THE PERMIAN CALCAREOUS ALGAE FROM SOUTHEASTERN ANATOLIA

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INTRODUCTION

In the summer of the year 1958, I received some limestone samples which were collected near the village of Hazru (Diyarbakır - SE Anatolia) by R. H. Wagner[1].

During 1951 and 1954, this region had already been studied by Dr. Necip Tolun. According to the latter the entire stratigraphical column, which ranges here from the Devonian into the Quaternary, would be deposited in an environment of continual subsidence. With regard to the Paleozoic he states that the Carboniferous strata, which cover the Devonian, consist of bituminous plant fossil containing sandstones. The Carboniferous is overlaid by Permian limestones from which he mentions:

Mizzia yabei Karp.
Mizzia sp.
Gymnocodium
Staffella sp.

R. H. Wagner's samples were collected by him from these Permian limestones, about 50 m. above the top of the Carboniferous sandstone. Thin sections prepared from these samples showed the presence of two distinct groups of green algae, which are the subject of the present study.

SYSTEMATIC DESCRIPTIONS

Class **CHLOROPHYTA**

Subclass CHLOROPHYCEAE

Order **Siphonocladales**

Family *DASTCLADACEAE*

Among the remains of Dasycladaceae, found in the Hazru region, there is an abundant representation of *Mizzia*. Furhermore, one fragment of *Gyroporella* has been found. No other examples of. Dasycladaceae have been encountered in the material from the Hazru region.

Genus *Mizzia* SCHUBERT 1907

Pl. I, fig. 1

Diagnosis (after Jonhson, 1951, p. 23).— «Thallus composed of several spherical or elongated members growing on a common stem, suggesting a string of beads. These members usually break apart at the narrow connecting necks. Central stem relatively thick, swelling in the center of each member and narrowing at the necks. The pores representing the primary branches unbranched, increasing in size toward the exterior and arranged in concentric rows around the stem. Sporangia unknown, possibly they developed within the central stalk.» This genus has been discussed in detail by Johnson and Dorr (1942).

Mizzia velebitana SCHUBERT

Pl. I, figs. 2-3; Pl. II, fig. 1

Mizzia Schubert, 1907, K. k. Geol. Reichsansalt, Verhandl. Wien, no. 8, p. 212.

Mizzia velebitana Schubert, 1908, K. k. Geol. Reichsansalt, Wien, Jahrbuch Band 58, Heft 2, p. 382, pl. 16, figs. 8-12.

Mizzia velebitana Karpinsky, 1908, Russ. Min. Gesell. Verh., ser. 2, vol. 46, p. 262, pl. 3, figs. 6-9.

Mizzia cf. *velebitana* Karpinsky, idem, p. 266, pl. 3, figs. 1, 3,4, 10-13.

Guadalupia ? sp. Girty, 1908, U.S. Geol. Survey Prof. Paper 58, p. 85, pl. 5, figs. 7-11.

Mizzia velebitana Pia, 1920, Zool. Botan. Gesell. Wien, Abh., Band 11, Heft 2, p. 19, figs. 12-23, pl. 1.

Mizzia velebitana Ogilvie Gordon, 1927, Geol. Besch. besonderer Berück. Über. III. Teil, Abh. Geol. Bundesanstalt, XXIV, 2, Wien. p. 72, Taf. IX. fig. 8.

Mizzia velebitana Pia, 1937, 2^{e} Cong. Strat. Carbonif. Heerlen 1935, Compte rendu, p. 765, pl. 9, fig. 3.

Mizzia velebitana Pia, 1940, Akad. Wiss. Wien, Math.-natur. Kl., Sitzungsber.

Mizzia velebitana Johnson and Dorr, 1942, Jour. Paleontology, vol. 16, no. 1, pp. 71-73, pl. 9, figs. 1,3; pl. 10, figs. 2, 3, 5; pl. 11, figs. 1, 2.

Mizzia velebitana Johnson, 1942, Geol. Soc. America Bull., vol. 53, pp. 203-205, pl. 2, figs. 1, 2, 4; pl. 3, figs. 1, 2, 3.

Mizzia velebitana Johnson, 1951, Journ. Paleontology, vol. 25, no. 1, p. 23, pl. 7, figs. 1-4.

