SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C NR 613 AVHANDLINGAR OCH UPPSATSER ÅRSBOK 60 NR 8

ERIK NORLING

ON THE GENUS *ICHTYOLARIA* WEDEKIND 1937

With 4 plates

STOCKHOLM 1966

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DAVIDSONS BOKTRYCKERI AB, VÄXJÖ

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ABSTRACT

The genus *Ichtyolaria* erected by Wedekind in 1937 is considered valid. Previous diagnoses of the genus are discussed, and a new diagnosis is presented after a revisional treatment of some important characteristics. Four species are described on material from Liassic beds in Skåne, S. Sweden. The terminology is explained at the end of the paper.

ACKNOWLEDGEMENTS

The writer is greatly indebted to Dr. F. Brotzen of the Geological Survey of Sweden for the first introduction to the Jurassic Foraminifera, for generous advice and valuable discussions, and for his kindness to put to my disposal his Liassic material from Kävlinge and Katslösa.

To Professor P. Thorslund, former Director of the Paleontological Institute, Uppsala University, the writer tenders his sincere gratitude for critical reading of the manuscript, and for extensive personal help.

The language was revised by Dr. J. Cornwell of the Geological Survey of Sweden. To these persons, as well as to those who have otherwise promoted the completion of this paper, I wish to express my sincere thanks.

Historical review

In 1937 Wedekind erected the genus *Ichtyolaria* for some Liassic Foraminifera previously referred to the genus *Frondicularia*. As his diagnosis was inadequate the new genus was not accepted until recently, being considered a synonym of *Frondicularia* DEFRANCE 1826. Owing to the increased knowledge of the internal characteristics of the test, the diagnostics of fossil Foraminifera have been improved and refined in recent years. In conformity with Wedekind (1937), many later workers on Foraminifera have stated that the Upper Paleozoic and Lower Mesozoic forms, usually referred to the genus Frondicularia, widely diverge from the Pliocene genotype *Frondicularia complanata* (DEFRANCE 1826) in many important characters. Nørvang (1957) referred Liassic forms, placed with *Frondicularia* (family *Nodosariidae)* by most previous students, to the genus *Spandelina* CUSHMAN & WATERS 1928 (family *Nodosinellidae).* The main reasons for his reclassification are summerized in his conclusions (p. 127:5): "A close examination of the various species in the material, has revealed that all species referred to the family *Nodosariidae* have well-preserved radiate apertures in contradistinction to the forms referred to the family *Nodosinellidae* which all have simple, rounded or oval apertures. The two families are fairly similar in the structure of the wall, which is calcareous and fibrous, but the *Nodosinellidae* differ from the *Nodosariidae* in having an imperforate wall, which in this connection means that pores — if present at all — are smaller or of the same size as the calcite needles and thus cannot be discerned in thin-sections. The similarity of the nodosinellid genera *Spandelina* and *Geinitzina* to the much younger nodosariid genera *Frondicularia* and *Lingulina* is supposed to be due to convergence." Brotzen (1963) stated that Liassic species of *Spandelina* sensu Nørvang actually have the same wall-structure as found in the nordosariid genera "Nodosaria" and "*Dentalina*" of the same age.

Pointing out the similarities and differences between the Liassic *Spandelina* sensu Nørvang and the Upper Paleozoic forms referred to this genus, but wishing to distinguish them from the genus *Frondicularia,* Brotzen proposed a new generic name for the Liassic forms, viz. *Neospandelina* BROTZEN 1963, with the type species *Frondicularia bicostata* D'ORBIGNY 1849. However, the genus *Ichtyolaria* WEDEKIND 1937 is based on the same type species and should therefore have priority. Contrary to Loeblich & Tappan (1964), who regard *Ichtyolaria* and *Neospandelina* as subjective synonyms of *Frondicularia,* Sellier De Civrieux & Dessauvagie (1965) have accepted the generic name *Ichtyolaria* for certain Permian and Liassic forms, stating that these forms widely diverge from the genotype *Frondicularia complanata* DEFRANCE (also examined by them) in many characters, inter alia in the degree of envelopment of successive chambers, the height of

chambers, the compression and elongation of the test, and the wall-structure. The present writer is inclined to support Sellier De Civrieux & Dessauvagie in their rehabilitation of Wedekind's genus *Ichtyolaria,* but suggests the following revision of their diagnosis of the genus.

Diagnoses of genus Ichtyolaria

WEDEKIND 1937. — The original diagnosis of genus Ichtyolaria, given by Wedekind, is insufficient. It just informs that the test is calcareous, ornamented with longitudinal costae, and have a lancet form, a flattened cross-section, and a terminal, central aperture.

SELLIER DE CIVRIEUX & DESSAUVAGIE 1965. — Being aware of the absence of an authentic diagnosis of Ichtyolaria, these authors have given a new comprehensive diagnosis of the genus (p. 69). Their diagnosis is divided into sections dealing with following features: test, aperture, proloculum, chamber arrangement, chamber form, septa, and test-wall. Most of their sectional descriptions are in accordance with the opinion of the present writer. The exceptions will be treated in the discussion below.

Sellier De Civrieux & Dessauvagie placed the following species with the genus:

LIASSIC SPECIES: *Ichtyolaria bicostata* (D'ORBIGNY 1849), *Ichtyolaria dubia* (BORNEMANN 1854), and *Ichtyolaria calvezi* SELLIER DE CIVRIEUX & DESSAUVAGIE 1965.

UPPER PERMIAN SPECIES: *Ichtyolaria permotaurica* SELLIER DE CIVRIEUX & DESSAUVAGIE 1965, *Ichtyolaria primitiva* SELLIER DE CIVRIEUX & DESSAUVAGIE 1965, and *Ichtyolaria latilimbata* SELLIER DE CIVRIEUX & DESSAUVAGIE 1965.

The Upper Permian species will not be treated in this connection. Of the Liassic species, *Ichtyolaria bicostata* and *Ichtyolaria dubia* are abundant in the Lower Lias of Sweden, and will be described in the present paper.

