbelina EGGER 1902 (1899) is valid. *Gümbelina* EGGER, 1902 (1899) and *Heterohelix* EHRENBERG, 1843 have both been used within the last fifty years, so, none of them are forgotten names. If MONTANARO GALLITELLI (1957) and HOFKER (1957) are right in stating the two genera to be synonymous, *Heterohelix* must be the legal name.

SYSTEMATIC DESCRIPTION

Family *Heterohelicidae* CUSHMAN, 1927
Subfamily *Heterohelicinae* CUSHMAN, 1927
Genus *Heterohelix* EHRENBERG, 1943

Heterohelix EHRENBERG, Abhandl. d. königl. Akad. d. Wiss., Berlin, 1843 p. 429.
Gümbelina EGGER, Abhandl. d. II Classe d. königl. Akad. d. Wiss., XXI. Bd. I. Abth. (1899), p. 31 ff., MÜNCHEN 1902.
Heterohelix EHRENBERG, 1841. MONTANARO GALLITELLI, 1957, p. 137 ff.
Heterohelix EHRENBERG, 1843. LOEBLICH & TAPPAN, 1964. Treatise on Invertebrate Paleontology, Pt. C, Vol. 2.

Diagnosis: Test calcareous, biserial or planispiral in the early stage, always biserial in the adult stage. Chambers generally inflated, globular to reniform. Walls bilamellar, radial, hyaline, perforate. Surface smooth to striate. Aperture interiomarginal, relatively large, symmetrical with simple margin (Based on diagnosis by MONTANARO GALLITELLI 1957, p. 137).

Description: Test calcareous. Walls bilamellar, radial, hyaline. Pores small, randomly distributed or arranged in longitudinal rows. Proloculum globular, placed apically or surrounded by 4–6 chambers forming an initial coil. Size of proloculum about 7–20 microns in external diameter. Presence of an initial coil does not seem to be confined to small-size proloculi, and a distinction between microsphaeric and megalosphaeric forms has not been possible so far. Later chambers biserially arranged, globular, subcylindrical, more or less compressed, broader than high or reniform, with transitional forms within one and the same specimen and within one and the same species. The younger chambers always more or less inflated. Number of chambers varying, 10–15 chambers common. Size of chambers generally increasing with growth of test, except for the first chamber after the proloculum, which is often smaller than this. In some specimens growth is very regular, in others size and shape of chambers are varying irregularly. When a certain size of chamber is reached, many specimens produce new chambers of nearly the same – or even smaller – size. This so called "pupa"-variety is present in smooth as well as in striate forms and in specimens with globular and subglobular as well as nonglobular chambers. It is not known why the size of chamber in some specimens after a certain point does not continue to increase as new chambers are added. The reason might be a change in ecological conditions, but since the phenomenon is apparently rather common, it might equally well be a result of some internal biological change, such as fertilization.

The shape of the test is determined by the size and shape of the chambers and the degree of their overlapping. Besides the already mentioned "normal" variations some other irregularities in the growth may be seen. Some chambers are too big or too small. Some tests have a slender initial part followed by big and coarse younger chambers. In a few specimens the longitudinal axis changes its direction because an aperture has developed at the outer margin instead of as normally at the inner margin. The shell surface is smooth, rough or striate, i.e. ornamented with fine longitudinal

costae. In all cases in which it has been checked, the striation proved to be due to coneshaped extensions of the calcite prisms forming the wall (Pl. 2 fig. 4, Pl. 3 fig 1). The character of the shell surface by itself is hardly suitable as a criterion for distinguishing between the species, since striation may be present in "smooth" species and "striate" species may be only slightly striate or partly smooth. Many authors have noted an intraspecific variation of this feature within *H. striata* which makes a delimitation from *H. globulosa* rather difficult since these two species can be diagnostically separated only by the presence or absence of striation (e.g. BERGGREN, 1962, p. 22).

The sutures are normally depressed but can be flush or limbate, especially in the initial part of the test.

The margin is in the initial part of the test entire or indented. A carina may be present. In one of the species here described (*H. pachymarginata* n.sp., Pl. 2 fig. 4, 6), the initial part of the test has a marginally thickened wall, which may possibly be regarded as a very broad, untypical carina. The margin in the adult part of the test is always more or less indented.

The aperture is symmetric, arched, situated of the base of the inner margin of the latest chamber, usually having approximately the same shape as the apertural face.

