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Upper Devonian/Lower Carboniferous calcareous algae from the Fore-Carpathian Depression

ABSTRACT: The calcareous algae occurring in deposits at the boundary between the Upper Devonian and Lower Carboniferous which has been reached in boreholes located in the Fore-Carpathian Depression (Southern Poland), are represented by twenty species (including six new ones) of Rhodophyta, Chlorophyta, Charophyta and Porostromata. These algae throve in a shallow-water marine basin, probably in a back-reef environment. As appears from their succession in profiles, these algae may be useful for stratigraphic correlation of the late-Paleozoic deposits of the Fore-Carpathian region.

INTRODUCTION

The calcareous algae, belonging to the Rhodophyta, Charophyta, Chlorophyta and Porostromata, were found in the Upper Devonian/Lower Carboniferous deposits in Bratkowice *1*, Gumniska *1*, Niwki *3*, and Tarnów *19* boreholes located in the Fore-Carpathian Depression between Dąbrowa Tarnowska, Tarnów, Mielec and Rzeszów (Fig. 1). The observations were conducted in thin sections put within the present writers' reach by Mrs. R. Zając from the Geological Institute whom they express their gratitude. They also feel indebted to Docent S. W. Alexandrowicz for his helpful remarks.

STRATIGRAPHIC POSITION OF ALGAE-BEARING DEPOSITS

Several borings indicating the presence of Later Paleozoic deposits overlaid by Mesozoic and Miocene formations have recently been made in the area of the Fore-Carpathian Depression. The occurrence of transi-

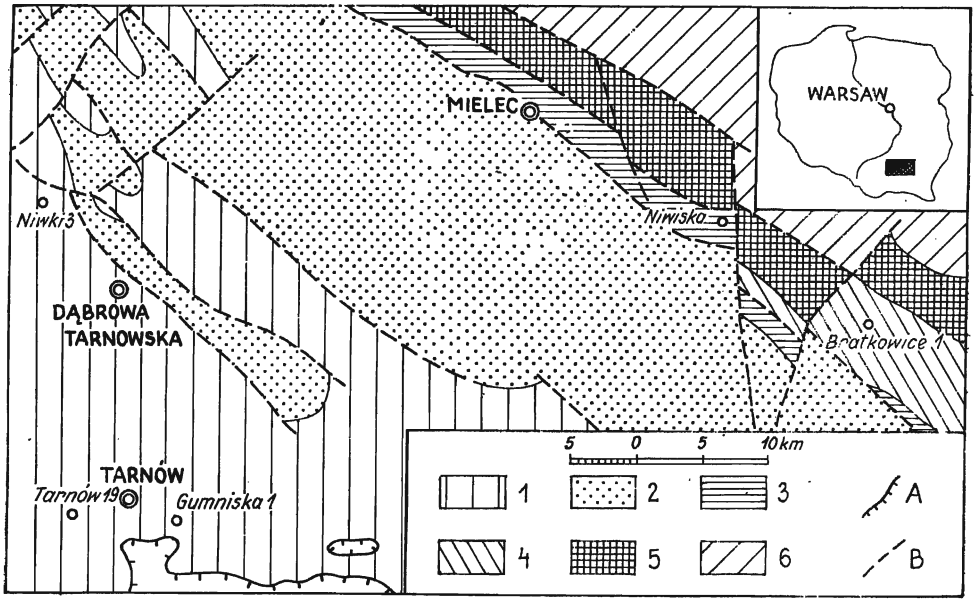


Fig. 1

Geological sketch map with location of the sample-bearing boreholes (Caenozoic deposits omitted); the inset shows situation of the region in Southern Poland

1 Cretaceous, *2* Jurassic, *3* Triassic, *4* Carboniferous, *5* Devonian, *6* Precambrian; *A* northern margin of the Carpathian nappic zone, *B* major faults

tional Devonian-Carboniferous beds has here been found locally (*cf.* Żakowa 1968).

Most of the algae described (*cf.* Bilan, Golonka & Zając 1972) occur in the Gumniska *1* and Niwki *3* boreholes, where the limestones contain microfossils from the boundary of the Famennian and Lower Carboniferous (Golonka & Zając 1972). *Parachaetetes paleozoicus* (Maslov) Pia and *Ortonella tarnoviensis* sp. n. were found in the Tarnów *19* borehole in the unstratified Lower Carboniferous deposits. A single specimen of *Acicularia* sp. was found in the Bratkowice *1* borehole in the Tournaisian deposits (*cf.* Czarnecki & Kwiatkowski 1961).

HISTORY OF STUDIES ON THE *UMBELLINA*

The systematic position of the forms previously described under the name *Umbella* has for several years been subject of discussion. These microfossils were considered as foraminifers of the family Lagenidae (*cf.* Lipina 1950, Reitlinger 1954, Bykova 1955, Fursenko 1959, Konoplina 1959, and others), Nodosinellidae (Loeblich & Tappan 1961, Ozonkowa 1962, Rich 1965, Toomey 1965) or Parathuramminidae (Conil & Lys

1964). They were also assigned to *Calcisphaera* (Lombard & Montayne 1952, Konishi 1958, Conil 1961). Recently, convincing arguments have been supplied for their assignment to the Charophyta.

Miklukho-Maklay (1961) called attention to the similarity in morphology occurring between the *Umbella* and Charophyta (Trochiliscales). He considered in fact that their occurrence in the Paleozoic deposits formed probably under the conditions of low salinity allows one to suppose that they belong to the Charophyta.

Chuvashov (1965) compared the structure of wall of foraminiferal tests with that of the areolae of oospores. The wall of the *Umbella* had originally a concentric structure. The character of the structure of wall and the presence of an apical lid induced that author to assume that the *Umbella* were fetuses or reproductive organs of plants.

Poyarkov (1966) found that the *Umbella* make up external coatings or utricles of oospore. This author compared the structure of the walls of foraminifer tests, gyrogonites and utricles. The differences between them are marked in the detail of the microstructure of the outer, light-colored layer.

According to Maslov (1947, 1956, 1961, 1966), the basal aperture in gyrogonites is covered with a basal plug. The presence of such plug was also found by Poyarkov (1966) in the representatives of *Umbella mica* Poyark. In the representatives of the genus *Umbella* s. s., the apical aperture is covered with a lid (Poyarkov 1966), which was also indicated by Lipina (1950), Bykova (1955) and Chuvashov (1965).

Reitlinger (1966) acknowledged the assignment of *Umbella* to the Charophyta. This author called attention to certain specimens determined by Bogush & Yuferov (1962) as *Umbella* and which in her opinion make up different organic remains (*Calcisphaera*?). According to Reitlinger (1966), specimens assigned by Conil (1961) to *Calcisphaera* should be assigned to *Umbella*.

Ajzenverg & Brazhnikova (1966) assigned *Umbella* to algae, but did not state precisely their systematic position. The assignment of *Umbella* to Charophyta was considered by Mamet (1970) as correct.

Loeblich & Tappan (1961) called the attention to the fact that the name *Umbella* was already used for the molusc *Umbella* d'Orbigny, 1841, and suggested the application of the name *Umbellina*. Mamet (1971) emphasized that *Umbella* was first assigned to Charophyta (Miklukho-Maklay 1961) about a month later. Referring to the rules of the botanical nomenclature code, Mamet indicated *Umbellina* Loeblich & Tappan as an appropriate name and expressed the opinion that the taxon *Umbella* Maslov should be discarded.

Recently, several new species of the Umbellinaceae have been described by Brazhnikova & Bertshenko (1971) from the Tournaisian of Donbas.

REMARKS ON THE TAXONOMY OF THE UMBELLINACEAE

The following diagnosic parameters of the utricle of *Umbellina* were mentioned and characterized by Poyarkov (1966):

(1) the presence and character of sculpture on the surface of utricle;
(2) the presence of a basal knob;
(3) the form of utricle and its internal space;
(4) the dimensions of utricle and its particular parts;
(5) the character of the structure of the apical and basal parts.

The character of external morphology and presence or absence of the basal knob were named by this author as characters decisive of the generic assignment. The type of the sculpture of utricle, its form and the form of its internal space and basal knob, the structure of the basal part of utricle, as well as its dimensions and the dimensions of its particular parts are specific characters (Poyarkov 1966).

Poyarkov (1965) distinguished three genera: *Umbella* Maslov and, new ones, *Quasiumbella* nad *Ellenia,* which he assigned to the family Umbellaceae Fursenko. The new species described in the present paper, i.e., *Umbellina nivkensis* sp. n., having a basal knob and roughnesses on the

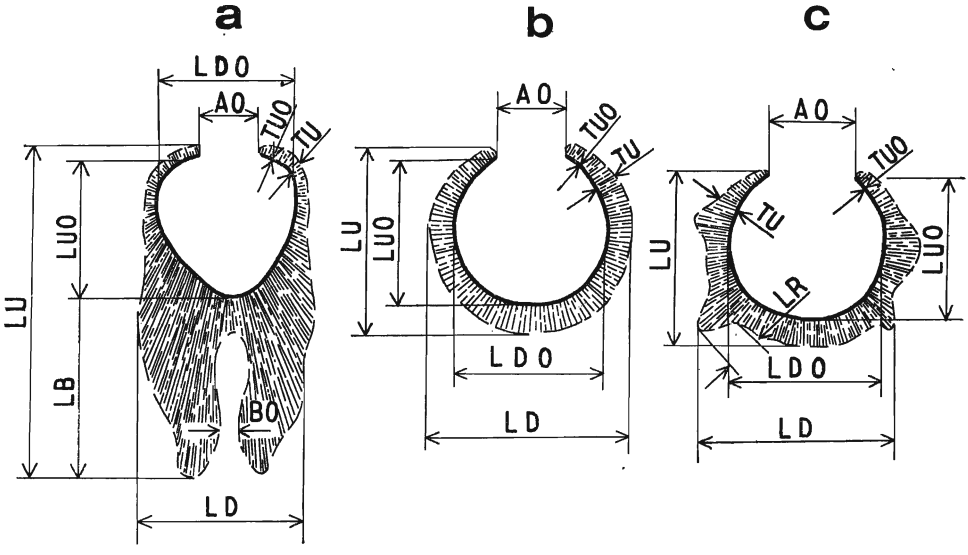


Fig. 2

Main taxonomic features of the utricles in longitudinal sections for the genera: a — *Umbellina,* b — *Quasiumbella,* c — *Ellenia*

LD utricle diameter, *LU* utricle height, *LDO* internal diameter of utricle, *TU* wall thickness of utricle, *TUO* thickness of the internal layer of wall, *AO* diameter of apical aperture, *BO* diameter of basal aperature, *LB* height of basal knob, *LR* rib height

external surface of utricle, displays, however, characters which it has in common with the genera *Umbellina* and *Ellenia*. A similar character of morphology is also recorded im *Umbellina* sp. *8* Ajzen. & Braz. and *Ellenia aculeata* Berch. Some specimens of *Umbellina bella* Maslov also have a sculpture on the surface of utricle. This may be seen, for instance, in Bykova's drawings (1955, Pl. 14, Figs 3—4 and 6—7), in which small, irregularly distributed nodules are visible on the surface of utricle.