Description of specimens.— Thallus composite, with symmetrical, pyriform or, more seldom, spherical members growing on a stem - like axis. They are mostly found isolated, because of their breaking off at the slender connection between members. The wall is traversed by numerous canals, representing the primary branches, which are generally constricted in the central part and enlarged at both ends. The branches appear in polygonal (mostly hexagonal) outline in tangential section on the outer side of the members. If the section runs closer to the central part of the branch, it becomes gradually more cir-

cular in outline. Some specimens appear to be covered by a thin calcareous membrane which, in certain places, shows the presence of small, more or less circular pores. No traces of sporangia have been observed.

Remarks. — The specimens described above from the Hazru region in SE Anatolia are closely similar to *Mizzia velebitana* Schubert from the Velebit Mts. in Yugoslavia (cf. Pia 1920, p. 19). Still, they differ somewhat in the shape of the members which are more distinctly pyriform in the Anatolian specimens than they are in the European material. Also, the constricted area between members is more slender and longer in the Anatolian specimens than in the European ones. In both these respects, the Anatolian specimens resemble more closely the material of *Mizzia velebitana* Schubert as described from the Apache Mts. in Texas (Harlan Johnson, 1951, p. 23). However, they have more symmetrical members then the American specimens.

Occurrence. — Turkey: Upper Permian of Hazru region (province of Diyarbakır) in SE Anatolia.

Localities. — Hill-top at 900 metres ENE of Hazru village (Coll. Wagner no. 3); at 400 metres SE of Girihabo tepesi (Coll. Wagner no. 4); on the slope of Zinareşebe tepesi (Coll. Wagner no. 8).

Dimensions of *Mizzia velebitana* SCHUBERT

	Longitudinal sections					*Transversal sections of equatorial region*				
L *Members' length*	2.760	2.280	2.760	2.880	2.976	*Counted 23 - 24 pores*				
D *Outer diameter*	1.896	1.992	2.040	2.040	2.400	2.160	2.100	2.160	1.960	2.352
d *Inner diameter*	0.984	1.800	1.272	1.200	1.680	1.584	1.480	1.536	1.320	1.680
s *Wall thickness*	0.456	0.360	0.384	0.400	0.360	0.336	0.360	0.300	0.360	0.360
p *Diameter of pores*	0.240	0.216	0.168	0.240	0.240	0.192	0.210	0.240	0.240	0.192
	Coll. no. 3			Coll. no. 8		Coll. no. 3		Coll. no. 8		Coll. no. 4

Furthermore, Europe: At Paklenica region, Velebit Mts. North Dalmatia, in dolomites and black shales. Kiurka at Parnes of Greece, in dark limestones. From the uppermost Carboniferous (Pia 1920, p. 22). Austria/Tirol from the Bellerophon limestones of the Upper Permian in the Western Dolomite region (Ogilvie Gordon, 1927, p. 73).

America: New Mexico, Guadalupe Mts. and Texas, Apache Mts. in late Middle or Upper Permian limestones (Johnson, 1942 and 1951).

Asia Minor: *M. velebitana* has been found in Permian limestones of the following regions: Hakkari, Muğla, Taurus, and Kayseri/Sarız.

Mizzia minuta JOHNSON et DORR

Pl. II, fig. 2

Mizzia minuta Johnson et Dorr, 1942, Journ. Paleontology, vol. 16, no. 1, pp. 73-75, pl. 9, fig. 2; pl. 12, fig. 2.

Mizzia minuta Johnson, 1942, Bull. Geol. Soc. America, vol. 53, p. 205, pl. 4, fig. 4; pl. 5, fig. 4.

Mizzia minuta Johnson, 1951, Journ. Paleontology, vol. 25, no. 1, p. 24, pl. 10, fig. 4.

Description of specimens. — Thallus unbranched, composite, consisting of several members which develop along a single axial cavity. Individual members are mostly symmetrical and ellipsoidal in shape (less often spherical). They are always found isolated, apparently breaking off easily at the connection between members. The members end always in a long and slender neck which may well have favoured breaking at that point. The wall of the members is traversed by numerous unbranched canals of which the diameter increases from the axial cavity outwards. In the equatorial region of the members the number of these canals amounts to 10-14. They are polygonal in outline on the outer side of the members. No trace of sporangia has been observed.