A very few specimens have apertures both at the inner and the outer margin, but apparently they do not differ in any other character and are here considered to belong to the genus, *Heterohelix.*

The edge of the aperture is without distinct lip but is usually a little thickened. This thickened edge shows in cross section a tiny central cavity. The calcite prisms of the wall around this cavity seems to be radially arranged. Some sections (Pl. 2 fig. 1 b) suggest the thickened edge to be constructed in the shape of a fold.

In some species lateral flanges at the aperture connect the two latest chambers. New chambers fit the outer rim of these flanges, which are often described as depressed triangular areas between the older chambers. This feature seems to be present in most species with a compressed test, e.g. in *H. pachymarginata* and *H. dentata,* but not in *H. robusta.*

The septal foramina have the same shape, relative size and position as the apertures.

Heterohelix pachymarginata n.sp.

Plate 1 fig. 1, 2; Plate 2 fig. 4, 5, 6.

Material: About 100 specimens from Upper Campanian and lowermost Maestrichtian in the Danish Embayment.

Derivation of name: Describing the broad, thickened initial margin.

Diagnosis: Test compressed, rather slender, with subglobular thin-walled chambers. Sutures straight, slightly depressed, in the early stage limbate. The raised sutures turn at the margin of the test in apical direction thus forming an entire, strongly thickened initial margin. Margin indented in the adult. Surface striate, at the initial part of the test strongly striate.

Remarks: As shown in plate 2 fig. 4, the thickened margin is not a real carina, but a rather broad girdle around the early part of the test. The proloculum wall is not thickened (Plate 2, fig. 6). Specimens with a true initial coil consisting of at least five chambers are not very abundant. But many specimens have their first chamber after the proloculum placed apically, thus forming a sort of coil with four chambers (Plate 2 fig. 1 b). It would actually not be unreasonable to regard such a chamberarrangement as a coil, since the septal foramina are not alternating but all turn to the same side.

The new species differ from *H. planata* (CUSHMAN) in the surface ornamentation, the more compressed form and the special initialmargin. In Campanian in the borehole Batum 16 A (Salling, Jutland) som specimens are morphologically rather close to *H. striata* (EHRENBERG) from which they mainly differ in possessing an entire, thickened initial margin. The strongly carinated *H. carinata* (CUSHMAN) seems according to CUSHMAN (1938, p. 18, pl. 3 fig. 10 a, 10 b) to have a real carina and to be stronger compressed than the Danish species.

Size of holotype: Length: 0.307 mm; breadth: 0.195 mm; thickness: 0.102 mm; 13 chambers.

Distribution: Upper Campanian and lowermost Maestrichtian at Hvide Klint (Møn). Upper Campanian in the borehole Batum 16 A (Salling, Northern Jutland). (White Chalk facies). Lowermost Maestrichtian at Lille Bissinge (Møn).

Stratigraphic Range: Upper Campanian to lowermost Maestrichtian.

Heterohelix dentata n. sp.

Pl. 1, fig. 3, 4, 5, 6, 8, 9, 11, Pl. 2 fig. 1, 2, 3.

Material: About 200 specimens from Upper and Lower Maestrichtian in the Danish Embayment.

Derivation of name: Describing adult periphery.

Diagnosis: Test broad, compressed, with low, compressed chambers. Adult chambers nearly reniform with a tooth-like marginal part which gives the margin a dentate look. Sutures slightly depressed, flush or slightly limbate. Wall thin, smooth or very slightly striate, finely perforate. Initial part of test often with a tiny coil; periphery entire, normally slightly keeled or moderately indented.

Remarks: The slightly reniform adult chambers give the test a resemblance to *H. pulchra* (BROTZEN), from which it differs in the less compressed test and the low initial chambers with the somewhat roughened surface and the slightly depressed to flush or even slightly limbate sutures. The cross section of the adult chambers is not circular as in H. pulchra, and the shape changes from the aperture to the periphery. This special shape of the peripheral part of the adult chambers and the dentate margin are never seen in *H. pulchra.*

H. dentata differs from *H. glabrans* (CUSHMAN), which is also present in Danish deposits, in the shape of the adult chambers and in the cross section of the adult margin which is broadly rounded and never subacute as by *H. glabrans.*

H. dentata is morphologically related to *H. planata* (CUSHMAN) which in the Upper Campanian and the lowermost Maestrichtian produces some specimens with adult chambers not very unlike those of *H. dentata* (see Plate 1 fig. 10). An examination of hypotypes from KEMP CLAY, Texas, has shown that typical specimens of *H. glabrans* (CUSHMAN) are present in the Danish Upper Maestrichtian. The specimen figured in plate 1 fig. 7 is morphologically very close to *H. dentata,* but has an atypical last chamber resembling those of *H. glabrans. H. dentata* is, so to speak, a morphologic transitional form between *H. planata* and *H. glabrans.*

Size of holotype: Length: 0.323 mm; breadth: 0.243 mm; thickness: 0.115 mm. 14 chambers.