It should be stated that *Ellenia* (Byk.) and *E. ollaria* (Byk.) have in their basal parts a distinctly thickened wall resembling a basal knob. This is visible in the illustrations of the author of this species (Bykova 1955, Pl. 14, Fig. 5) and in the photograph of *Umbellina ollaria* presented by Chuvashov (1965, Pl. 28, Fig. 3). The presence of the thickening of the wall in the basal part and, at the same time, of the sculpture are also displayed by *Ellenia poyarkovi* sp. n.

A distinction of a new genus marked by the presence of the basal knob and, simultaneously, of the sculpture does not seem to be necessary, since the position of such a hypothetical genus would be vague in relation to both *Umbellina* and *Ellenia*. The boundaries between such three taxons would not be more distinct than those between the genera *Umbellina* and *Ellenia* after the assigning to the former of utricles with a basal knob and sculptured surface and to the latter of sculptured utricles sometimes having certain elements of sculpture in the form of a basal knob.

The determination of a mutual relationship of thus defined genera (apart from their other characters mentioned by the authors of the genera) resolves itself to a precise definition of a difference between the basal knob and other elements of sculpture similar to it:

(1) the basal knob is situated in the lower part of utricle opposite the apical aperture; differently situated thickenings of the wall should be considered as elements of sculpture (e.g., *Ellenia poyarkovi* sp. n.);

(2) the width of the basal knob in its upper part is approximately equal to the diameter of utricle; elements of sculpture of utricle (e.g. *Ellenia famena* and *E. ollaria*) are narrower;

(3) the basal knob is frequently extended downwards as, e.g., in *Umbella bashkirica* (Byk.) in a photo in Poyarkova's paper (Pl. 2, Fig. 11) or in the specimens illustrated by Toomey (1965, Pl. 24); this character is not recorded in ribs which occur on the surface of utricle.

The amount of the material studied and the spatial orientation of sections are of a decisive importance to a proper determination of such taxonomic parameters as the basal knob and the sculpture of the surface of utricle. Poyarkov (1966) found that utricles should be studied only on longitudinal or approximately longitudinal sections. Since in this position such morphological elements of utricle as longitudinal ribbing, number and shape of longitudinal ribs are not always visible, such

a view is not correct. The utricles should be examined on variously oriented sections, although admittedly longitudinal sections are of the greatest importance.

SYSTEMATIC DESCRIPTION

Type **Charophyta**
Family **Umbellinaceae**
Genus *UMBELLINA* Loeblich & Tappan, 1961
Umbellina nivkensis sp. n.
(Pl. 1, Figs 1—2; Pl. 3, Figs 2—3)

Holotype: specimen figured in Pl. 1, Fig. 1.
Type horizon: Upper Devonian/Lower Carboniferous transitional beds.
Type locality: Niwki 3 borehole near Dąbrowa Tarnowska, depth 2,449.1—2,455 m.
Derivation of the name: nivkensis — found in a borehole near the locality Niwki.

Material. — Six specimens (sections varying in spatial orientation).

Diagnosis. — Internal space of utricle plano-oval or round in outline; basal knob not very high, shaped like a truncate cone; surface of utricle uneven, with slight thickenings of wall.

Description. — A utricle oval in outline, with a distinct although not very high basal knob shaped like a truncate cone. The external surface of utricle uneven, with several not very high thickenings of wall. Internal space plano-oval or round in outline. The wall of utricle bilaminar. Internal layer dark, microgranular, very thin. External layer light-colored, variable in thickness, with a radial-fibrous microstructure.

Dimensions (in μm):

	Holotype	Other specimens
diameter of utricle	605	480—550
height of utricle	710	425—517
diameter of internal space	444	331—390
height of internal space	370	294—344
thickness of utricle wall	70—120	30—120
diameter of apical aperture		160
height of basal knob	268	

Variability. — In the material observed, the variability is caused primarily by a variable orientation of sections. The situation and height of roughnesses on the surface of utricle are the most variable elements.

Remarks. — The species displays a similarity to *U. bashkirica* Byk. var. *magna* Poyark., from which it differs in an uneven surface of utricle, variable thickness of wall and shape of basal knob. From *Umbellina* sp. *8* Ajzen. & Braz. it differs in the shape of internal space and character of sculpture, from *U. bykova* Reitl. var. *grandis* Reitl. in dimensions, shape of internal space and basal knob and uneven surface of utricle and, finally, from other species of the genus *Umbellina* in an uneven surface of utricle or in dimensions.

Occurrence. — Niwki *3* borehole near Dąbrowa Tarnowska, deposits of indefinite age between the Upper Devonian and Lower Carboniferous, depth of 2,449.1—2,455 m; Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

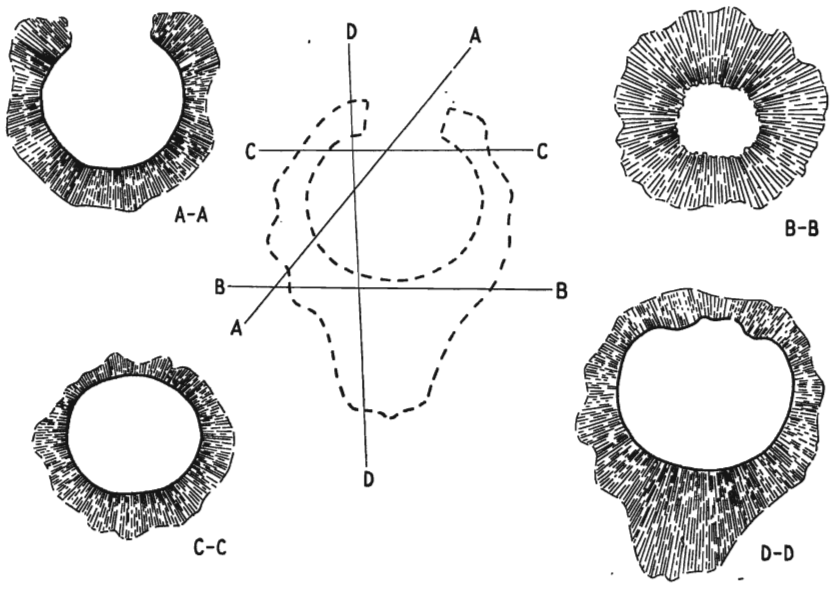


Fig. 3

Various sections of the utricle in *Umbellina nivkensis* sp. n.
A—A oblique section, *B—B* and *C—C* transverse sections, *D—D* longitudinal section

Umbellina cf. *pugatchovensis* Bykova, 1955
(Pl. 2, Fig. 6)

Material. — One specimen.

Description. — Utricles of an oval form with smooth surface. Internal space round in outline. Thickness of wall increasing in the basal part of utricle. Wall bilaminar. Internal layer dark, microgranular in structure, considerably thinner than the external layer which is light-colored and radial-fibrous in microstructure.

Dimensions (in μm):

	Specimen described	Range of variability acc. to Bykova
diameter of utricle	169	150—260
height of utricle	184	190—770
diameter of internal space	110	
height of internal space	101	
thickness of wall of utricle	18	18—26
height of basal knob	46	47—100

Remarks. — The specimen is in principle contained within the variability range given by Bykova (1955). Despite a distinct similarity to *U. pugatchovensis* Bykova (*cf.* Bykova 1955, pp. 41—42, Pl. 11, Figs 1—3; Chuvashov 1965, p. 88, Pl. 28, Figs 4—7), the specimen under study has been marked "cf." since it is a diagonal section. This fact seems to be reflected in the difference in the shape of internal space observed between the holotype and the specimen described.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,200.3—3,202 m.

Umbellina sp. *A*
(Pl. 3, Fig. 4)

Material. — One specimen.

Description. — Basal knob wide, slightly extending downwards, shaped like a crown with three regularly distributed protuberances.

Remarks. — The specimen displays a certain similarity to the basal knob of the utricle presented by Toomey (1965, Pl. 24, Fig. b).

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Umbellina sp. *B*
(Pl. 1, Fig. 3)

Material. — One specimen.

Description. — Basal knob wide, relatively low, with two low, sharp protuberances.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Umbellina sp. *C*
(Pl. 3, Fig. 1)

Material. — One specimen.

Description. — A utricle round in outline, with a basal knob extending downwards. Internal space round. Wall of utricle bilaminar. Internal layer dark, microgranular, relatively thick, but it thickness is variable. External layer ligth-colored, thicker, radial-fibrous in microstructure.