Remarks. — The specimens described here are different from *Mizzia velebitana* Schubert because of the markedly smaller size of its members as well as by the smaller number of canals which traverse their walls. In regard to these properties they conform to the description of *Mizzia minuta* Johnson and Dorr from the Permian of Texas, which has also the same measurements of members and canals. The ellipsoidal shape of the members and the long and slender neck at the end of the Anatolian specimens offers a certain degree of contrast with the North American specimens from Texas which are characterized by more spherical members. However, this difference is not supposed to be important enough to warrant a new variety name for the Anatolian specimens.

Dimensions of *Mizzia minuta* JOHNSON et DORR

	Longitudinal sections			*Transversal sections of equatorial region*		
L *Members' length*	1.860	1.320	1.080	*Counted 10-14 pores*		
D *Outer diameter*	0.864	0.888	0.864	0.952	0.960	1.008
d *Inner diameter*	0.360	0.288	0.360	—	—	0.588
s *Wall thickness*	0.240	0.240	0.264	—	—	0.588
p *Diameter of pores*	—	—	0.144	0.196	0.168	0.192
	Coll. no. 4		Coll. no. 3	Coll. no. 4		

Occurrence, — Turkey: Upper Permian deposits of Hazru region (Diyarbakır prov.) in SE Anatolia.

Localities. — Hill-top at 900 metres ENE of Hazru village (Coll. Wagner no. 3); at 400 metres SE of Girihabo hill (Coll. Wagner no. 4).

Furtherniore, America: New Mexico, Guadalupe Mts. and Texas, Apache Mts. in late Middle or Upper Permian limestones (Johnson, 1942 and 1951).

Mizzia yabei (KARPINSKY) PIA

Pl. II, figs. 3-4

Stolleyella (?) yabei Karpinsky, 1908, Verh. russ. min. Ges. St. Petersburg, (2) 46, pp. 268-269, Text - fig.

Stolleyella velebitana Karpinsky, 1908, Verh. russ. min. Ges. St. Petersburg, pl. 3, fig. 8.

Mizzia yabei Pia, 1920, Zool-Botan. Gesellschaft. p. 23, pl. I, figs. 4-6.

Mizzia yabei Ogilvie Gordon, 1927, Abh. Geol. Bundesanstalt Band: XXIV, Heft 2, p. 73, pl. IX, fig. 10.

Mizzia yabei Pia, 1937, II Congres Stratig. Carbonifere, Heerlen. C. R. 1935. p. 828.

Mizzia yabei Johnson et Dorr, 1942, Jour. Paleont, vol. 16, p. 75, pl. 10, figs. 1-6; pl. 12, figs. 1, 3.

Mizzia yabei Johnson, 1942, Bull. Geol. Soc. America, vol. 53, p. 207, pl. 3, figs. 4, 6; pl. 7, fig. 2.

Description of specimens- — Members elongate elliptical, about twice longer than broad, with the largest diameter near the upper part of the member. Branches non-ramified. Each member is clearly constricted at the base. Broken-off members show the constricted area as a neck-like projection which is often open at the end. No connected members have been observed in the specimens at hand. The wall of the members is traversed by numerous small canals which show a hexagonal outline at opening on the outer side. No traces of sporangia have been observed.

Remarks. — Mizzia yabei (Karpinsky) may be distinguished in longitudinal section from *Mizzia velebitana* because of the latter's larger size and more globular aspect of the members. From *Mizzia minuta* it differs only because of the more elongated elliptical habit of the members in *Mizzia yabei.* Because of the similarity in dimensions, it is practically impossible to distinguish between *Mizzia yabei* and *Alizzia minuta* in transverse section. *Mizzia velebitana* is outstanding because of its bigger size. There are numerous transverse sections of small *Mizzia* fragments in the material at hand, which may well belong to *Mizzia yabei* members cut near the constricted area.

Our specimens of *Mizzia yabei* seem to conform quite well to those figured by Pia (1920) and Ogilvie Gordon (1927) from the Upper Permian of the Velebit Mountains in Yugoslavia and the Dolomite region in Tirol (Central Europe).

Dimensions of *Mizzia yabei* (KARPINSKY)

	Longitudinal sections					
L *Members' length*	1.500	1.480	1.368	2.300	2.400	2.526
D *Outer diameter*	0.960	0.720	0.864	1.176	1.200	1.320
d *Inner diameter*	0.456	0.240	0.216	0.240	0.480	0.550
s *Wall thickness*	0.240	0.240	0.288	0.480	0.360	0.400
p *Diameter of pores*	—	0.168	—	0.216	—	0.240
	Coll. no. 4			Coll. no. 8		

Occurrence- — Turkey: Upper Permian limestones in the Hazru region (prov. Diyarbakır) in SE Anatolia.