Distribution: Upper Maestrichtian in "Dania" by Mariager, Fristrup (North Jutland), Højerup (Stevns), Storebælt (borehole G.I. no. 21); Lower Maestrichtian in the Batum area (borehole 16A and outcrop "Skandia") and in the Ålborg area (at most localities, such as "Norden", "Danmark", "Rørdal" etc.) (White Chalk facies).

Stratigraphic range: Upper part of Lower Maestrichtian to the lower Danian boundary.

Heterohelix robusta n.sp.

Plate 1, fig. 12, 13, 14; Plate 3 fig. 1, 2, 3.

Material: About 100 specimens from Campanian and Lower Maestrichtian in the Danish Embayment.

Derivation of name: Describing the robust habitus.

Diagnosis: Test large and coarse with strongly globular chambers increasing rapidly in size. Sutures flush or slightly depressed in the early stage, later stronger depressed. Walls very thick. Surface ornamented by coarse longitudinal costae.

Remarks: The marginal angle may be from 50° up to approximately 80° (in most other species it is about 45°–60°). Specimens with an initial coil have not been observed, neither have specimens forming a morphologic transition to other Danish species. The new species has been compared with *H. ultimatumida* (WHITE), 1929, p. 39 and pl. 4, fig. 13a-b, and CUSHMAN 1938, p. 13 ff. and pl. 2 fig. 17, 18. CUSHMAN supposes the holotype of WHITE to be a juvenile specimen and figures a young hypotype and an adult parahypotype. Some specimens of the Danish species, *H. robusta* look like the CUSHMAN parahypotype (op. cit. pl. 2 fig. 18) but are strongly costate also in the younger chambers.

The new species has also been compared with *H. punctulata* (CUSHMAN)

from which it differs in being clearly striate all over and in having no initial keel.

This species seems to be closely related to no other Danish species. Concerning shape of chambers and type of ornamentation one could describe it as a very large and coarse *H. striata* (in fact CUSHMAN, 1938 mentions *H. striata* of this size), but the lack of any transitional forms in the Danish material speaks against a real relationship.

Size of holotype: Length: 0.474 mm; breadth: 0.317 mm; thickness: 0.205 mm. 13 chambers.

Distribution: Lowermost Maestrichtian and Upper Campanian in Hvide Klint (Møn) and in the borehole Batum 16A. The species has also been observed in some deep borings around the boundary Upper Campanian – Lower Maestrichtian (White Chalk facies).

Stratigraphic range: Until now *H. robusta* is known only from the Upper Campanian and the lowermost Maestrichtian in the Danish Embayment.

DANSK SAMMENDRAG

Foraminiferslægten *Heterohelix* EHRENBERG, 1843 er vidt udbredt og meget talstærkt repræsenteret i danske aflejringer fra øvre kridt.

Slægten anses for at være pelagisk. Den store horisontale udbredelse, som pelagiske arter kan forventes at have, rummer en mulighed for at foretage biostratigrafiske korrelationer over store afstande.

I det danske *Heterohelix*-materiale (STENESTAD, 1968) forekommer tre ikke tidligere beskrevne morfologiske typer, som er let genkendelige og som har en for slægten forholdsvis begrænset stratigrafisk udbredelse. Disse tre typer præsenteres her som nye arter. *H. pachymarginata* kendes foreløbig fra Øvre Campanien og aller nederste Maastrichtien. *H. dentata* forekommer i den øvre del af Nedre Maastrichtien og i Øvre Maastrichtien, og *H. robusta* kendes fra Øvre Campanien og det aller nederste Maastrichtien. De tre arter er indtil nu kun observeret i skrivekridt-facies og i danske aflejringer. Foruden artsbeskrivelserne anføres en a'jour ført slægtsdiagnose og en slægtsbeskrivelse, som indeholder nogle nye iagttagelser af morfologiske detaljer og en omvurdering af nogle skal-karakterer, der hidtil har været betragtet som artskendemærker.