Dimensions (in μm):

diameter of utricle	147
height of utricle	370
diameter of internal space	147
height of internal space	160
thickness of wall of utricle	25—120
thickness of internal layer	10—30

Remarks. — This is a diagonal section not passing through the apical aperture and, consequently, the basal knob is marked only fragmentarily.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Genus *QUASIUMBELLA* Poyarkov, 1965
Quasiumbella nana (Reitlinger) Poyarkov, 1966
(Pl. 1, Fig. 7)

1954. *Umbella nana* Reitlinger; Reitlinger, p. 76, Pl. 22, Fig. 12.
1964. *Umbella cuttis* Conil & Lys; Conil & Lys, pp. 38—39, Pl. 5, Fig. 44.
1966. *Quasiumbella nana* (Reitlinger) Poyarkov; Poyarkov, p. 138, Pl. 1, Figs 2, 5.

Material. — Two specimens.

Dimensions (in μm):

Parameters	Specimens a	Specimens b	Reitlinger	Ranges of variability according to Conil & Lys	Ranges of variability according to Poyarkov
diameter of utricle	160	184	140—160	160—250	200—251
height of utricle	160	211	170—200	160—250	200—280
diam. of internal space	129	138		145—210	105—193
height of internal space	147	156		145—210	118—202
thickness of wall	20	25—35	12—20	15—20	25—34
diam. of apical aperture				130	67

Remarks. — The specimens are in conformity with the descriptions of Reitlinger (1954) and Poyarkov (1966). A new species *U. cutis* was erected by Conil & Lys (1964); the utricle and its internal space in which do not differ in form and dimensions from *Q. nana* (Reitl.). The only difference is observed in the size of apical aperture, which, however, does not seem to be a sufficient basis for separating a new taxon, the more so as the diameter of the apical aperture depends to a considerable degree on the orientation of section.

Groups *Umbella nana* and *Umbella? lageniformis* were separated by Reitlinger (1966) from five morphological groups. *Q. nana* (Reitl.) was assigned by Mamet (1970) to a new genus *Lagenumbella*. He also acknowledged *U.? lageniformis* to be a genotype of this genus. The form of utricle and its internal space in *Q. nana* (Reitl.) display a symmetry and do not have features characteristic of lageno-shaped utricles of the genus *Lagenumbella* Mamet.

Occurrence. — Upper Frasnian of the Russian Platform (Reitlinger 1954) and Lower Famennian of the Tyan-shan (Poyarkov 1966); Upper Famennian of the Dinant Basin and Strunian of the Liège Basin (Conil & Lys 1964); Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Quasiumbella globula (Reitlinger) Poyarkov, 1966
(Pl. 2, Fig. 7)

1966. *Umbella globula* Reitlinger; Reitlinger, p. 217, Pl. 1, Figs 1—3.
1966. *Quasiumbella globula* (Reitlinger) Poyarkov; Poyarkov, p. 189, Pl. 1, Fig. 16.

Material. — One specimen.

Dimensions (in μm):

Parameters	Specimen described	Ranges of variability according to Reitlinger	Ranges of variability according to Poyarkov
diameter of utricle	312	160—250	195—240
height of utricle	240	160—270	195—240
diam. of internal space	138	100—190	76—144
height of internal space	120	100—190	76—144
thickness of wall	c. 75	to 45	50—65
diam. of apical aperture	105	30	25

Remarks. — The section is to a considerable degree in conformity with Reitlinger's (1966) and Poyarkov's (1966) descriptions. It slightly differs from them in the thickness of wall and in a considerable larger diameter of apical aperture, which depends to a considerable extent on the orientation of the section. The size of the apical aperture is not considered as an essential diagnostic character and, consequently, despite a considerable difference between the holotype and the specimen described, the latter has been assigned to *Q. globula* (Reitl.).

Occurrence. — Etreungtian of SW Armenia (Reitlinger 1966) and Upper Famennian of the Tyan-shan (Poyarkov 1966); Niwki *3* borehole near Dąbrowa Tarnowska, depth 2,343—2,348.7 m.

Genus *ELLENIA* Poyarkov, 1965
Ellenia spinosa (Conil & Lys) Mamet, 1970
(Pl. 3, Fig. 5)

1961. *Calcisphère èspineuse àcortex fibro-radiàire;* Conil, Pl. 18, Fig. 31.
1964. *Umbella spinosa* Conil & Lys; Conil & Lys, p. 41, Pl. 5, Figs 55—57.
1970. *Ellenia spinosa* (Conil & Lys) Mamet; Mamet, p. 1169.

Material. — One specimen.
Dimensions (in μm):

diameter of utricle	517
height of utricle	462
diameter of internal space	313
height of internal space	331
thickness of wall (total)	50—92
thickness of internal layer	15
height of ribs	35—180

Remarks. — The section conforms with the description of Conil & Lys (1964). It differs from *E. famena* (Byk.) and *E. ollaria* (Byk.) in the character of sculpture and from *E. ornata* (Byk.) in dimensions and character of the morphology of utricle.

Occurrence. — Upper Famennian of the Dinant Basin (Conil & Lys 1964); Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Ellenia famena (Bykova) Poyarkov, 1965
(Pl. 2, Figs 1—2)

1955. *Umbella famena* Bykova; Bykova, p. 43, Pl. 11, Fig. 7; Pl. 15, Figs 3—7.
1965. *Elenia famena* (Bykova) Poyarkov; Poyarkov, p. 730.

Material. — Four specimens in a thin section.
Dimensions (in μm):

Parameters	Specimens 1	2	3	4	Range of variability acc. to Bykova
diam. of utricle	517	580	642	587	290—550
height of utricle	517	550	568	550	310—550
diam. of internal space	370	462	407	444	
height of int. space	344	470	388	388	
thickness of wall	50—100	30—130	60—150	55—120	50—120
diam. of apical aperture					120—330

Remarks. — The specimens conform with the description of Bykova; they very slightly exceed the range of variability given by this author. Only one section of *E. famena* was presented by Bykova (1955); this was probably a transverse section. The specmiens here described do not depart in shape from the section presented by Bykova; they have a varying number of longitudinal ribs.

Occurrence. — Upper Famennian of the Volgograd region (Bykova 1955); Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Ellenia poyarkovi sp. n.
(Pl. 1, Figs 4—6)

Holotype: specimen presented in Pl. 1, Fig. 4.
Type horizon: Devonian-Carboniferous transitional beds.
Type locality: Gumniska 1 borehole near Tarnów, depth 3,200.3—3,202 m.
Derivation of the name: in honor of B. V. Poyarkov, a Soviet geologist and paleontologist.

Material. — Four variously oriented sections.

Diagnosis. — Internal space of utricle round, external surface rough. A thickening of wall distinct in basal part.

Description. — Sections of utricle irregularly semicircular. External surface rough, with a few small thickenings of wall. A more distinct thickening, conical in outline, is visible in the basal part. Internal space round. Wall of utricle relatively thick, bilaminar. Internal layer dark, microgranular, considerably thinner than the external layer which is light-colored and radial-fibrous in microstructure.

Dimensions (in μm):

	Holotype	Other specimens
diameter of utricle	416	321—499
height of utricle	331	240—444
diameter of internal space	184	147—239
height of internal space	184	128—230
thickness of the wall of utricle	110	70—125
diameter of apical aperture	130	105—147
height of apical aperture	92	70—92

Variability. — Fluctuations in the thickness of wall and height of the swellings of the wall of utricle are observed in sections. The variability of other characters is to a considerable extent caused by a varying orientation of sections.

Remarks. — The species is marked by a considerable thickness of wall in relation to the diameter of internal space of utricle. This character allows one to distinguish easily *E. poyarkovi* sp. n. from most of the known representatives of the genus *Ellenia;* from *E. formosa* Berch. and *E. crassa* Berch. it differs in the character of the sculpture of utricle.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,200.3—3,202 m; Niwki *3* borehole, depth 2,449.1—2,455 m.

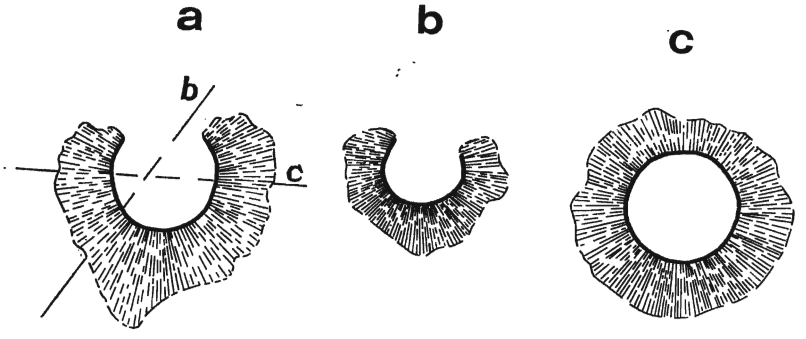


Fig. 4

Various sections of the utricle in *Ellenia poyarkovi* sp. n.
a longitudinal section and orientation of the other ones: oblique (*b*) and transverse (*c*)

Ellenia ampulliformis sp. n.
(Pl. 2, Figs 3—5)

Holotype: specimen figured in Pl. 2, Fig. 3.
Type horizon: Devonian-Carboniferous transitional beds.
Type locality: Gumniska *1* borehole near Tarnów, depth 3,200—3,202 m.
Derivation of the name: Lat. *ampulla* — vesse, bottle.

Material. — Four specimens (variously oriented sections).

Diagnosis. — Internal space of utricle round; sculpture expressed by a high protuberance in the basal part of utricle.

Description. — A utricle round in outline. Sculpture expressed in the occurrence of a high, narrow and distinct protuberance in the basal part. Internal space round in outline. Wall of utricle bilaminar. External layer light-colored, radial-fibrous in microstructure, considerably thicker than the internal, darker layer, whose microstructure is granular.

Dimensions (in μm):

	Holotype	Other specimens
diameter of utricle	407	344—440
height of utricle	344	294—462
diameter of internal space	315	239—331
height of internal space	300	239—331
thickness of wall	40	30—50
height of basal protuberance	126	152
diameter of apical aperture	220	

Remarks. — The species under study differs from *E. ollaria* (Byk.) in a narrower apical protuberance and lower utricle and from other known species of the genus *Ellenia* in the character of sculpture and size.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,200.3—3,202 m.