Localities. — At 400 metres south of Girihabo tepesi (Coll. Wagner no. 4); On the slope of Zinareşebe tepesi (Coll. Wagner no. 8).

Furthermore, Europe: At Paklenica region, Velebit Mts. North Dalmatia. Most in dolomites and less in black shales. Austria/Tirol from the Bellerophon limestones of the Upper Permian in the Western Dolomite region (Ogilvie Gordon/1927, p. 73).

Asia: Akasaka region, Japan. In black massive limestone zone of *Neoschwagerina globosa*. From the uppermost Carboniferous (Pia, 1920, p. 24).

America: New Mexico, Guadalupe Mts, in late Middle or Upper Permian limestones (Johnson, 1942).

Asia Minor: *M. yabei* has been found in Upper Permian limestones of the Taurus region.

Genus: *Gyroporella* GUMBEL 1872 emend BENECKE

For a diagnosis of this genus see Pia, 1912, p. 35, as well as Pia, 1920, p. 34.

Gyroporella sp.

Pl. III, fig. 1

In our material there is only one longitudinal section which shows the general characteristics of the genus *Gyroporella*. This is not enough to identify the species, for which a more ample choice of specimens would be required.

Description of specimen. — Long cylindrical thallus which expands at the top to a club-shaped appearence. It consists of a relatively large central cavity surrounded by a calcereous wall traversed by numerous primary branches which end in pores on the outer wall. No sporangia were observed.

Dimension :

Length of the thallus	*Width of the thallus*	*Diameter central stem*	*Thickness calcareous wall*	*Diameter of branch*
3.576	0.936	0.432	0.240	0.110

Remarks- — The dimensions of our fragment resemble those of *Gyroporella symetrica* Johnson. It cannot be identified with this species, however, because no other characteristics of this species are visible in the specimen at hand.

Occurrence.— Asia Minor: Upper Permian of Hazru region (province of Diyarbakır) in SE Anatolia.

Locality. — Hill - top at 900 metres ENE of Hazru village (Coll. Wagner no. 3).

Order **Siphonales**

Family *CODIACEAE*

Only one genus from this family is present in our material.

Genus *Gymnocodium* PIA 1919

This genus is characterized by a cylindrical, oval and club-shaped thallus, which may consist of numerous well-defined segments. These are cylindrical, oval or cone-shaped, and circular or oval in cross-section. Thallus single or dichotomizing. It is covered by a calcareous wall perforated by numerous pores. In the calcareous body there are dark tubular molds which are preserved in a lighter calcareous mass. The inner part of the thallus is seldom preserved. In well-preserved specimens the original plant fibres can be seen as longitudinal streaks through the central part of the thallus and radiating at the margin. The marginal parts of the plant fibres are calcified and constitute together the calcareous wall of the thallus. The amount of calcification may vary enormously. They end in well-marked pores on the outer wall. Sporangia spherical to oval-shaped. They are placed in the outer parts of the thallus.

Gymnocodium nodusum OGILVIE GORDON 1927

PL III, figs. 2-4; Pl. IV, fig. 1.

Gymnocodium nodosum Ogilvie Gordon, 1927, Geol. Besch. besonderer Berück. Über. III. Teil, Abhan. Geol. Bunde. Band XXIV, Heft 2, Wien p. 71, Taf. IX, fig. 9; Taf. XIII, fig. 5.

Gymnocodium nodosum Pia, 1937, 2^{e} Congres Stratig. Garbonif. Heerlen, 1935, Compte rendu, p. 833, pl. II, fig. 7.

Gymnocodium nodosum Elliott, 1955, Micropaleontology, vol. 1, no. 1, p. 85.

Gymnocodium nodosum. Accordi, 1956, Jour. Palaeon. Soc. India, vol. 1, no. 1, p. 83, Pl. 7, fig. 2; Pl. 8, part of fig. 4; Pl, 9, figs. 1-3; Pl. 12, figs. 1-8.