DISCUSSION. — The a p e r t u r e in *Ichtyolaria* is described by Sellier De Civrieux & Dessauvagie (p. 70) as being distinct, oval or elliptical, with a smooth border. In the Liassic species studied by the present writer, oval or round, radiate apertures predominate, while smooth-bordered apertures are rare. In other papers dealing with species here referred to the genus *Ichtyolaria* (earlier *Frondicularia),* (Macfadyen 1936, 1941; Ellis & Messina 1941; Tappan 1951; Gerke 1957; Nørvang 1957; and Loeblich & Tappan 1964), we find that opinions diverge concerning the shape of the aperture. It seems as if the shape is highly variable even within one and the same species. Until it has been clarified whether this variation is primary or caused by secondary alteration it seems impossible to use the form of the aperture as a basic criterion in classification.

The t e s t - w a l l is described by Sellier De Civrieux & Dessauvagie (p. 70) as being calcareous, usually finely granular, more seldom indistinctly radiate. Perforation inappreciable. Primary lamination inappreciable; secondary lamination absent. Concerning the t e x t u r e of the test, the present investigation has shown that ornamental elements (longitudinal ribs and marginal costae) have a granular texture, while the interornamental parts of the test (in Liassic forms) always are fibrous-radiate. The ornamental elements do not only affect the external parts of the test, but also the internal. They actually penetrate the test-wall, giving rise to an alternating granular and fibrous texture of the wall. Because of the penetrative ability of the granular ornamental elements a longitudinal thin-section (plane X_1X_2) may completely fall within a granular zone of the test. As far as known to the present writer, these granular zones of the test, corresponding to penetrative ornamental elements, have not been commented on before. It is believed therefore, that in this, and other cases, the texture of the test-wall has been erronously interpreted. The fact that Sellier De Civrieux & Dessauvagie have found a fibrous texture in forms lacking marginal costae. (e. g. in *Ichtyolaria permotaurica,* Pl. XII: Figs. 4 a—c, and in *Ichtyolaria latilimbata,* Pl. XIV: Figs. 11 a—c), and a granular texture in forms having marginal costae *(Ichtyolaria bicostata, I. dubia)* seems to support this interpretation. Concerning the p e r f o r a t i o n of the test-wall in *Ichtyolaria,* the present investigations have shown that the Liassic species examined at least are clearly perforated. However, the perforation is usually difficult to observe in a longitudinal thin-section (Plane X_1X_2), partly because of the difficulty of distinguishing the fine pore canals from the radiating fibers of the calcite and partly because of the alternating fibrous and granular-imperforate segments of the test-wall, the latter segments corresponding to the penetrative ornamental elements. The perforation (Pl. IV: Figs. 1—4) can best be studied if the specimen is ground longitudinally from one side only down to the opposite side of the test. The pore openings inside the test can then be observed easily under high magnification. By melting the embedding medium and turning over the specimen, the external pore openings can be studied.

Because of this new evidence concerning the wall-structure in *Ichtyolaria,* a revised diagnosis of the genus is proposed here. It is partly based on that given by Sellier De Civrieux & Dessauvagie (on Permian representatives of the genus), and partly on the observations made by the present writer (on Liassic species).

Proposed new diagnosis

Genus *Ichtyolaria* WEDEKIND 1937

TYPE SPECIES. — *Frondicularia bicostata* D'ORBIGNY 1849

SYNONYMOUS. — *Neospandelina* BROTZEN 1963

DIAGNOSIS OF THE GENUS. — T e s t calcareous, polythalamous, elongate, compressed. Form in frontal view variable, elliptical, oval or late rhomboidal; in

lateral view elliptical. Transverse section elliptical, oval or bilobate. Size variable; Permian species: length 0,40—0,75 mm, breadth 0,15—0,25 mm; Liassic species: length 0,80—1,40 mm, breadth 0,20—0,35 mm.

Chamber arrangement uniserial, orthoserial. No. of chambers 7—12 in megalospheric forms; 12—20 in microspheric forms. Chamber sutures distinct or indistinct, chevron-shaped.

Aperture distinct, more or less protruding, oval or round, radiate (with radiating slits), or with a smooth border.

Ornamentation. — Test smooth or ornamented with longitudinal striae, ribs or costae. Ornamental elements granular, contrary to the interornamental parts of the test, which are distinctly fibrous-radiate (at least in Liassic forms). The ornamental elements penetrate the test-wall, giving rise to an alternating granular and fibrous texture of the wall.

Test-wall essentially fibrous-radiate, perforate (at least in Liassic species). In ornamented forms, the test is composed of longitudinally arranged fibrous, perforate segments alternating with granular, imperforate segments, the latter being the penetrative ornamental elements. An indistinct primary lamination may occur. Secondary lamination absent. The primary wall of a chamber slightly overlaps that of the preceeding one. Thickness variable; usually 5—10 microns in the proximal part of the test, 15—20 microns in the distal part.

Perforation affects the whole test, with the exception of apertural area, ornamental elements, chamber sutures, and the main parts of septa. In perforated areas, the pores are frequent and essentially evenly distributed. Pore openings round or oval. Pore diameter: 0,50—0,75 microns in the proloculum, 0,30—0,50 microns in the later chambers.

Septa inverted V-shaped with the foramina at the top angles. Texture of septa, fibrous-radiate with the exception of narrow longitudinal segments corresponding to penetrative ornamental elements, which are granular. Essentially imperforate. Primary lamination inappreciable. Thickness 5—10 microns in the proximal part, 15—20 microns in the distal part of the test.

OCCURRENCE. — Permian — Jurassic.

Material and methods

MATERIAL. — The foraminifers examined, about 300 specimens, are from the Lower Lias of Skåne, S. Sweden. They were taken from cores of two borings at Kävlinge, 12 km NW of Lund, and one boring in Öresund, offshore from Hälsingborg, and from the classical outcrop at Katslösa, 10 km SE of Hälsingborg. The Kävlinge and Katslösa material was collected by Dr. F. Brotzen, the Öresund material by the present writer. In addition, numerous specimens of Ichtyolaria collected in material from the U. Lower Lias, Waddington Brick Pit, Lincolnshire, England, have been examined for comparative studies. This material was kindly placed to my disposal by Professor P. Thorslund, Paleontological Institution of

Uppsala University. The repository of the collections is the Geological Survey of Sweden, Stockholm (SGU). Notes on the Liassic stratigraphy of the borings and outcrop are given on p. 9.