Type **Rhodophyta**
Class **Florideae**
Order **Cryptonemiales**
Family **Solenoporaceae**
Genus *PARACHAETETES* Deninger, 1906
Parachaetetes glenwoodensis (Johnson, 1945)
(Pl. 4, Fig. 1)

1945. *Solenopora glenwoodensis* Johnson; Johnson, pp. 837—838, Pl. 3, Fig. 3.
1956. *Parachaetetes glenwoodensis* (Johnson) Johnson et Konishi; Johnson & Konishi, p. 90, Pl. 2, Figs 4—5.

Material. — One specimen.

Remarks. — The specimen strictly conforms in the shape and dimensions of cells with the species described by Johnson (1945) and Johnson & Konishi (1956).

Occurrence. — Lower Carboniferous of Colorado and Saskatchewan (Johnson 1945, Johnson & Konishi 1956); Gumniska *1* borehole, Devonian-Carboniferous transitional beds, depth 3,200.3—3,202 m.

Parachaetetes paleozoicus (Maslov) Pia, 1937
(Pl. 4, Fig. 2)

1935. *Solenophyllum paleozoicum* Maslov; Maslov, p. 18, Figs 1—9, Pls 2—4.
1937. *Parachaetetes paleozoicus* (Maslov) Pia; Pia, pp. 798—799.
1956. *Parachaetetes paleozoicus* (Maslov) Pia; Maslov, p. 73, Pl. 22.
1959. *Parachaetetes paleozoicus* (Maslov) Pia; Malakhova, p. 97, Pl. 8, Figs 3—5; Pl. 9, Figs 1—3.
1962. *Parachaetetes paleozoicus* (Maslov) Pia; Maslov, p. 122, Fig. 94.
1965. *Parachaetetes paleozoicus* (Maslov) Pia; Chuvashov, p. 80, Pl. 24, Figs 1—4.

Material. — One specimen.

Remarks. — The specimen resembles in the development of thallus and in microstructure the specimens described by Maslov (1935, 1956, 1962) from the Lower Carboniferous of the Ural, but has considerably larger cells, whose dimensions conform with those observed by Chuvashov (1965) in specimens from the Upper Famennian of the Ural. Perhaps, a new subgenus should be distinguished on the basis of Chuvashov's specimens and of those from the Carpathian foreland. A poor material and its recrystallization do not, however, entitle the present writers to draw such conclusions.

Occurrence. — Famennian and Lower Carboniferous of the Ural, Tournaisian of Donbas (Maslov 1935, 1956, 1962; Malakhova 1959; Chuvashov 1965); Lower Carboniferous of Germany (Pia 1937); Tarnów *19* borehole, probably Lower Carboniferous, depth 2,626—2,632.5 m.

Subgenus *TOMILITHON* Maslov, 1962
Parachaetetes (Tomilithon) johnsoni Maslov, 1962
(Pl. 5, Fig. 1)

1962. *Parachaetetes (Tomilithon) johnsoni* Maslov; Maslov, pp. 191—192, Fig. 128, Pls 35—36.
1965. *Parachaetetes (Tomilithon) johnsoni* Maslov; Chuvashov, pp. 80—81, Pl. 25, Figs 1—3.

Material. — One specimen.

Remarks. — In the development of its thallus, dimensions of cells and their variability, the specimen strictly conforms with those described by Maslov and Chuvashov.

Occurrence. — Famennian of the Ural and Tournaisian of Western Siberia (Maslov 1962, Chuvashov 1965); Gumniska *1* borehole near Tarnów, Devonian--Carboniferous transitional beds, depth 3,200.3—3,202 m.

Genus *SOLENOPORA* Dybowski, 1879
Solenopora elliotti sp. n.
(Pl. 5, Fig. 2)

Holotype: specimen presented in Pl. 5, Fig. 2.
Type horizon: Lower Carboniferous (?).
Type locality: Niwki *3* borehole near Dąbrowa Tarnowska, depth 2,276—2,279.5 m.
Derivation of the name: in honor of Graham F. Elliott, a well known British investigator of fossil calcareous algae.

Material. — One specimen.

Description. — The thallus forms a round nodule, lobate in the external part and displaying a tendency to form new branchings. Specimen 1.6 mm in size, structure of thallus compact, hypothallus lacking, perithallus vegetal, formed by rows of cells running radially from the center. The rows are slightly undulate. The cells

they are formed of are rectangular in longitudinal and polygonal, rounded and sometimes subcircular in transverse section. Cells vary in width (within small limits) in particular rows, with a certain tendency to increase it prior to the division of cells. Within the entire thallus, the width fluctuates within limits of 30 and 42 μm. Lateral walls of cells thick (about 10 to 15 μm), distinct, transverse septa thin, indistinct, about 5 μm thick, distributed at various levels. Length of cells variable, fluctuating within limits of 35 and 150 μm, mostly 80 μm. Cells very frequently divided into two descendant ones. No reproductive organs recorded.

Remarks. — The specimen is similar to several species known from the younger Paleozoic, but differs from them to such a degree that it seems purposeful to separate a new species. It differs from *S. concentrica* Maslov in the dimensions of cells and distribution of transverse septa, from *S. dionantina* Pia in the shape of thallus and distribution of transverse septa, and from *S. hillae* Paul in the lack of hypothallus and variability of the length of cells of the perithallus.

Occurrence. — Niwki *3* borehole near Dąbrowa Tarnowska, probably Lower Carboniferous, depth 2,276—2,279.5 m.

Type **Chlorophyta**
Class **Chlorophyceae**
Order **Siphonales**
Family **Dasycladaceae**
Genus *ACICULARIA* d'Archiac, 1843
Acicularia sp.
(Pl. 1, Fig. 8)

Material. — One specimen.

Remarks. — Algae of the genus *Acicularia* are common in the Jurassic and younger deposits; the oldest specimens known so far come from the Permian (Güvenc 1966). No *Acicularia* have hitherto been known from the Carboniferous. The presented specimen represents probably a new species, but a scarce material does not allow one to describe it satisfactorily.

Occurrence. — Bratkowice *1* borehole, Tournaisian, depth 2,669.8—2,671.8 m.

Genus *KONINCKOPORA* Lee, 1912 emend. Wood, 1943
Koninckopora sp.
(Pl. 8, Fig. 1)

Material. — One specimen.

Description. — A single, fragmentary thallus reveals cells closely adhering to each other and forming a continuous layer; cells are 100 to 150 μm in diameter, the walls of cells being 5 to 10 μm and layers of cells 400 μm thick.

Remarks. — The specimen conforms with the genus *Koninckopora;* due to the scarcity of material no specific diagnosis can be made.

Occurrence. — Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Family **Codiaceae**

Genus *GARWOODIA* Wood, 1941

Garwoodia media Johnson, 1945

(Pl. 8, Fig. 2)

1945. *Garwoodia media* Johnson; Johnson, p. 839, Pl. 4, Figs 2—3.

Material. — One specimen.

Description. — A single, fragmentary thallus 0.4 × 0.8 mm in size. Thallus composed of threads (tubes) 30 to 35 μm in diameter. The tubes display characteristic forklike branchings. Parcticular branchings deflect at a nearly right angle, then turn and take a direction parallel to the original threads. Each thread produces two or three branchings. The distance between particular threads suggests a thickness of wall of 8 to 15 μm. No reproduction organs recorded.

Remarks. — The dimensions of the threads of alga correspond to those given by Johnson (1945) for the species *Garwoodia media.*

Occurrence. — Lower Carboniferous of Colorado (Johnson 1945); Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

Genus *ORTONELLA* Garwood, 1913

Ortonella tarnoviensis sp. n.

(Pl. 6, Figs 1—2; Pl. 7, Fig. 1)

Holotype: specimen presented in Pl. 6, Fig. 1.
Type horizon: Lower Carboniferous (?).
Type locality: Tarnów *19* borehole, depth 2,626—2,632.5 m.
Derivation of the name: tarnoviensis — found in a borehole near Tarnów.

Material. — Three specimens.

Description. — The thallus forms a nodule 8 mm in size, oval, with regular margins and not lobular. No distinct concentric growth is visible. The thallus forms a bundle of threads (tubes), which grows radially from the center. The tubes are arranged rather irregularly and do not border on each other. The spaces between them amount to 50 μm and more. Inside, they are filled with a crystalline calcite, their external walls composed of a microcrystalline calcium carbonate fuse with a micritic substance which fills the space between particular threads. The inner diameter of tubes fluctuates within limits of 57 and 76 μm. The threads of alga branch dichotomously to form two derivatives at an angle of 57 to 65°. The branchings are spaced at interwals of 60 to 160 μm. No reproduction organs recorded. As the result of the grain-diminution process, the structure of thallus is locally obliterated.

Remarks. — The specimen differs from most known species of the genus *Ortonella* in a large angle of branching of algal threads. This angle is approximately the same as that observed in *Ortonella moscovica* Maslov but the presented specimen considerably differs in a larger diameter of tubes.

Maslov (1956) assigned the genus *Ortonella* (in fact, the same as *Garwoodia*) to the Schizophyta. The character of the development and branching of tubes is, however, similar to that in Recent algae of the family Codiaceae. The present writers resolved, therefore, to assign the described algae of the genera *Ortonella* and *Garwoodia* to the Codiaceae. A similar view is accepted by most investigators,

including Johnson (1961), as well as is expressed in an earlier paper of one of the writers (Golonka 1969).

Occurrence. — Tarnów *19* borehole, Lower Carboniferous(?), depth 2,626—2,632.5 m.