REFERENCES

BERGGREEN, W. A., 1962. Some Planktonic Foraminifera from the Maestrichtian and Type Danian Stages of Denmark and Southern Sweden. – *Stockholm Contr. Geol.*, vol. 9 no. 1.

BROTZEN, F., 1936. Foraminiferen aus dem schwedischen, untersten Senon von Eriksdal in Schonen. – *Sveriges Geol. Unders.*, Årsbok 30 (1936) No. 3, Ser C. No. 396.

CUSHMAN, J. A., 1938. Cretaceous Species of Gümbelina and Related Genera. – *Contr. Cush. Lab. Foram. Res.* Vol. 14 pt. 1.

EGGER, J. G., 1902 (1899). Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen. – *Abhandl. d. II. Classe d. Königl. Akad. d. Wiss.* XXI Bd. 1 Abth. (1899).

EHRENBERG, 1843 (1841). Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. – *Abhandl. d. königl. Akad. d. Wiss. z. Berlin.* I. Theil. 1841.

HOFKER, J., 1957. Foraminiferen der Oberkreide von Nordwestdeutschland und Holland. – *Beiheft Geol. Jb.* Heft 27, Hannover.

INTERNATIONAL TRUST FOR ZOOLOGICAL NOMENCLATURE. International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology, London, 1961.

LOEBLICH, A. R., jr. and TAPPAN, H., 1961. The Genera Microaulopora KUNTZ, and Guembelina KUNTZ, 1895, and the Status of Guembelina EGGER, 1899. – *Jour. Paleonology* Vol. 35 no. 3. p. 625 ff.

LOEBLICH, A. R., jr., and TAPPAN, H., 1964; Foraminiferida. – *Treatise on invertebrate paleontology. Part C Protista 2; The Geological Society of America/ The University of Kansas Press.*

MONTANARO GALLITELLI, E.; 1957. A Revision of the Foraminiferal Family Heterohelicidae – In: *Studies in Foraminifera – U. S. Nat. Mus. Bull.* 215. Washington.

STENESTAD, E., 1968 (in press). The Genus Heterohelix EHRENBERG, 1843 (Foraminifera) from the Senonian of Denmark. – *Arch. des Sci. de Genève.* (Printing should be completed by January 31, 1968).

WHITE, M. P., 1929. Some Index Foraminifera of the Tampico Embayment Area of Mexico. – (Part 3). – *Jour. Paleontology* Vol. 3, No. 1. 1929.

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Plate 1.

Figs. 1, 2. *Heterohelix pachymarginata* n.sp. Lowermost Maestrichtian, Hvide Klint (Møn). Sample 23612. 1a-c Holotype. (D. G. U. type catalogue No. 1968-EST-1). 2. Paraype. (D. G. U. type catalogue No. 1968-EST-2).

Figs. 3, 4, 5, 6, 8, 9, 11. *Heterohelix dentata* n.sp. 3a-c. Uppermost Maestrichtian (*Pseudotextularia elegans* faunizone). "Dania" (Mariager) Sample 5938. Holotype. (D. G. U. type catalogue No. 1968-EST-3). 8. Same sample. Paratype. (D. G. U. catalogue No. 1968-EST-4). 4, 5. Lower Maestrichtian. Borehole Batum 16A (Salling). Sample K 4d (26 m below ground). Paratype. (D. G. U. type catalogue No. 1968-EST-5). 6. Lower Maestrichtian. Same locality. Sample K 14 (47 m below ground). Paratype. (D. G. U. type catalogue No. 1968-EST-6). 9. Lower Maestrichtian. Same locality. Sample K. 21b (60 m below ground). Paratype. (D. G. U. type catalogue No. 1968-EST-7). 11. Lower Maestrichtian. Borehole Rørdal nr. 1. Sample K 86b (126 m below ground). (D. G. U. type catalogue No. 1968-EST-12).

Fig. 7. *Heterohelix cf. dentata.* Lower Maestrichtian. Batum 16A. Sample K 3 (22 m below ground). (D. G. U. type catalogue No. 1968-EST-8). Showing atypical last chamber resembling those of *H. glabrans* (CUSHMAN).

Fig. 10. *Heterohelix planata* (CUSHMAN). Upper Campanian. Borehole Batum 16A. Sample K. 60 (140 m below ground).

Figs. 12, 13, 14. *Heterohelix robusta* n.sp. Lowermost Maestrichtian. Hvide Klint (Møn). Sample 23612. 12a-c. Holotype. (D. G. U. type catalogue No. 1968-EST-9). 13, 14. Paratypes (D. G. U. type catalogue Nos. 1968-EST-10, 1968-EST-11). All figures 75 ×.