Description of specimens. — Thallus cylindrical, oval or cone-shaped; sometimes they are seen to be branched, although mostly they are found single. The thallus shows a more or less regular thickening and constricting of members. Consequently, they are separated by neck-shaped area. Up to 2 or 3 connected members may be observed in the sections. Each member is oval or, more fre-

quently, cone-shaped. The upper part of each member is only slightly constricted, so that the greatest diameter of the members is to be found at the distal side. In most sections no algal threads are observed in the inner part of the members, so that a hollow remains within the thick calcareous wall. The thickness of the wall is more or less constant throughout the thallus. The wall is traversed by numerous large pores, which widen outwards. They show a hexagonal outline in tangential section. Near the calcareous wall of the members there are sporangia of oval or spherical shape which, on the proximal side, taper into a blunt protuberance. These protuberances point practically always towards the outer side of the member's wall. The sporangia are placed oblique to the central axis (Pl. III, fig. 4). The specimens in hand show big members and large pores. Their measurements are given in Table I.

Remarks.— The Anatolian specimens described here are similar in general appearance to both *Gymnocodium belterophontis* Rothpletz and *Gymnocodium nodosum* Ogilvie Gordon. The latter has generally larger dimensions and a proportionally wider central cavity as well as a thicker calcareous wall. These characteristics are visible as well in our specimens, so that they should be attributed to *G. nodosum.* The dimension differences between *G. bellerophontis, G. nodosum* and Anatolian specimens are shown in Table II.

Table I

Dimensions (in mm.) Anatolian specimen in longitudinal sections

Size of the members			*Thickness of the calcification*	*The diameter of the pores*	*Dimensions of the sporangia*
Length	*Outer diameter of the largest part*	*Inner diameter of the largest part*			
2.400	2.352	—	—	0.066	—
3.480	2.400	1.560	0.504	0.077	0.330 x 0.440
3.240	2.400	1.200	0.720	0.066	—
1.920	1.272	0.456	0.456	0.055	0.330 x 0.600
—	—	—	—	—	0.336 x 0.576

Table II

	G. bellerophonti	*Anatolian specimen*	G. nodosum
Outer diameter	0.500-1.250 *mm.*	1.720-2.422	2.250-3.500
Inner diameter	0.070-0.150	1.100-1.560	1.160-2.280
Thicknes of the wall	0.012-0.015	0.360-0.724	—
Pores diameter	0.020-0.050	0.066-0.077	—

Occurrence. — Turkey: Upper Permian of Hazru region (province of Diyarbakır) in SE Anatolia.

Localities. — On the slope of Zinareşebe tepesi (Coll. Wagner no. 6, 8).

Furthermore, Austria / Tirol from the Bellerophon limestones from the Upper Permian to passage of the Lower Trias in the Western Dolomites (Ogilvie Gordon 1927, p. 727).

Gymnocodium fragile PIA

PL IV, figs. 2, 3

Gymnocodium fragile Pia, 1937, 2e Congres Strat. Carbonif. Heerlen 1935, Compte rendu. p. 834, PL 12, figs. 1, 2.

Gymnocodium fragile Johnson, 1951, Journal Paleontology, vol. 25, No. 1, p. 28, PL 9, figs. 1-7.

Permocalculus fragilis Elliott, 1955, Micropaleontology, vol. I, No. 1, p. 86, PL 1, figs. 1-2.

Description of specimens. — Only two tangential sections of this species were observed. Thallus cylindrical (constrictions between members are only faintly indicated). Surface covered by closely-spaced pores. Sporangia cortical and circular in transverse section. Branched algal threads are observed.

D:	2.688	Pore diam:	0.022	Diameter of sporangia in transverse	
D:	3.000	Pore diam:	0.033	section :	0.220

The dimensions of the central cavity could not be measured as only tangential sections were available.

Remarks. — In general appearance and dimensions this form resembles closely Pia's illustration of *G. fragile* (Pia, 1937). Our specimens conform also quite well to Harlan Johnson's description and figures of *G.* cf. *fragile* from the Apache Mountains. They are also very similar to Elliott's *Permocalculus fragilis.* The genus *Permocalculus* Elliott is founded on such characteristics (i.e. a relatively big thallus and numerous small pores) as are considered more suitable for a distinction between species, so that it is preferred here to stick to the name *Gymnocodium.*

Occurrence.— Turkey: Upper Permian of Hazru region (province of Diyarbakır) in SE Anatolia.

Localities. — Hill- top at 900 metres ENE of Hazru village (Coll. Wagner no. 3); on the slope of Zinareşebe tepesi (Coll. Wagner no. 6, 8).

Furthermore, Europe / Yugoslavia : Bosna. From the Permian (Pia, 1937).

