NEWER LIME-SECRETING ALGAE FROM THE MIDDLE CARBONIFEROUS OF THE BÜKK MOUNTAINS, NORTHERN HUNGARY

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INTRODUCTION

It was recognized during geological excursions in the Bükk Mountains that certain limestone lenses of the Upper Moscovian shale sequence yield other calcareous algae than those *dasycladaceans* (*Vermiporella* sp., *Anthracoporella* sp., *A. spectabilis* PIA and *Dvinella comata* CHVOROVA) described previously by HERAK, M. and KOCHANSKY, V. [1963]. From limestone samples came from the No. 1 railway cutting of Nagyvisnyó, from the eastern side of the Bánvölgy (NW to the Dédes Castle), from the southern vicinity of the village Mályinka, from Kapubérc, from western side of the summit of Tarófő and from deeper part of the main lens of Nagyberenás the forms of the genera *Archaeolithophyllum, Ivanovia, Oligoporella*? and *Osagia* have been recognized. The first two genera belong into the phylloid algae of PRAY, L. C. and WRAY, J. L. [1963]. The genus *Macroporella* is classed among the family *Dasycladaceae*, while the *Osagia* is a crustose calcareous alga of uncertain systematic position.

Most interesting are the *phylloid algae*, which are similar in shape and size to leaves and are slightly or strongerly wavy. In spite of the morphological similarity that suggested by their common name, these are forms of different groups (e.g. green or red algae). This group was named by American authors, because these *phylloid algae* are abundant, occasionally in rock-forming quantity in the Middle and Upper Carboniferous (Pennsylvanian) and Lower Permian of the USA. On the other hand, the preservation of the cavities between the wavy plates of these algae promotes significantly the formation of hydrocarbon traps within the embedding rocks. This group thoroughly treated also in the Soviet Union, e. g. the description of the genus *Ivanovia* was given by CHVOROVA, I. V. [1946].

The present paper, besides of the summarization of this group hitherto unknown in Hungary, widens the knowledges about the geographical distribution of these forms.

CHARACTERIZATION OF THE EMBEDDING STRATA

The Upper Moscovian, 5 to 50 m thick limestone lenses of the Bükk Mountains consist of dark-grey, locally brownish or brownish to light-grey, stratified limestones. The steeply dipping lenses, which are interrupted by dark shale beds, generally form parallel lines. At the above mentioned localities, on the weathered surfaces of the limestone beds, the thicker or thinner, slightly or strongerly wavy, simple or branching pattern of the lim-secreting algae is easily recognizable, because the

sparitic infilling of the internal cavities of the algal tubes and plates is rather resistant to the weathering as compared to the micritic or micro-sparitic matrix. The algae significantly facilitated the formation of the limestone lenses, by the following causes:

a) the connected pieces of the vertically growing forms — which are fastened together by crustose forms — supply a rigid fabric to the rock;
b) the fine calcareous mud, which formed from the broken and disintegrated parts of the wave-fragmented algae, supports the quantity of the sediment;
c) the vertically growing forms — by slowing the water agitation down — promote the in situ deposition of the calcareous mud.

On the basis of recent similarities, the environment of the algae was probably the shallow water. *Lithophyllum*, the recent equivalent of the *Archaeolithophyllum* habitates mainly the littoral zone [WRAY, J. L. 1964], but in the sublittoral zone, to the depth of 30 m, also can be found. An other possibility is that the phylloid algal colonies developed on the topographic heights of the former sea-floor, because the transillumination was more favourable here.

In the samples the position of the phylloid algal thalli shows a slight orientation (Plate II, *Fig. 1*), suggesting probably the smuggle of the algal plates to the sedimentation surface. On the other hand, this feature shows a slight water agitation, which would caused by the algal mat itself.

The fossil material of the studied samples — excepted the ones came from the deeper part of the main lens of Nagyberenás — yielded almost exclusively *Archaeolithophyllum* and *Ivanovia* specimens, and additional forms are smaller *foraminifers* and *crinoidal* ossicles. The representatives of the genera *Ivanovia* and *Archaeolithophyllum* are associated in the No. 1 railway cutting of Nagyvisnyó, but enrich in different parts of the limestone lens. This monotonity of the fossil content suggests that the algal mat of decreased water agitation did not favoure the proper life environment for other benthonic organisms.

On the other hand, the main lens of Nagyberenás suggests a more favourable environment with stronger agitation and increased food-supply, because besides of the rarer *Archaeolithophyllum* and *Ivanovia, Oligoporella?* sp., *Osagia* sp., *Bradyina* sp. (Foraminifera), some *Chaetetes* (tabulate coral) colony fragment, *gastropod* sections and *crinoidal* ossicles also can be found.

Because of the considerable recrystallization of the phylloid algal fossils of the Bükk Mountains, it was hard to range these remains into the proper ones of the four most important phylloid algal genera (*Anchicodium* JOHNSON, 1946; *Archaeolithophyllum* JOHNSON, 1956; *Eugonophyllum* KONISHI et WRAY, 1961 and *Ivanovia* CHVOROVA, 1946). Similar was the case with the recently found *Oligoporella?* sp. and *Osagia* sp. forms. In spite of the broader determinations used here, the author hopes that the following descriptions will convincingly record the Hungarian occurrence of these algal genera.