METHODS. — After separation from the residues the foraminifers were washed in alcohol and, if necessary, cleaned with fine needles. To obtain oriented thin-sections, selected specimens were embedded in a transparent medium and ground in the well-known way on a glass plate covered with a paste of carborundum powder soaked in water (Glaessner 1945). The embedding media used are: 1) Lakeside Brand Termoplastic Cement No. 70 (manufactured by Lakeside Chemical Corp., Chicago, Illinois), 2) Canadabalsam (naturell) S 2584 (manufactured by Kebo Aktiebolag, Stockholm), 3) Soredur H 67 and 4) Soredur H 75, cold, setting polyesters (manufactured by Svenska Oljeslageri Aktiebolaget, Gothenburg), and Technovit No. 4071 D, a cold, (rapid) setting polyester (manufactured by Svenska Dentalexport Aktiebolaget, Malmö).

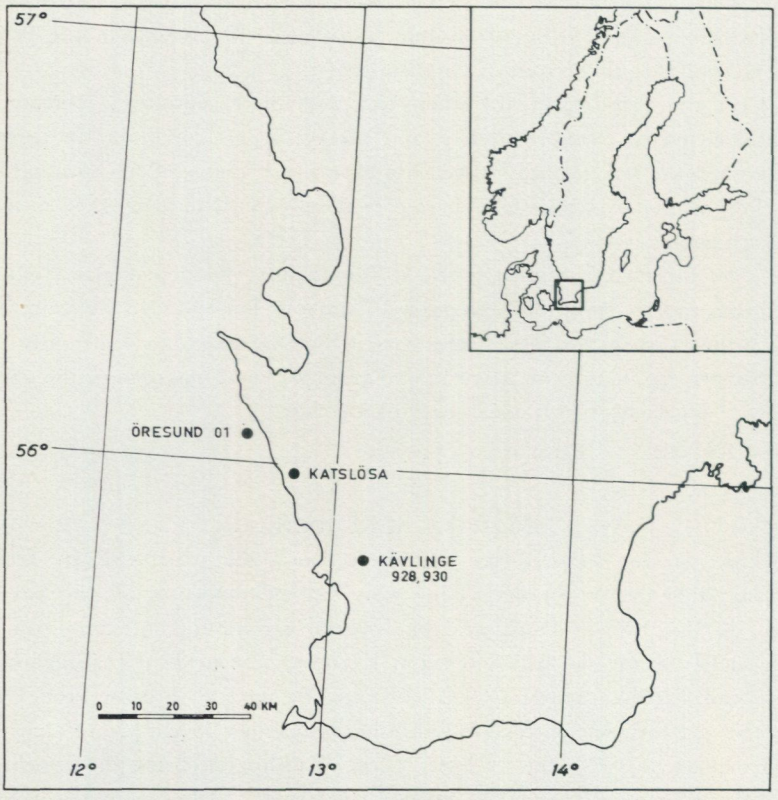

Fig. 1. Sketch map showing the location of localities mentioned in the text. The inset map displays the position of the county of Skåne relative to the rest of Sweden.

The most frequently used embedding media were "Lakeside" and Canadabalsam. "Lakeside" has the advantage that, once hardened, it can be melted again by heating. This medium has been used for obtaining thin-sections ground from both sides. Canadabalsam has been used especially for embedding of specimens with air-filled chambers. In this case, the slide or small plastic box containing the embedded specimen was put into a vacuum dessiccator before hardening the medium by heating, and was kept there until the air was expelled from the chambers.

The polyesters mentioned have been used as embedding media when making serial sections. They have the advantage that the ground part of the specimen can be etched in a dilute acid without affecting the embedding medium. They are also resistant to acetone, a property which is necessary when making replicas on plastic films from the etched surface. The embedding and replication techniques applied by the present writer are modifications of those described by Honjo (1963). For making replicas, a 34 microns thin acetyl cellulose film was used (Bioden RFA manufactured by Oken Shoji Co., Ltd., Ginza E 6—7, Tokyo). The orientation of the thin-sections can be seen in Plate I, fig. 3, and Plate III, figs. 1, 2).

The photomicroscope used was a Zeiss Ultraphot II, equipped with phase contrast condensor, polarisor and analysor, allowing magnifications up to 2,500 x. The film has invariably been Agfa Isopan 13°DIN, 9×12 cm.

Stratigraphical remarks

In 1951, three borings were carried out at Kävlinge for the Geological Survey of Sweden. Two of them, placed in the valley of the Kävlinge River, W of the village, passed into Liassic strata. Below a Pleistocene cover of about 30 m in both borings, sequences mainly of grey-green sand and sandstone occur, intercalated with layers of clay and claystone.

KÄVLINGE No. 928. — The pre-Quaternary sequence between 28,75 m and 83,25 m, consisting of grey-green sand and sandstone, rich in oolitic chamosite, contains a fairly rich foraminiferal fauna in the portion between 54 m and 83,25 m. Certain fauna elements indicate that these beds belong to Lias γ. This seems evident from the presence of the following species: *Bolivina liasica* (TERQUEM) occurring in NW Europe from Lias γ to Lias δ, *"Dentalina" häusleri* SCHICK and *Tristix liasina* (BERTHELIN) known from beds older than Lias δ. Furthermore, the lack of *"Marginulina" prima f. spinata* TERQUEM, index fossil of uppermost Lias β and Lower Lias γ, and the presence of *"Astacolus" denticula-carinata* FRANKE, suggest that the above portion could be referred to Upper Lias γ.

In KÄVLINGE No. 930 (pre-Quaternary sequence: 29,20—176 m +), the occurrence of *Bolivina liasica* (TERQUEM), *Ichtyolaria mesoliasica* (BRAND), and *"Astacolus" denticula-carinata* FRANKE in the upper part of the core section has

been taken as an indication of Upper Lias γ age, since neither *Ichtyolaria mesoliasica* nor *"Astacolus" denticula-carinata* seem to pass into Lias δ in NW Europe. Lower Lias γ beds also seem to be present, as is indicated by the occurrence of *"Marginulina" prima f. spinata* TERQUEM together with typical Lias γ forms in the interval 60—80 m. Below 103 m, no foraminifers have been found. However, for lithological reasons it is most likely that Lias β also is present. Between 106 and 122 m, grey and red or brown clays occur. The location of these very characteristically coloured clays in the sequence, indicates the presence of Pankarp Beds, which have been referred to Lias β by Bölau (1954, 1959).

However, without further studies, the limit between Lias γ and Lias β cannot be drawn in the core section.