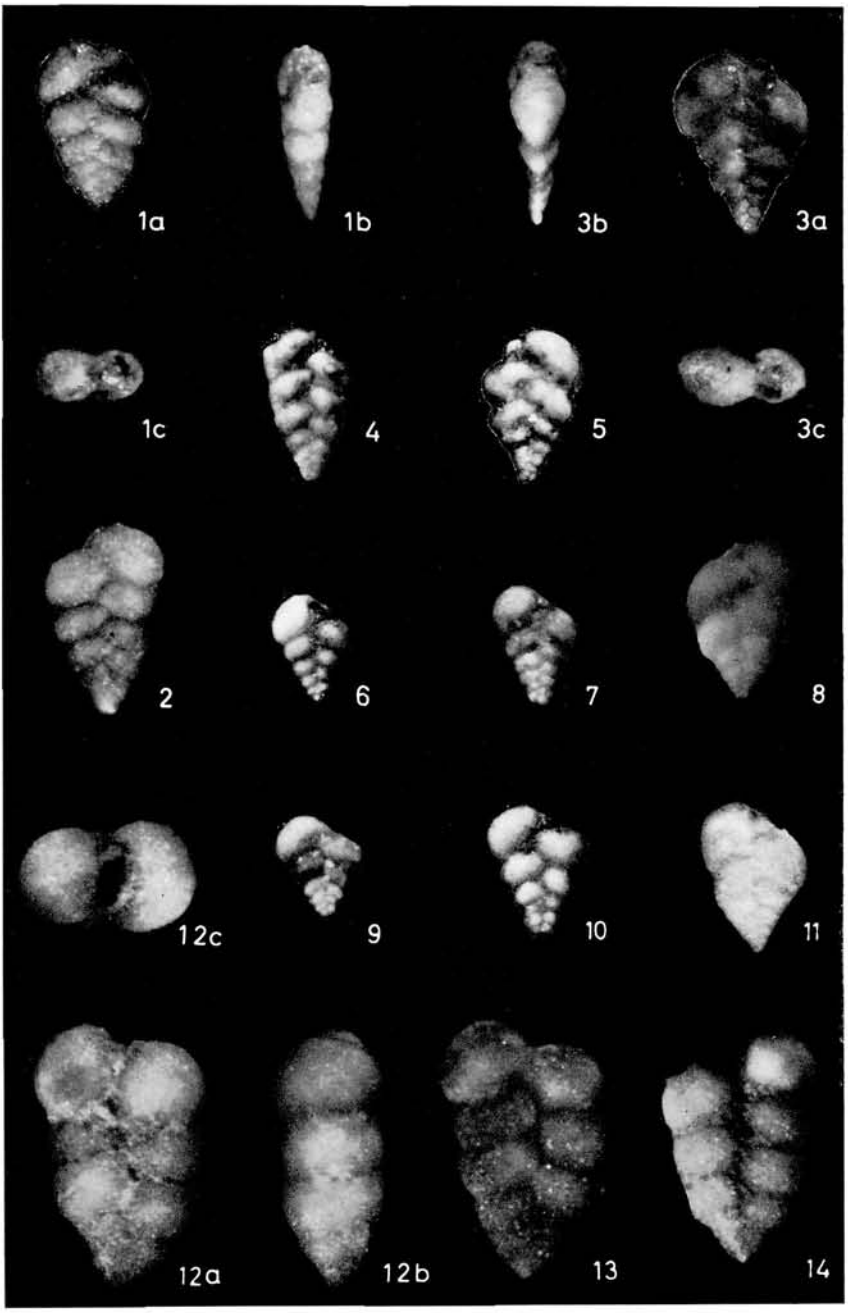
Plate 2.

Figs. 1, 2, 3. *Heterohelix dentata* n.sp. Lower Maestrichtian, upper part. Ålborg area. 1a, b. Longitudinal sections showing chamber arrangement, initial coils with five and four chambers and (1 b, last chamber) the thickened edge of the aperture. 2a, b, "semi section" (half test ground away), focus deep (2a) to show chamber arrangement and apertural flanges and focus high (2b) showing smooth surface at the adult chambers and rough surface (not very distinct) at the initial chambers. 3. cross section of initial part of test showing ornamentation and thickness variation of the wall. All 200 ×.