Type **Chlorophyta** or **Schizophyta**
Section **Porostromata**
Genus *GIRVANELLA* Nicholson & Etheridge, 1878
Girvanella ducii Wethered, 1890, subsp. *chuvashovi* subsp. n.
(Pl. 7, Fig. 2)

1946. *Girvanella* aff. *ducii* Wethered (1890); Johnson, pp. 1101—1102, Pl. 4, Fig. 2.
1965. *Girvanella* aff. *ducii* Wethered; Chuvashov, p. 74, Pl. 17, Fig. 3.

Derivation of the name: in honor of B. I. Chuvashov, a Soviet investigator of fossil calcareous algae.

Material. — Two specimens.

Description. — The alga forms nodules a few *mm* in size. They are composed of algal tubes arranged loosely and irregularly, locally twisted around each other. The tubes are filled with a light-colored, crystalline calcite. Their walls are composed of a dark, microcrystalline calcite and frequently fuse with the micritic environment. Dichotomous branchings are visible here and there. The internal diameter of tubes fluctuates within limits of 24 and 28 μm.

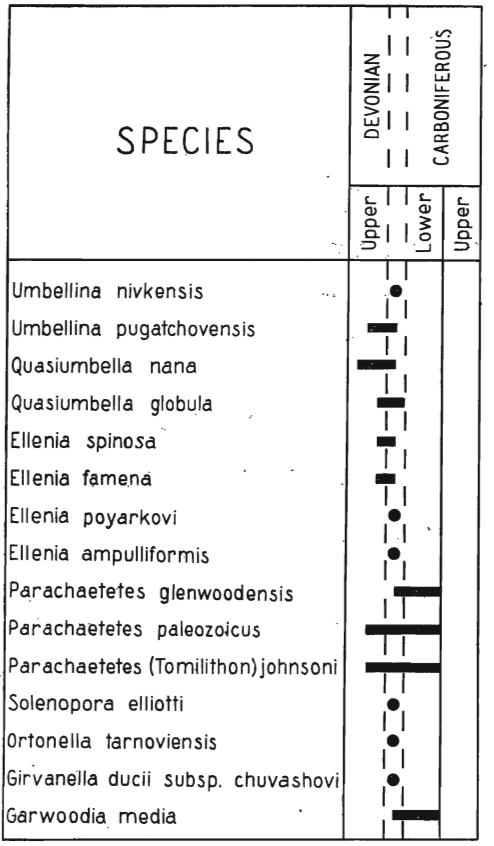
Remarks. — As typical dimensions of the species *Girvanella ducii,* Wethered (1890) gives a diameter of tubes of 20 μm measured along the external diameter. On the basis of Wethered's specimens, Wood (1963) gives 15 to 20 μm as an internal and 26 to 33 μm as an external diameter. The specimen under study, however, considerably differs in much larger dimensions from a typical *Girvanella ducii,* regardless of the fact which of the definitions would be adopted. Similar dimensions are given by Johnson and Chuvashov for the specimens which they describe as *Girvanella* aff. *ducii.* Since the dimensions of cells make up a fundamental diagnostic character of particular species of the genus *Girvanella,* the separation of a new subspecies seems to be purposeful.

Occurrence. — Famennian of the Ural (Chuvashov 1965), Upper Carboniferous and Lower Permian of the USA (Johnson 1946); Gumniska *1* borehole near Tarnów, Devonian-Carboniferous transitional beds, depth 3,130—3,136.8 m.

ECOLOGICAL AND STRATIGRAPHIC REMARKS

The algae described lived in a shallow, warm, marine environment, marked by a mobile water. Recent green and red algae live in waters with a normal or subnormal salinity (Maslov 1956, 1962; Johnson 1961). The Charophyta live in waters with an incomplete salinity. Fossil algae of the family Umbellinaceae have been found in deposits indicative of a marine environment. An admixture of terrigenic material, indicating a relatively small distance from the land, has been found in the deposits with algae from the Carpathian foreland. The algae do not form assemblages biohermal in character. They are found as single, separate thalli,

Table 1



Stratigraphical range of the discussed algae, based on referenced papers (Bykova 1955; Johnson & Konishi 1956; Maslov 1956, 1962; Conil & Lys 1964; Chuvashov 1965; Poyarkov 1966, Reitlinger 1966); inferred position of the new described species is marked by dots

but the utricles of the Umbellinaceae are concentrated in definite intercalations in which they occur abundantly. The green and red algae occur fairly abundantly; this indicates favorable conditions of their development, particularly good photic conditions. Assuming that the presence of the of the terrigenic material decreases the transparency of water, these algae lived in a very shallow basin, the depth of which did not exceed a dozen or so meters. The character of the algal assemblage and the presence of ostracods and *Calcisphaera* seem to indicate an environment of the "back reef" type.

Algae the family Umbellinaceae on the whole occur within narrow age limits and with an extensive geographical distribution. In the light of hitherto conducted studies, their occurrence ranges from the Givetian till Tournaisian (Reitlinger 1966, Mamet 1970). In many cases, the distri-

bution of particular species is confined to stages and even their parts (*cf.* Table 1). The discussed algae may therefore, in view of the scarcity of other fossils, play a certain role in stratigraphic correlation of the deposits from the Devonian-Carboniferous boundary of the Fore-Carpathian Depression.

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Cracow, June 1972

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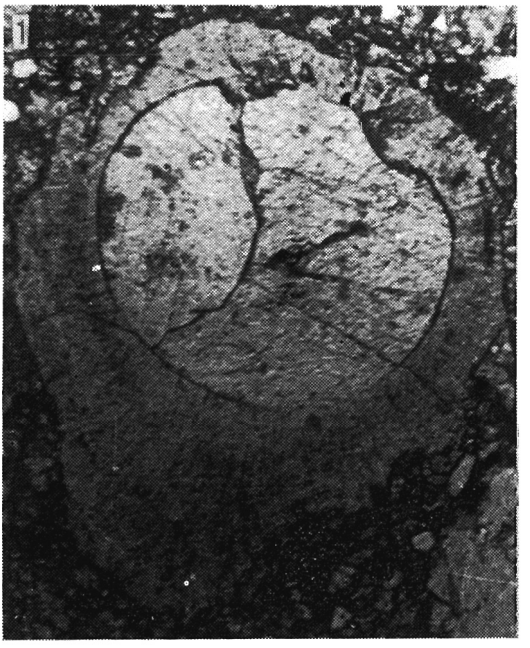
PLATE 1

1 — *Umbellina nivkensis* sp. n. (holotype); borehole Niwki *3* (depth 2449—2455).
2 — *Umbellina nivkensis* sp. n. (paratype); ibidem.
3 — *Umbellina* sp. *B;* Gumniska *1* (3200—3202).
4 — *Ellenia poyarkovi* sp. n. (holotype); Gumniska *1* (3200—3202).
5-6 — *Ellenia poyarkovi* sp. n. (paratypes); ibidem.
7 — *Quasiumbella nana* (Reitlinger) Poyarkov; Gumniska *1* (3130—3136).
8 — *Acicularia* sp.; Bratkowice *1* (2669—2671).