Boring ÖRESUND 01 (Location: E 12° 39′ 30″, N 56° 4′ 3″. Water depth: 17 m). — During the last ten years, geophysical, geotechnical, and geological surveys have been undertaken in Öresund in order to find out the best location for a bridge or tunnel between Sweden and Denmark. For this project, two borings were made in Öresund between Hälsingborg and Helsingør in 1958, one boring on the Danish side of the sound, the other on the Swedish side. The latter boring, ÖRESUND 01, was carried out by Svenska Diamant Bergborrning AB (The Swedish Diamond Rock Drilling Co.) as a core drilling. The core section was examined from a lithological-stratigraphical point of view by Dr. E. Mohrén at the Geological Survey of Sweden. According to his interpretation the sequence of dark grey claystones, intercalated with thin layers of siltstone and iron siltstone, below a 3,5 m thick Pleistocene cover, should be of Liassic age. The present writer's study of the microfossils has confirmed this result as far as the core portion between 9,16 m and 42,80 m is concerned. The Liassic age of the sequence is established by the occurrense of *"Dentalina" matutina* D'ORBIGNY and *"Marginulina" prima* D'ORBIGNY. Furthermore, the age of the sequence can be limited to Lias α_3—Lower Lias β, as an assemblage is found containing forms disappearing in L. Lias β, for instance *"Planularia" inaequistriata* (TERQUEM), together with forms appearing in Lias α_3 in NW Europe, inter alia *"Dentalina" matutina* D'ORBIGNY and *Vaginulina listi* (BORNEMANN).

As known from other borings in Öresund (Larsen 1965, Bang in Larsen 1965), neither the foraminiferal fauna nor the lithology provide evidence for locating the limit between Lias α and Lias β within this area. Using local geological terms, this claystone formation occurs between the Döshult Sandstones and the characteristic Pankarp Beds of grey and redbrown clays with claystones (see Troedsson 1951; Bölau 1954, 1959; Larsen 1965).

THE KATSLÖSA SECTION. — A comprehensive account of the Liassic stratigraphy of the Katslösa section, about 10 km SE of Hälsingborg, was published by Troedsson (1951). The strata, occasionally exposed in 1945 at the bottom of a ditch-system of c. 400 m in length, were measured by Drs. F. Brotzen and E.

Mohrén. From ENE to WSW the section includes Lias α_3 (Döshult Stage), the uppermost Lias β and Lias γ (Katslösa Stage). Troedsson stated that the main part of Lias β was missing, not only in the Katslösa section, but in NW Skåne as a whole. However, Bölau (1959) has shown that red and grey-green clays and sandstones (Pankarp Beds), earlier supposed to be of Rhaetic age, actually should be referred to Lias β. At Katslösa, the Pankarp Beds are represented only by a 0,24 m thin horizon of red clay followed by non-marine, yellowish sandstone of small vertical extension, the latter also being referred by him to Lias β.

Reyment (1959) has i different opinion concerning the Liassic stratigraphy of NW Skåne, for he considers that certain ammonites indicate that the Katslösa Stage (sensu Troedsson) should belong to Lias β rather than to Lias γ.

Among the foraminifers collected by Brotzen, certain forms give a hint of the stratigraphical range. The occurrence of *"Planularia" inaequistriata* (TERQUEM) and *"Dentalina" matutina* D'ORBIGNY in the NE part of the section (Loc. 700—775 sensu Troedsson), suggests that this part of the section is not older than Lias α_3 and not younger than Lower Lias β. In the central part of the section (Loc. 825—875 sensu Troedsson) *"Marginulina" prima f. spinata* TERQUEM and *"Dentalina" häusleri* SCHICK occur in abundance. These two characteristic forms are restricted to the uppermost Lias β and the Lower Lias γ in NW Europe, the latter form being found also in Upper Lias γ. In the SW part of the section (Loc. 875—1000 sensu Troedsson) typical Lias γ forms occur, such as *Ichtyolaria mesoliasica* (BRAND), *"Astacolus" denticulacarinata* FRANKE and *Tristix liasina* (BERTHELIN). The foraminiferal fauna suggests that the marine parts of the Katslösa section include Lias α_3—Lower Lias β, possibly the uppermost Lias β, and Lias γ, while the main part of Lias β (including the Pankarp Beds) seems to be missing, as already stated by Troedsson (1951) and Bölau (1959).

Description of Species

Ichtyolaria bicostata (D'ORBIGNY 1849)
Pl. I, figs. 1—3; Pl. III, figs. 1—2;
Pl. IV, figs. 1—4.

1849 *Frondicularia bicostata* D'ORBIGNY. — p. 242, No. 256.
1936 *Frondicularia bicostata* D'ORBIGNY. — Macfadyen, p. 149, Pl. 1, fig. 256 (type figure).
1957 *Spandelina bicostata* (D'ORBIGNY) *subsp. bicostata* (D'ORBIGNY). — Nørvang, p. 69, figs. 62—64, 67, 68.
1965 *Ichtyolaria bicostata* (D'ORBIGNY). — Sellier De Civrieux & Dessauvagie, p. 71, Pl. X, fig. 8; Pl. XXI, figs. 4 a—h.

HOLOTYPE and TYPE STRATUM. — *Frondicularia bicostata* D'ORBIGNY, Jurassic, 8th Étage, Lias.

SWEDISH MATERIAL. — Numerous specimens from borings Kävlinge No. 928 and No. 930 and from Öresund 01.

MATERIAL FOR COMPARISON. — About 25 specimens from Waddington Brick Pit, Lincolnshire, England (U. Lias β).

DESCRIPTION. — T e s t elongate, with maximum breadth usually at the ontogenetically latest or penultimate chamber. Form in frontal view varying from elliptical to rhomboidal, in lateral view elliptical. Transverse section elliptical, oval or slightly bilobate. Size variable, usually 0,8—1,0 mm in length; 0,20—0,25 mm in breadth; 0,05—0,08 mm in thickness.

C h a m b e r s 8—10 in megalosperic forms, about 15 in microspheric forms. Arrangement uniserial, orthoserial. Chamber sutures distinct or indistinct, inverted V-shaped. Proloculum more or less spherical, later chambers chevron-shaped.

A p e r t u r e terminal, central, more or less protruding. Form oval or round, usually radiate (with radiating slits), rarely with a smooth border.