America : Texas Apache Mts. in late Middle or Upper Permian limestones (Johnson, 1951).

Asia/Iraq: In Northern Iraq Permian limestones formation, which is continuous of the Harbol formation of Turkey (Elliott, 1955).

CONCLUSIONS

From the Hazru region in SE Anatolia some limestone samples were brought by R. H. Wagner and examined by the present author. These samples came from about 50 metres above a horizon with continental strata containing a fossil flora of Middle Permian (Upper Shihhotse series in N China) or Upper Permian (Raniganj stage of the Lower Gondwanas in India) age. From the limestone samples a number of well-preserved remains of calcareous Algae were obtained which showed an association of species comparable to those encountered by different authors in the Upper Permian of Europe, N America and E Asia (Japan). Under these circumstances, it seems to be most probable that the limestone samples received from the Hazru region in SE Anatolia came as well from the Upper Permian.

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EXPLANATION OF PLATES

(All figures from Hazro/Anatolia)

PLATE - I

Mizzia

Fig. 1 - *Mizzia* limestone. 10 x
Fig. 2 - *Mizzia velebitana* Schubert. Transverse section 20 x
Fig. 3 - *Mizzia velebitana* Schubert. Longitudinal section 20 x

PLATE - II

Mizzia

Fig. 1 - *Mizzia velebitana* Schubert. Transverse and longitudinal sections both 20 x
Fig. 2 - *Mizzia mintita* Johnson and Dorr, limestone 10 X
Fig. 3 - *Mizzia yabei* (Karpinsky). Longitudinal section with *Mizzia velebitana* Sch. Transverse sections 20 x
Fig. 4 - *Mizzia yabei* (Karpinsky). Longitudinal section 20 x

PLATE - III

Gyroporella and Gymnocodium

Fig. 1 - *Gyroporella* sp ind. Longitudinal section 20 x
Fig. 2 - *Gymnocodium nodosum* Ogilvie Gordon. Tangential section 20 x
Fig. 3 - *Gymnocodium nodosum* Ogilvie Gordon. Limestone 10 x
Fig. 4 - *Gymnocodium nodosum* Ogilvie Gordon. Longitudinal section with sporangium 20 x

PLATE - IV

Gymnocodium

Fig. 1 - *Gymnocodium nodosum* Ogilvie Gordon. Transversal sections 20 x
Fig. 2 - *Gymnocodium fragile* Pia. Tangential section 20 X
Fig. 3 - *Gymnocodium fragile* Pia. Tangential section 20 x