All figures are × 108, except Fig. 7 — × 114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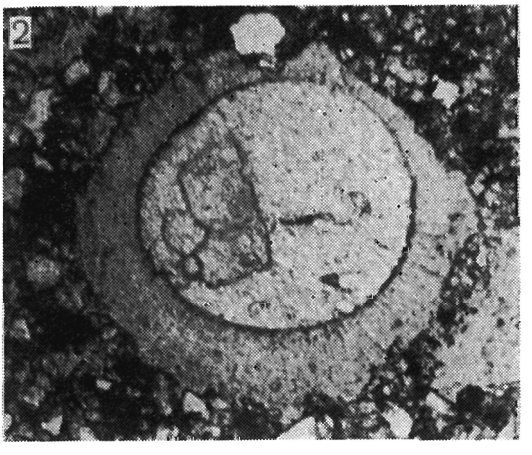
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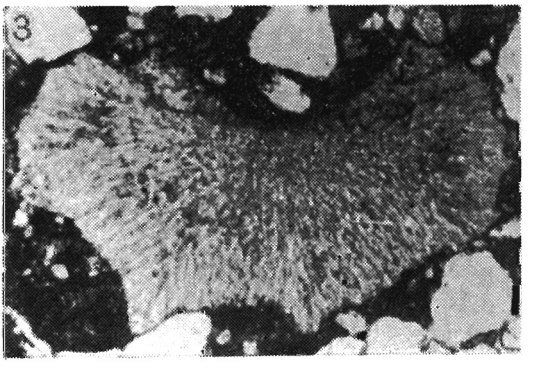
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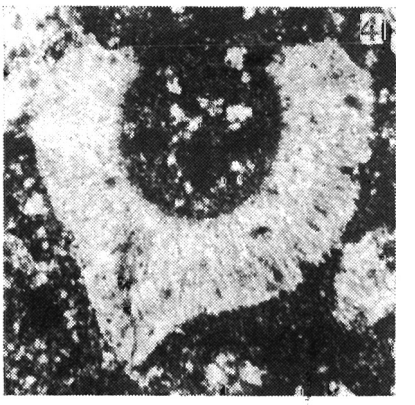
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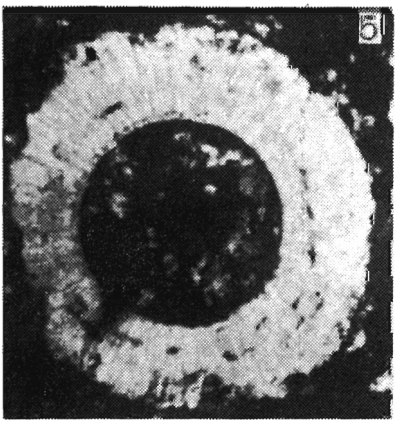
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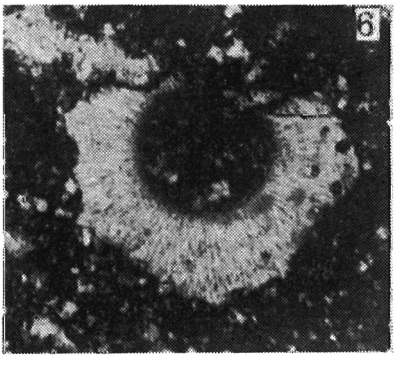
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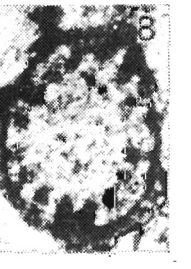
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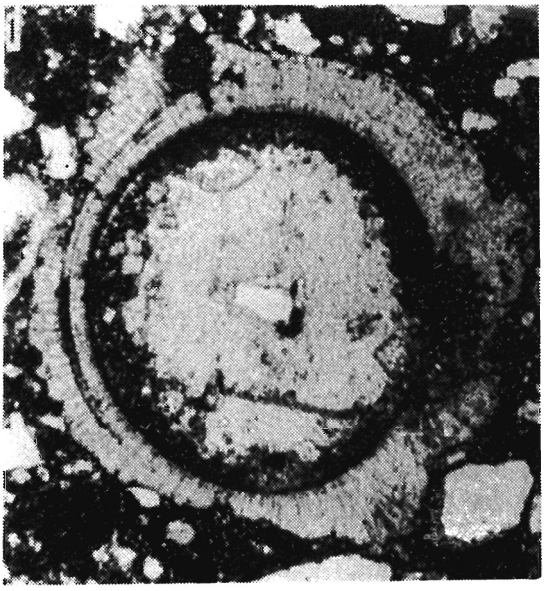
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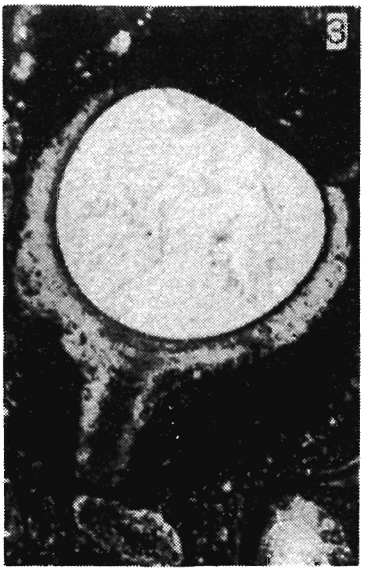
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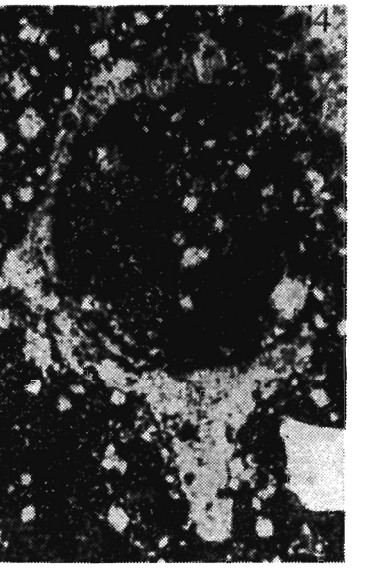
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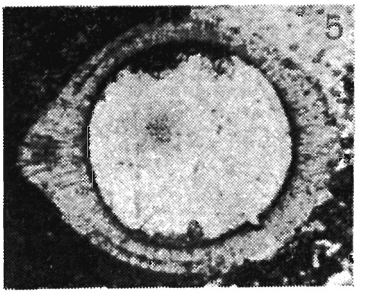
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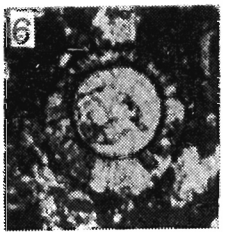
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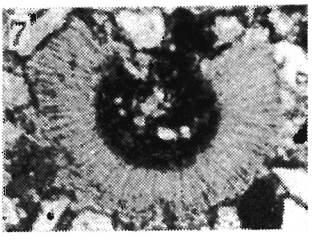
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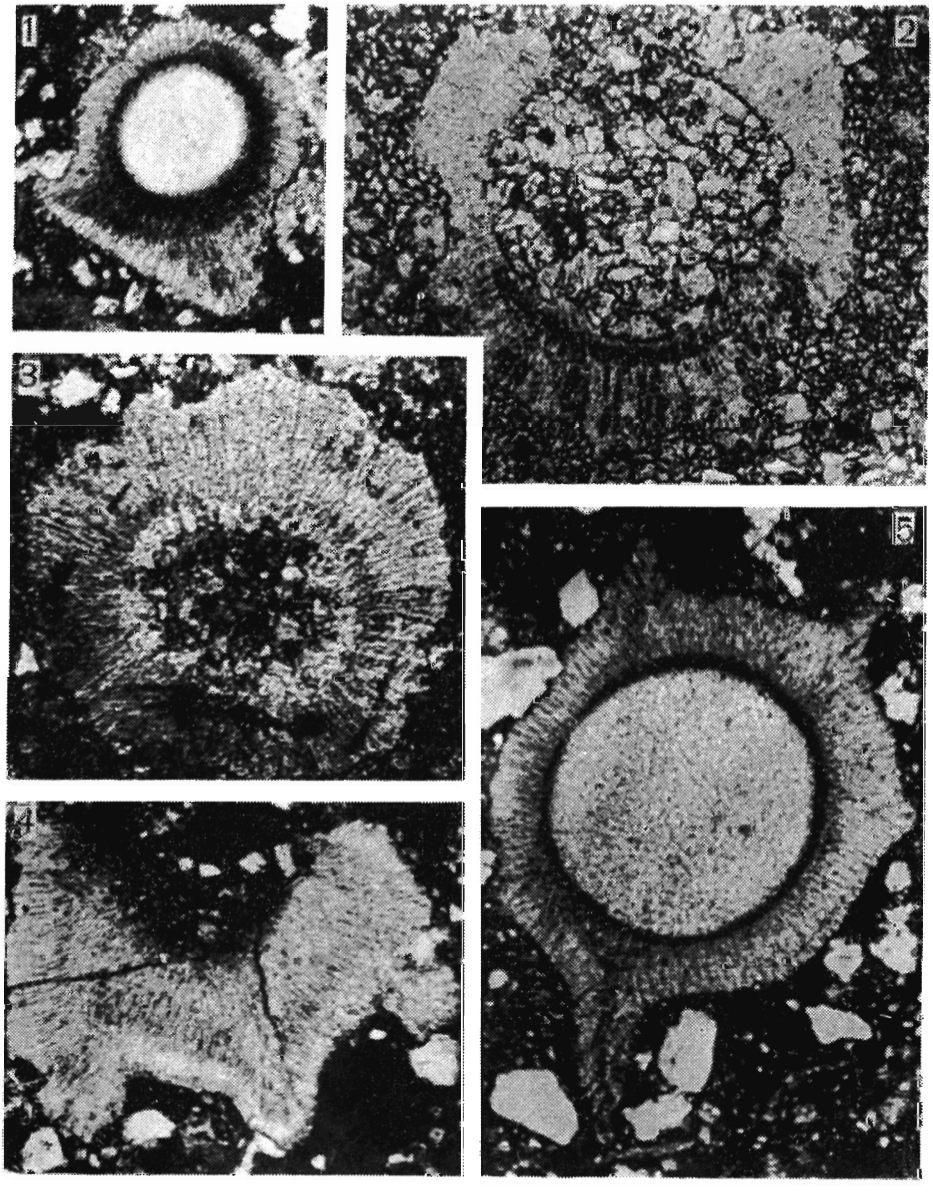
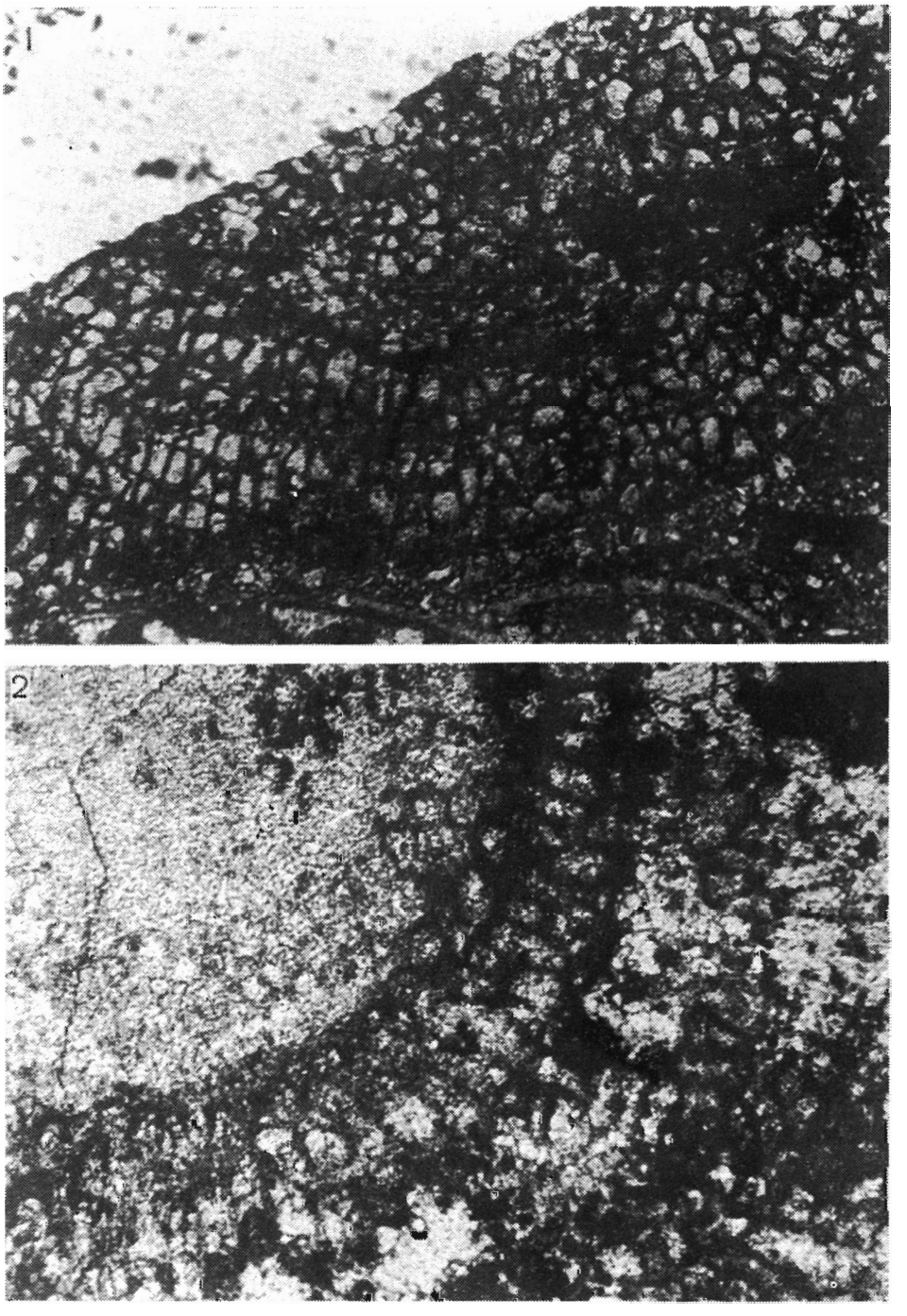