O r n a m e n t a t i o n. — Test usually with four longitudinal ribs on each side in addition to more or less strong marginal costae. Two ribs generally stronger, extending continuously for almost the full length of the test. The other ribs usually discontinuous. Marginal costae of vesiculous texture at the surface, passing over into a granular one in the inner parts, granules being closely packed polygonal grains. Ribs have the same texture as marginal costae. The ornamental elements penetrate the test-wall, giving rise to an alternating granular and fibrous texture of the wall. Ornamental elements on the whole imperforate, as are the chamber sutures.

T e s t - w a l l nonlamellar, calcareous, fibrous-radiate, and perforate, with the exception of the narrow segments corresponding to penetrative ornamental elements, which are granular and imperforate. Thickness variable, usually 5—10 microns in the initial part of the test, 15—20 microns in last formed parts of the test.

P e r f o r a t i o n. — Pores frequent, nearly of equal size and evenly distributed in perforated parts of the test; in the wall of proloculum, however, being somewhat less frequent but slightly larger, 0,50—0,75 microns, as compared with those of the later chambers, 0,30—0,50 microns. Apertural area, ornamental elements, main parts of septa, and chamber sutures always imperforate.

S e p t a without a primary lamination, fibrous-radiate, with interruptions for narrow granular segments corresponding to the penetrative ornamental elements. Form inverted V-shaped with the more or less protruding foramen at the top angle. Thickness 4—8 microns in the proximal part, 15—20 microns in the distal part of the test.

OCCURRENCE. — Lias α_3— Lower Lias β: Öresund 01; 14,9—40,3 m.
Lias β (?) — Lias γ: Katslösa; 780—1000 m.
Lias γ: Kävlinge No. 928; 54—83 m, Kävlinge No. 930; 29—103 m.

Ichtyolaria dubia (BORNEMANN 1854)
Pl. I, figs. 4—6

1854 *Frondicularia dubia* BORNEMANN. — p. 57, Pl. 3, figs. 23 a—c.
1957 *Spandelina bicostata* (D'ORBIGNY) *subsp. dubia* (BORNEMANN). — Nørvang, p. 66, figs. 60, 61, 65.
1965 *Ichtyolaria dubia* (BORNEMANN). — Sellier De Civrieux & Dessauvagie, p. 72, Pl. XXII, figs. 1 a—d, 2 a—f.

HOLOTYPE and TYPE STRATUM. — A well preserved specimen figured by Bornemann 1854. "Lias, Belemnitenschichten; Kalkstein und zwischen denselben lagernden Mergelthonschichten."

SWEDISH MATERIAL. — Numerous specimens from borings Kävlinge No. 928, No. 930, Öresund 01, and Katslösa outcrop.

REMARKS. — Regarding the external form and morphology of the test, this species has been well described and illustrated by many authors, inter alia by Barnard (1957), Nørvang (1957), and Espitalié & Sigal (1960), and the Swedish specimens do not contribute to the knowledge of its outer characters. It is worth mentioning that the a p e r t u r e is oval or round, and radiate with radiating slits. Internal morphology and structure similar to those of Ichtyolaria bicostata.

MEASUREMENTS. — Length c. 1,2 mm; breadth 0,3—0,4 mm; thickness 0,05—0,08 mm. Wall thickness (excl. marginal costae): proximal part of test: 5—8 microns; distal part of test: 8—15 microns. Septa: proximal part of test: 3—8 microns; distal part of test: 10—15 microns.

OCCURRENCE. — Lias α_3/Lower Lias β: Öresund 01; 14,90—15,11 m, 21,08—21,31 m, 25,97—26,88 m, 26,88—28,19 m, 33,48—33,79 m, 38,41—40,30 m, 40,30—40,70 m.

Lias γ: Kävlinge No. 928; 54—83 m.
Kävlinge No. 930; 29—103 m.
Katslösa; 855—1000 m.

Ichtyolaria baueri (BURBACH), 1886.
Pl. II, figs. 1, 2

1886 *Frondicularia baueri* BURBACH. — p. 52, Pl. 2, figs. 48—52 (type figure).
1957 *Spandelina bicostata* (D'ORBIGNY) *subsp. baueri* (BURBACH). — Nørvang, p. 68, fig. 66.

HOLOTYPE and TYPE STRATUM. — *Frondicularia baueri* BURBACH. "Jura, Lias δ, Amaltheenthon; ein hellgelbich-grauer bis bräunlich-grauer Thonmergel."

SWEDISH MATERIAL. — Rare in samples from all localities treated.

DESCRIPTION. — T e s t late rhomboidal to elliptical, ornamented with 6—7 longitudinal ribs, the central ones extending for almost the full length of the test. Marginal costae usually strong.

A p e r t u r e protruding, oval or round with a smooth border, or with radiating slits. Chamber sutures usually indistinct. Number of chambers 8—10 in megalospheric forms; usually more in microspheric forms.

Internal morphology and structure similar to those of *I. bicostata.*

REMARKS. — *I. baueri* shows resemblance to both *I. dubia* and *I. bicostata.* Typically, the marginal ribs in *I. baueri* are more reduced than in *I. dubia,* and less reduced than in *I. bicostata.* Furthermore, the marginal ribs do not converge towards the aperture as in *I. dubia.*

OCCURRENCE. — Lias α_3/Lower Lias β: Öresund 01; 21,08—21,31 m. Only two specimens.

Lias γ: Kävlinge No. 928; 70,25 m.
Kävlinge No. 930; 72 m, 103,25 m.
Katslösa outcrop; 850—1000 m.

Ichtyolaria sulcata (BORNEMANN), 1854.
Pl. II, figs. 3, 4.

1854 *Frondicularia sulcata* BORNEMANN. — p. 37, Pl. 3, figs. 22 a, c.
1957 *Spandelina bicostata* (D'ORBIGNY) *subsp. sulcata* (BORNEMANN). —Nørvang, p. 63, figs. 56—59.

HOLOTYPE and TYPE STRATUM. — A well preserved specimen figured by Bornemann, 1854; Pl. 3, fig. 22. "Lias, Belemnitenschichten; Kalkstein und zwischen denselben lagernden Mergelthonschichten."

SWEDISH MATERIAL. — Numerous specimens from localities mentioned.