Figs. 4, 5, 6. *Heterohelix pachymarginata* n.sp. Lowermost Maestrichtian. Hvide Klint (Møn). 4. Cross section of initial part of test showing laterally thickened wall. 300 ×. 5. "Semi section" (see above) showing surface ornamentation. 200 ×. 6. Longitudional section of initial part of test showing laterally thickened wall. 300 ×.
All photographed in transmitted light.

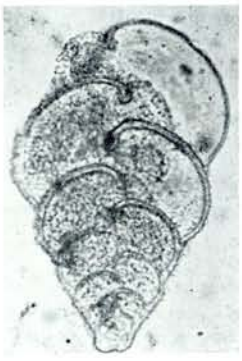
Plate 3.

Figs. 1, 2, 3. *Heterohelix robusta* n.sp. Lowermost Maestrichtian Hvide Klint (Møn). 1. Cross section showing thick wall, pores, and radially arranged calcite prisms, the cone-shaped extensions of which form the surface ornamentation. 300 ×. 2. Surface ornamentation. Axial part of "Semi section" (see expl. pl. 2) 200 ×. 3. Longitudinal section showing thick walls and thin septae. 300 ×.
All photographed in transmitted light.



Phot. CHR. WESTERGAARD.

1a



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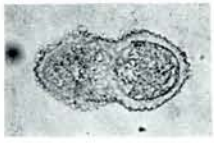

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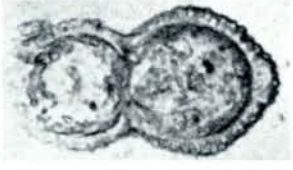

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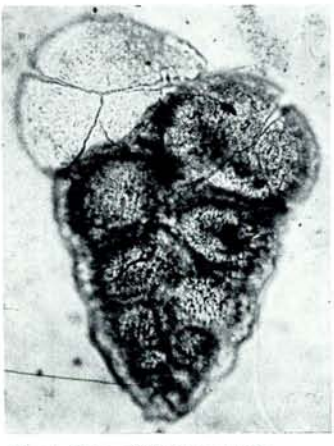

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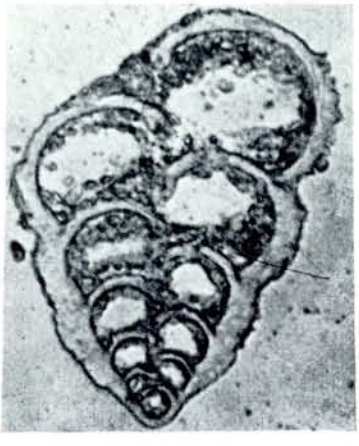

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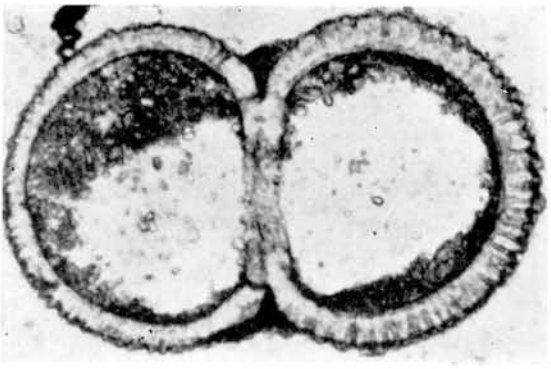

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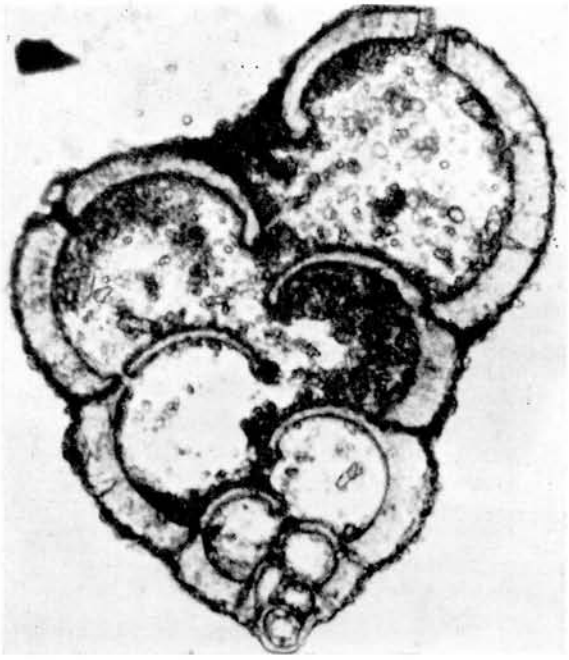

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