PLATE 3

1 — *Umbellina* sp. *C*; borehole Gumniska *1* (depth 3200—3202).
2-3 *Umbellina nivkensis* sp. n. (paratypes); Niwki *3* (2449—2455).
4 — *Umbellina* sp. *A*; Gumniska *1* (3200—3202).
5 — *Ellenia spinosa* (Conil & Lys) Mamet; Gumniska *1* (3130—3136).
All figures are × 108

PLATE 2 (*opposite page*)

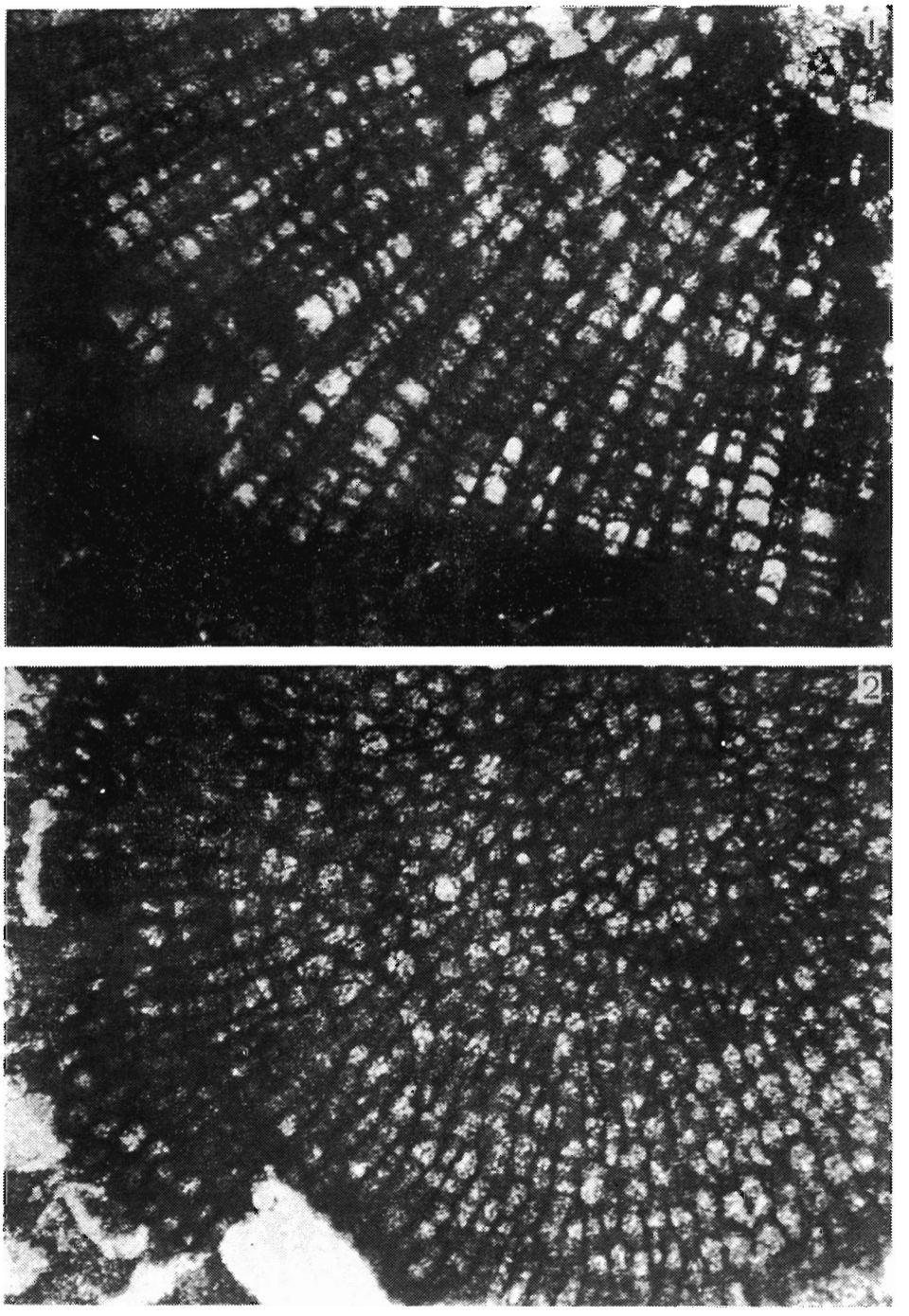
1-2 — *Ellenia famena* (Bykova) Poyarkov; borehole Gumniska *1* (depth 3130—3136).
3 — *Ellenia ampulliformis* sp. n. (holotype); Gumniska *1* (3200—3202).
4-5 *Ellenia ampulliformis* sp. n. (paratypes); ibidem.
6 — *Umbellina* cf. *pugatchovensis* Bykova; ibidem.
7 — *Quasiumbella globula* (Reitlinger) Poyarkov; Niwki *3* (2343—2348).
All figures are × 108



1 — *Parachaetetes glenwoodensis* (Johnson); borehole Gumniska *1* (depth 3200—3202).

2 — *Parachaetetes paleozoicus* (Maslov) Pia; Tarnów *19* (2626—2632).

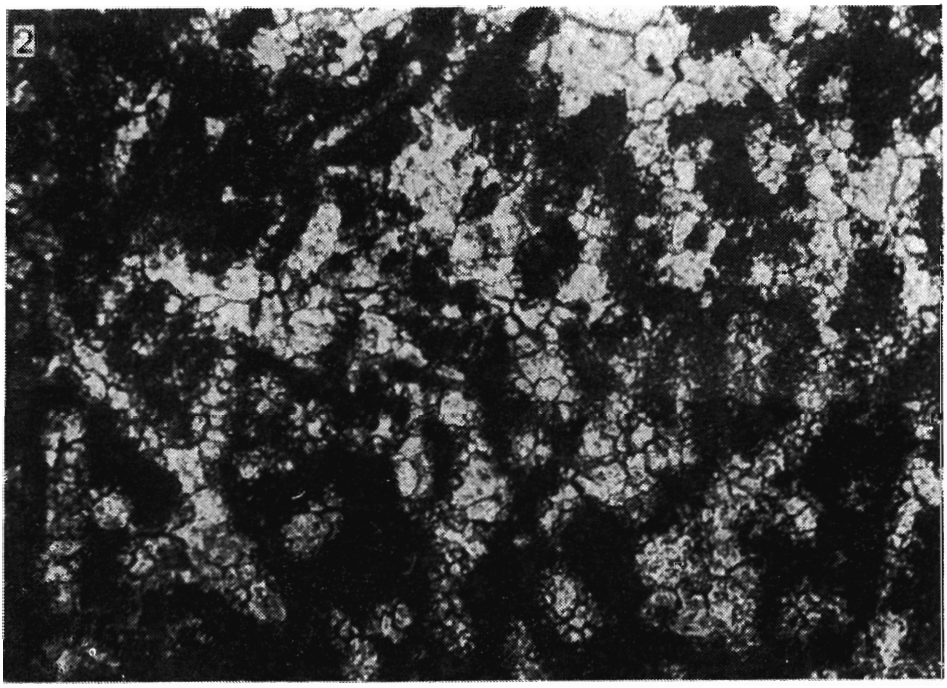
Both figures are × 100

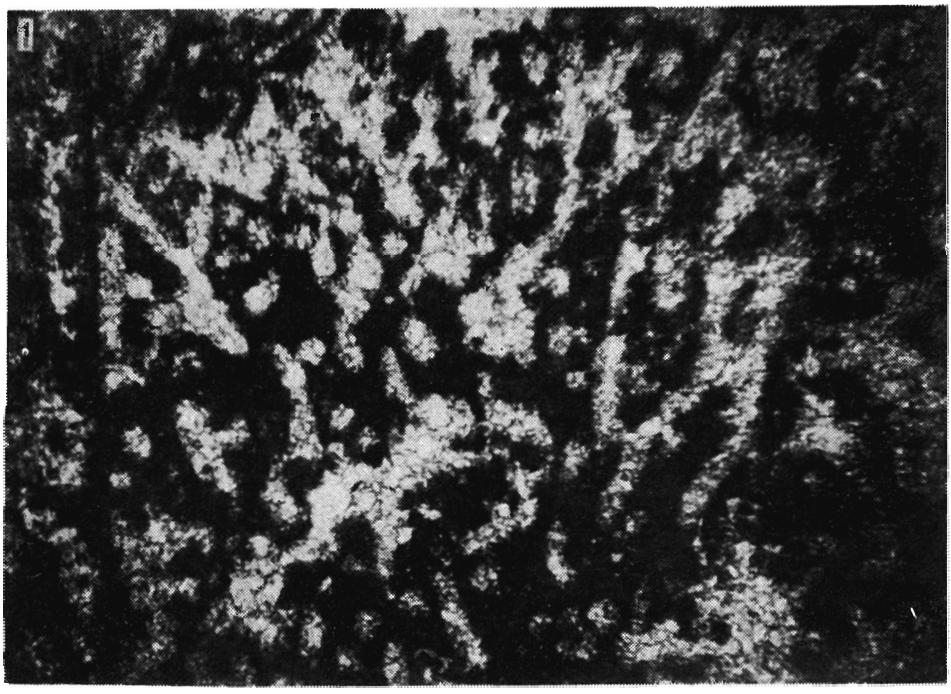


1 — *Parachaetetes (Tomilithon) johnsoni* Maslov; borehole Gumniska *1* (depth 3200—3202).