DESCRIPTION. — T e s t late rhomboidal or elliptical; oval or elliptical in transverse section; ornamented with 7—12 strong, straight ribs (often like costae); with or without peripheral costae. Chamber sutures usually indistinct. Number of chambers 9—11 in megalospheric specimens, usually more in microspheric. A p e r t u r e more or less protruding, oval or round, usually with a smooth border. Length of test: 1—1,4 mm; breadth: 0,3—0,45 mm. Internal structure similar to that of. *I. bicostata.*

OCCURRENCE. — Lias α 3/Lower Lias β: Öresund 01; 21,08—21,31 m. Rare.
Upper Lias β (?). — Lias γ: Katslösa; 830—1000 m.
Lias γ: Kävlinge No. 928; 54 m, 72,25 m.
Kävlinge No. 930; 29 m, 72,25 m, 103,25 m.

Glossary of some morphological terms

Aperture: The term aperture is used only for the single major opening in the distal wall of the last chamber.
Bilobate: Having two lobes, separated by a median depression.
Chamber suture: Seamlike junction of two consecutive chambers.
Chevron-shaped: Inverted V-shaped.

Costa:	In foraminiferal terminology usually referred to as a relatively thin and deep rib.
Distal:	Further from proloculum in direction of growth.
Fibrous:	Crystals, being so small that they look like fibers, form a fibrous texture.
Fibrous radiate:	If each fiber-like crystal is arranged with its c-axis normal to the surface of the test, the test-wall is said to be fibrous radiate.
Foramen:	The major opening between two consecutive chambers.
Granular:	When the individual grains in a crystalline aggregate show no marked elongation, the mineral is said to be granular. In ornamented Ichtyolaria, the ornamental elements are essentially granular, the granules being polygonal calcite grains.
Lamination:	See primary lamination and secondary lamination.
Late rhomboidal:	The test in frontal view having the shape of a rhomboid with its shorter diagonal in the distal part of the test.
Orthoserial:	The axis of the serial development of the chambers is a straight line.
Polythalamous:	Composed of several chambers.
Primary lamination:	Calcite (and aragonite) may occur in aggregates of flattened plates, a form referred to as lamellar by the mineralogist. The individual plates or lamina are generally parallel, but can be curved around a common center, giving a concentric form. This type of lamination occurs in calcareous foraminiferal tests. It is called primary lamination to avoid confusion with the lamination of secretory origin (secondary lamination).
Proximal:	Nearer to proloculum in direction of growth.
Secondary lamination:	When, in a polythalamous foraminifer, the new chamber wall covers the previously formed test completely and adheres to it, the test-wall is referred to as secondarily lamellar. It means, according to Reiss (1963, p. 17), that "each chamber is formed essentially by one lamella (herein referred to as "main" or "outer" lamella), but its chamber walls consist (except in the case of its being the ontogenetically last chamber) of several outer lamellae, viz. of its own and of supplementary lamellae of subsequently deposited chambers".
Septum:	In all polythalamous Foraminifera each chamber envelops a certain part of the preceeding chamber. Part of the chamber wall of the latter becomes thereby a "septum".
Texture:	Crystalline structure.
Vesiculous:	Having small bladders (hollow spaces).

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Abreviations

SGU = Sveriges Geologiska Undersökning.
DGU = Danmarks Geologiske Undersøgelse.
GFF = Geologiska Föreningens i Stockholm Förhandlingar.

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PLATE I

page

Figs. 1—3 *Ichtyolaria bicostata* (D'ORBIGNY 1849) 12

1. Microspheric (?) specimen in frontal view Lias α_3/Lower Lias β. Öresund 01; 21,08—21,31 m.
2. Microspheric specimen. Longitudinal section. Upper Lias β (?)/Lower Lias γ. Katslösa 862 m.
3. Schematic drawing to show position of photographed areas (black squares) figured in Plate IV, and the sectioning plane X_1X_2 referred to in the text.

Figs. 4—6 *Ichtyolaria dubia* (BORNEMANN 1854) 13

4. Megalospheric form in frontal view. Lias α_3/Lower Lias β. Öresund 01; 21,08—21,31 m.
5. Megalospheric specimen in frontal view. Upper Lias β (?)/Lower Lias γ. Katslösa 862 m.
6. Megalospheric. specimen. Longitudinal section. Upper Lias β (?)/Lower Lias γ. Katslösa 862 m.

PLATE II

page

Figs. 1—2 *Ichtyolaria baueri* (BURBACH 1886) 14

1. Megalospheric specimen in frontal view. Lias γ. Katslösa 962 m.
2. Microspheric specimen. Longitudinal section. Lias γ. Kävlinge No. 930; 63,5—64,5 m.

Figs. 3—4 *Ichtyolaria sulcata* (BORNEMANN 1854) 15

3. Megalospheric specimen in frontal view. Lias α_3/Lower Lias β. Öresund 01; 35,5—36,6 m.
4. Megalospheric specimen. Longitudinal section. Upper Lias β (?)/Lower Lias γ. Katslösa 862 m.

PLATE III

page

Figs. 1—2 *Ichtyolaria bicostata* (D'ORBIGNY 1849) 12

1. Schematic drawing showing position of transverse sections (a—f) in fig. 2.

2 a—f. Transverse sections showing granular, imperforate, penetrative ribs (black), and fibrous-radiate parts of perforate test-wall and imperforate septa (white). Drawings based on thin sections and acetate peel replicas. Lias γ. Katslösa 962 m.

PLATE IV

page

Figs. 1—4 *Ichtyolaria bicostata* (D'ORBIGNY 1849) 12

Lias γ. Kävlinge No. 930; 63,5—64,6 m. Photographs showing internal pore patterns of the test. Greater black spots are grains of carborundum and/or air-bubbles in the embedding medium. The position of reproduced areas is given in Pl. I, fig. 3.

1. Pore pattern of apertural chamber.
2. Imperforate, penetrative rib (left), chamber suture with few pores (upper left part), and heavy perforated chamber wall.
3. Parts of a septum with few pores (upper right and left corners), inverted V-shaped chamber suture with few pores (lower halves of diagonals), and heavy perforated areas.
4. Pore pattern of proloculum.