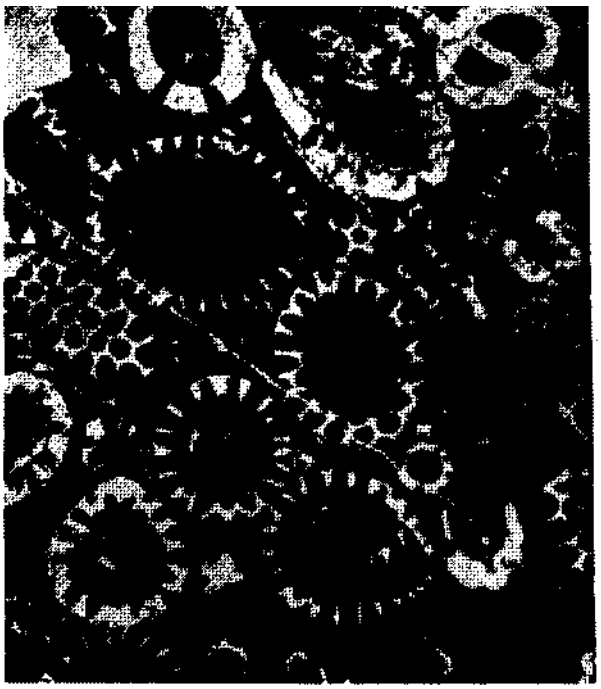

Fig. 1 10 ×

Fig. 2 20 ×

Fig. 3 20 ×

Fig. 1 20 ×

Fig. 2 10 ×

Fig. 3 20 ×

Fig. 4 20 ×

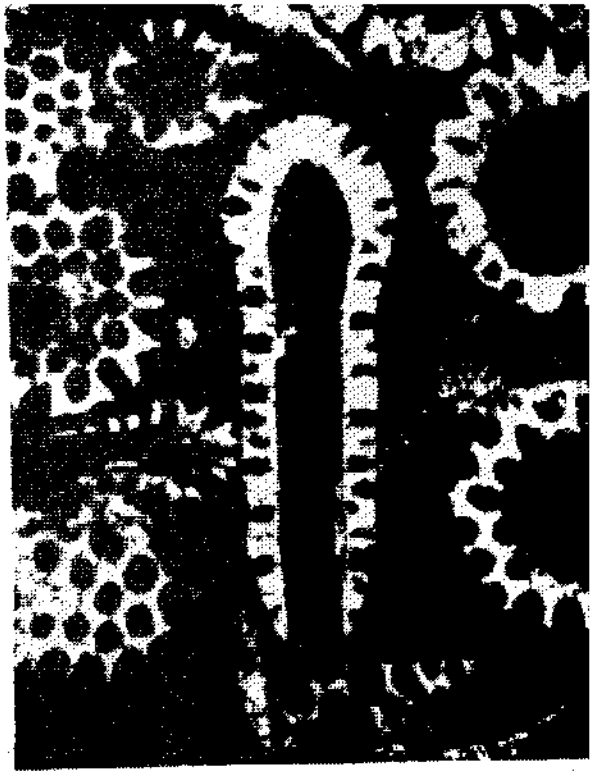

Fig. 1 20 ×

Fig. 2 20 ×

Fig. 3 10 ×

Fig. 4 20 ×

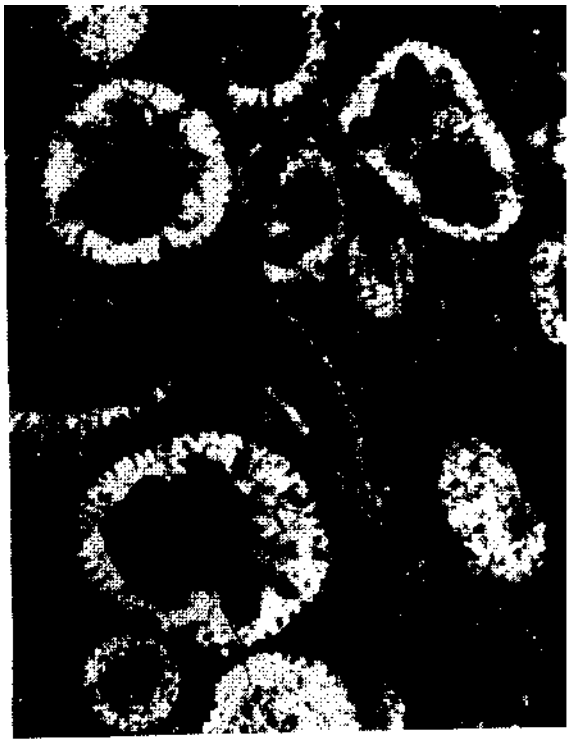

Fig. 1 20 ×

Fig. 2 20 ×

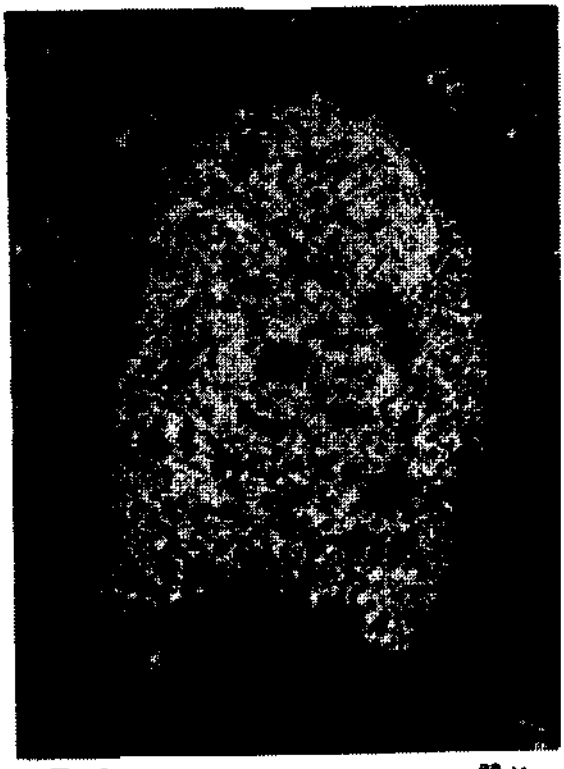

Fig. 3 20 ×