2 — *Solenopora elliotti* sp. n. (holotype); Niwki *3* (2276—2279).

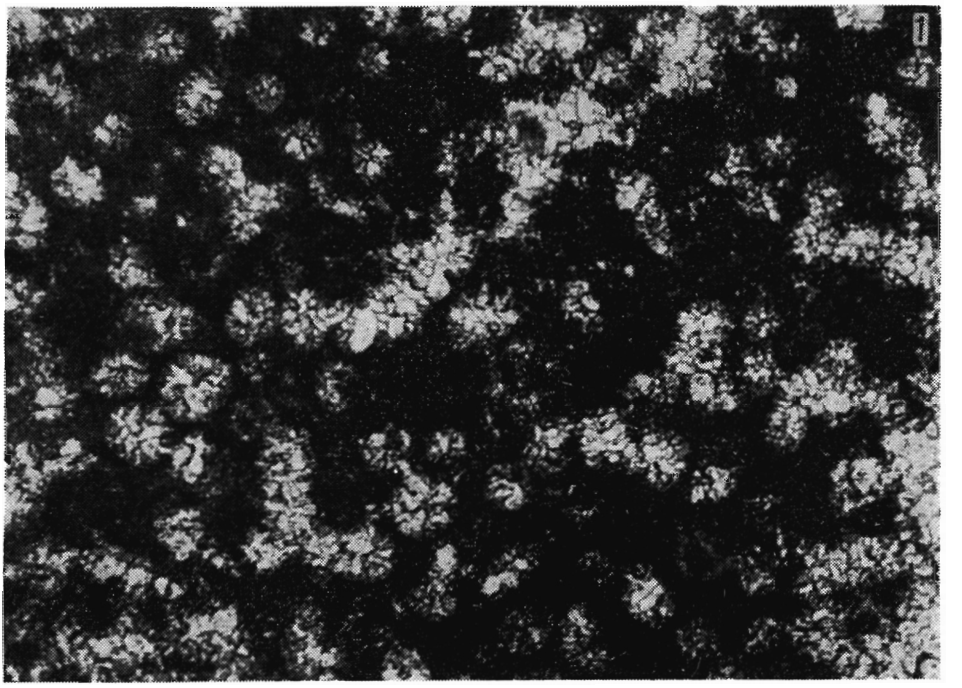
Both figures are × 100

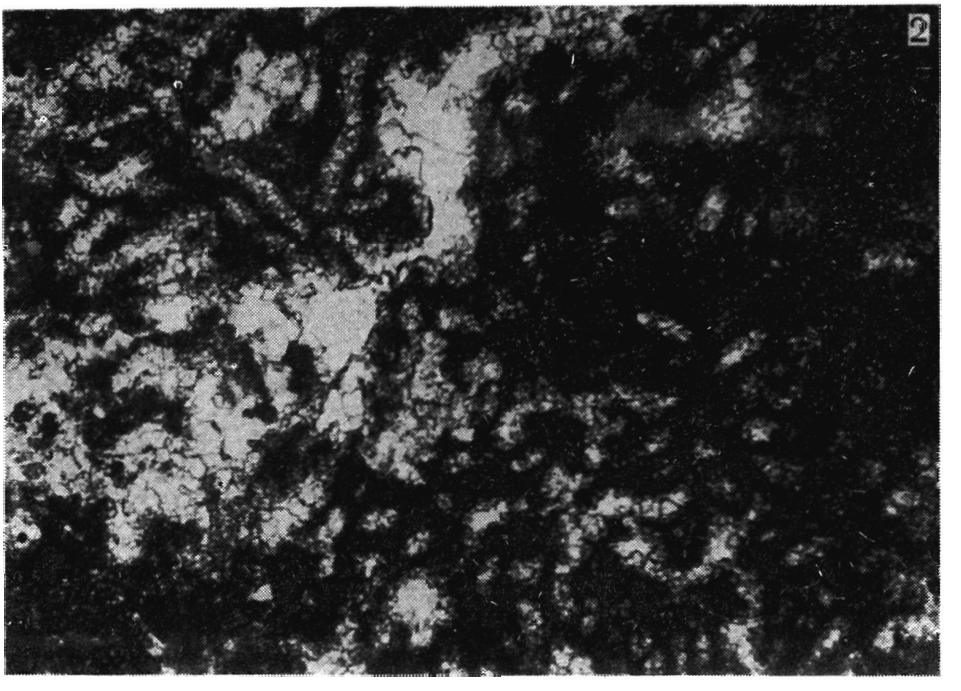




1 — *Ortonella tarnoviensis* sp. n. (holotype in longitudinal section); borehole Tarnów *19* (depth 2626—2632); × 55.

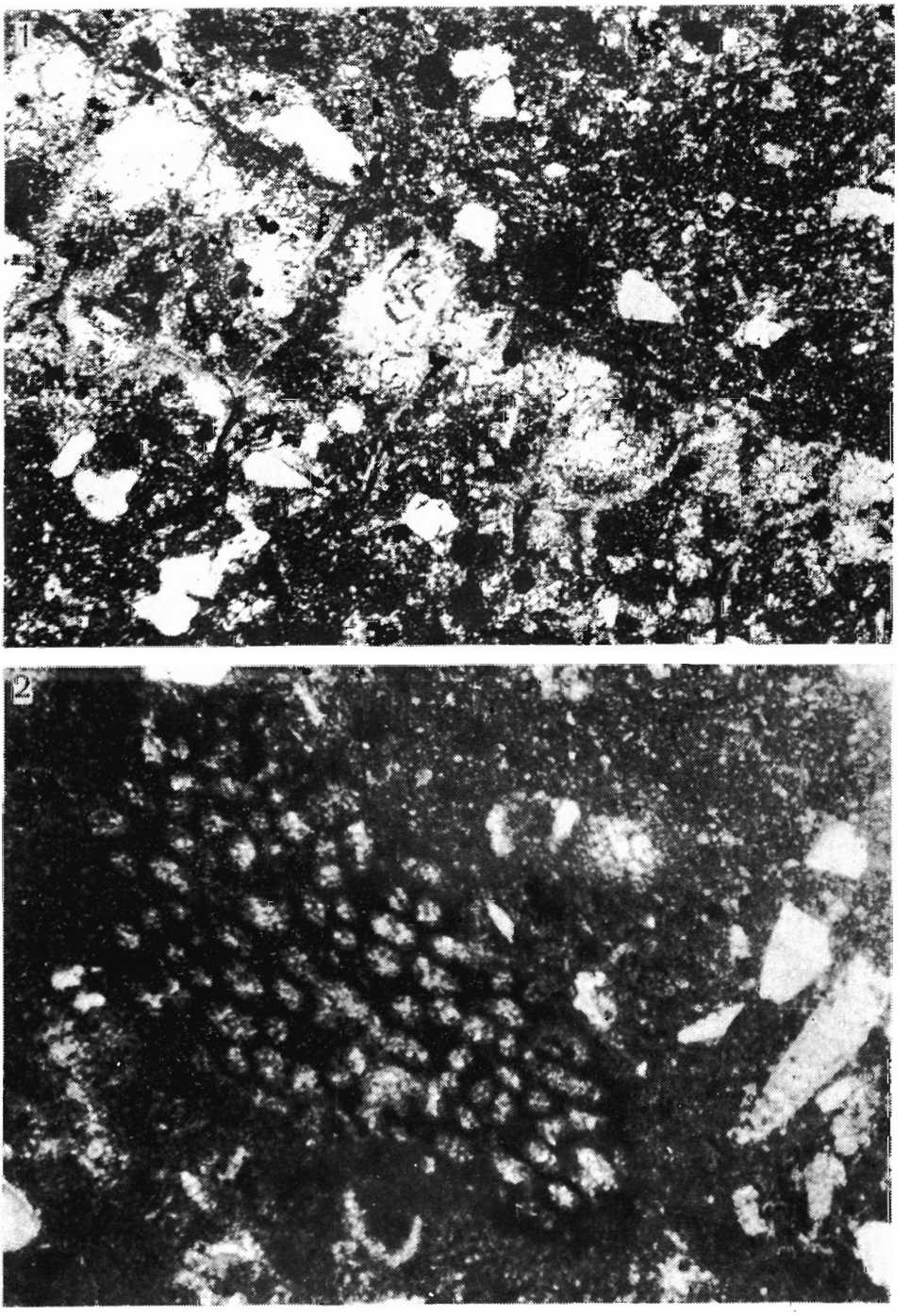
2 — Fragment of the preceding figure; × 100.





1 — *Ortonella tarnoviensis* sp. n (holotype in transverse section, *cf.* Pl, 6, Figs 1—2); × 100.

2 — *Girvanella ducii* subsp. *chuvashovi* subsp. n. (holotype); borehole Gumniska 1 (depth 3130—3136); × 108.



1 — *Koninckopora* sp.; borehole Gumniska 1 (depth 3136—3136).
2 — *Garwoodia media* Johnson; ibidem.

Both figures are × 100