Plate I

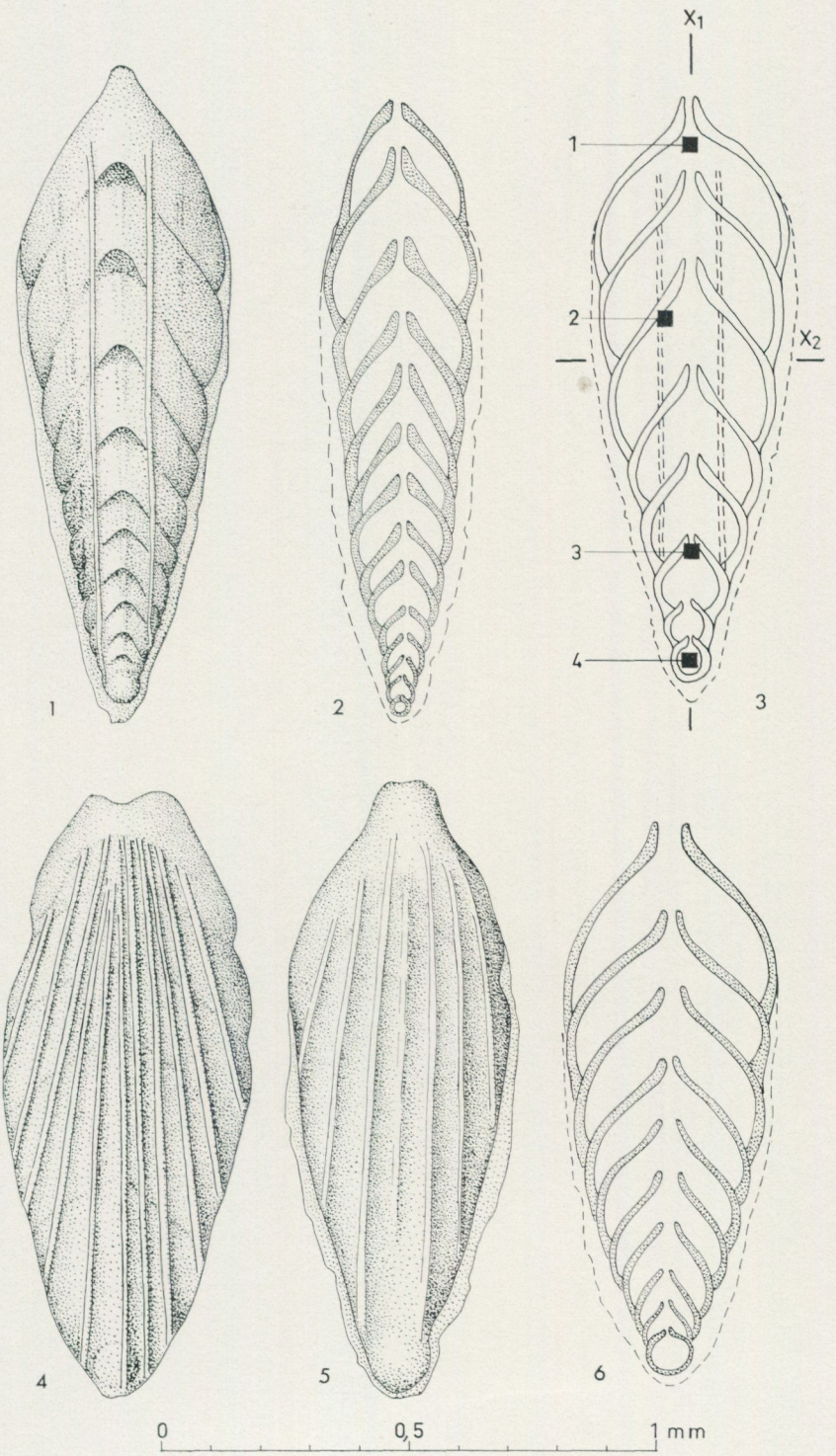


Plate II

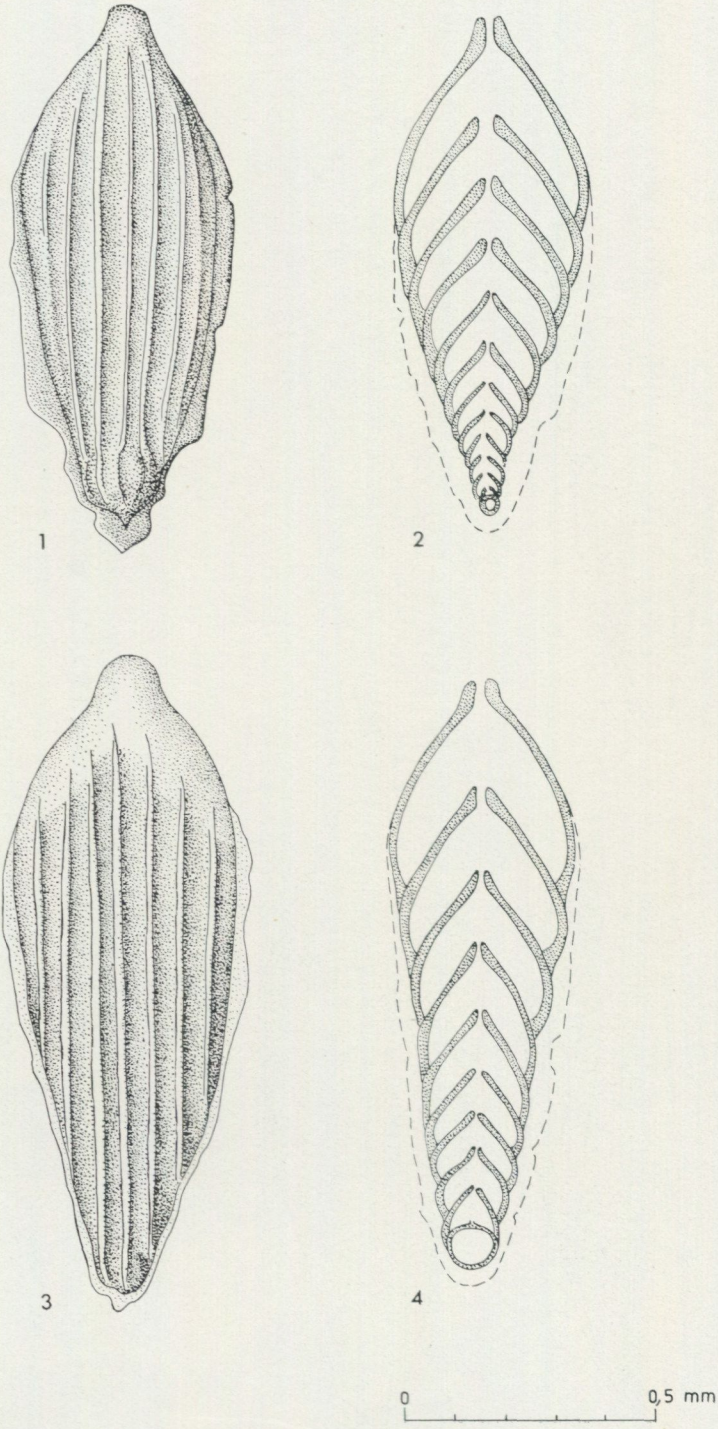


Plate III

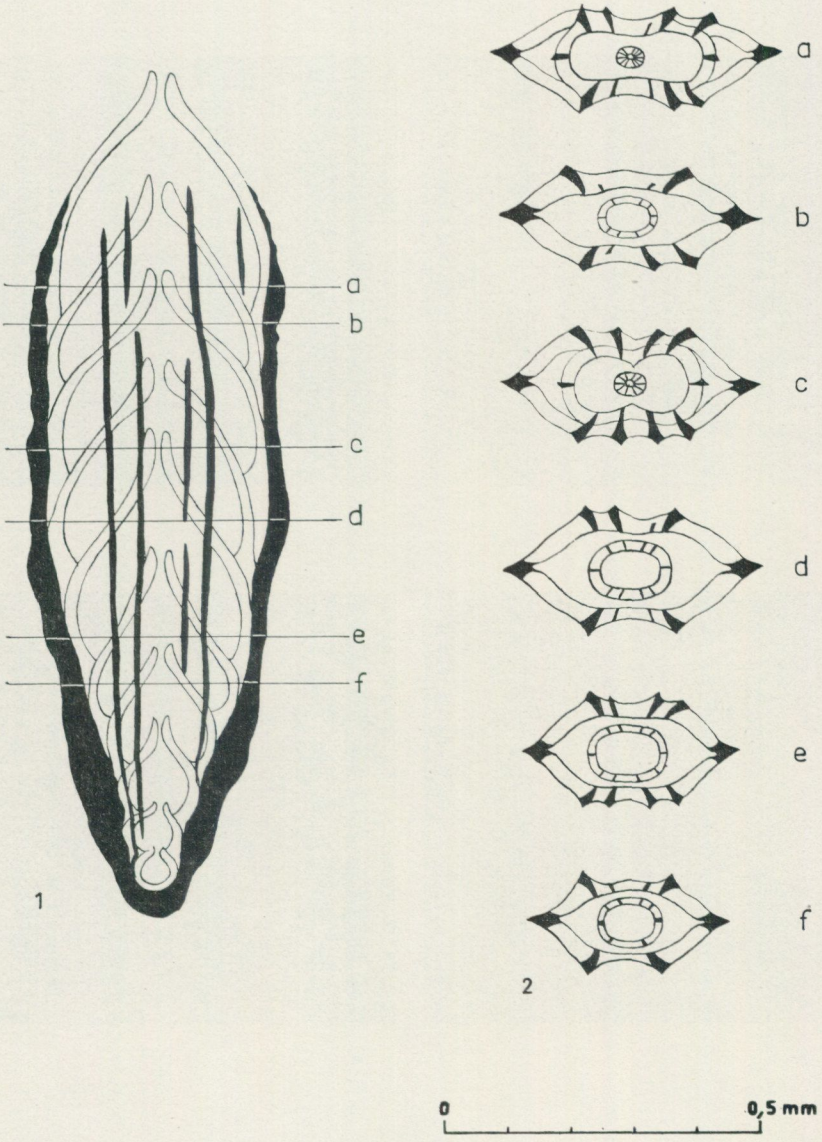
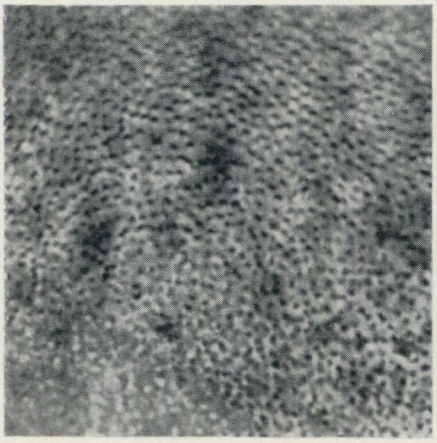


Plate IV



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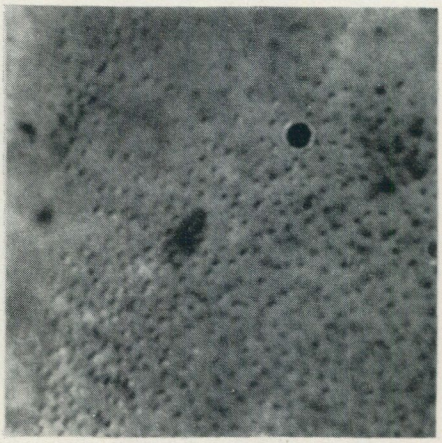

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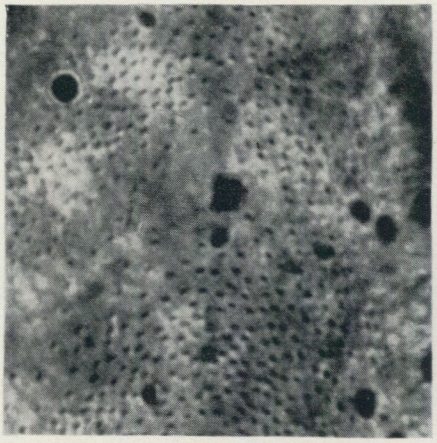

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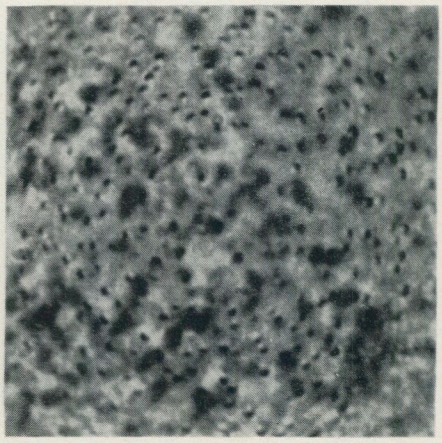

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