PHYLUM: Chlorophycophyta PAPENFUSS, 1946
Class: CHLOROPHYCEAE KÜTZING, 1843

Family: DASYCLADACEAE

Genus: *Oligoporella* PIA, 1912
Genotype: *O. pilosa* PIA

Oligoporella? sp.
PLATE I, Figs. 1—4

Description: Thallus cylindrical, central stem relatively thick. Open pores situating at different intervals form rather irregular whorls, nearly perpendicular to the central stem. Diameter of the thallus (D) 1,1 to 1,5 mm, wall-thickness (d) 0,13 to 0,30 mm, pore diameter (p) 0,11 to 0,16 mm.
Remarks: Paleozoic forms assigned to the genus *Oligoporella* have been recorded mainly from the Permian of Japan (JOHNSON, J. H. 1963, p. 177). But the Japanese Upper Pennsylvanian *Oligoporella* sp. — is rather a *Macroporella.* Unfortunately the specimen number and the preservation of the hitherto available specimens from the Bükk Mountains unable a closer determination, but it is probably a new species.

Locality: Deeper part of the main lens of Nagyberenás.
Age: Upper Moscovian — Permian — Triassic.
Distribution: USA; Europe; Japan (for the genus).

Family: CODIACEAE (TREVISAN) ZANARDINI, 1843
Genus: *Ivanovia* CHVOROVA, 1946
Genotype: *I. tenuissima* CHVOROVA (1946, pp. 737—739, *Figs. 1—2*)

Ivanova sp.
PLATE II, Figs. 1—3
1963. *Ivanovia* sp.—JOHNSON,
pp. 23—24; PLATE 20, Fig. 3

Description: Slightly or strongerly wavy plates resembling leaves in shape and size, with 1 to 3 mm thickness in the Bükk Mountains' specimens and 1 to 1,5 mm thickness in general. The plates have a three-layered structure, i.e. the central medulla is bordered by two thinner cortex. On the basis of the comparison to the related genus *Anchicodium*, the medulla was presumably made up of mass of threads with non-calcified walls. Hence the original structure of the medulla is non visible on the available specimens; this is substituted sparitic or microsparitic infilling.
Remarks: The basis for the separation of this genus from the related genera of this same family is the mode of development of the originally calcareous cortex. According to KONISHI, K. and WRAY, J. L. [1961], on the basis of the cortic structure, these genera can be ragned into the phylogenetic lineage shown here in *Fig. 1.* The initial member of this lineage is the still crustless *Calcifolium*, the next members are the *Ivanovia* and *Anchicodium*, characterized by dark columnar and light triangular crustal parts, respectively. The endform is the *Eugonophyllum*, which shows a "double" crustal structure, uniting practically the features of the previous members *(Fig. 1*, Plate I, *Fig. 3).*

On the other hand, owing usually to the state of preservation, among these above mentioned three genera only the determination of the *Eugonophyllum* is possible on the basis of *merely the crustal structure studies.* As it was emphasized by JOHNSON, J. H. [1963], to make distinction between the genera *Anchicodium* and *Ivanovia* is doubtful enough. Therefore, besides the crustal structure, the shape of the thallus should also be take into consideration. Namely the *Anchicodium* is re-

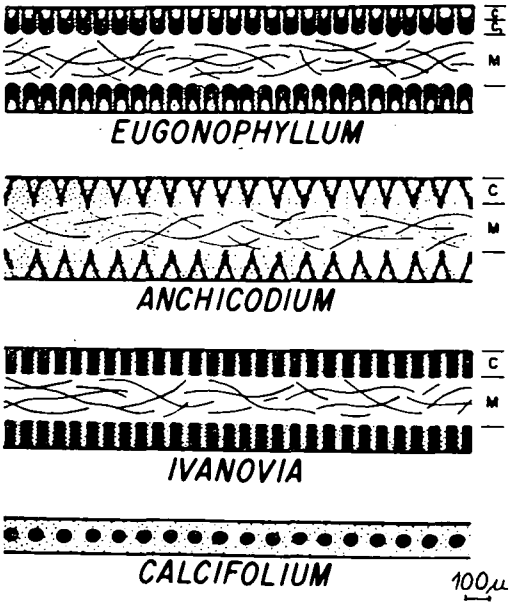


Fig. 1. Schematic diagram illustrating wall structures and phylogenetic progression of the Late Paleozoic phylloid *Codiaceae* after KONISHI, K.—WRAY, J. L. [1961. Degree of primary calcification is indicated by density of dotting. Inner part shot with filaments=medulla; that is bordered by cortex. (*Calcifolium* has yet no cortex.)

garded by JOHNSON, J. H. [1946, 1963] as a branching, cylindrical form (Plate I, *Fig. 4*), and the *Ivanovia* is characterized by CHVOROVA I. V. [1946] as a definitely plate form (see Plate I, *Fig. 5*). However, recent studies [*in* KONISHI, K. and WRAY, J. L. 1961] suggest a possible laminar thallus of certain *Anchicodium* species.

Accepting the conclusions of JOHNSON, the Bükk Mountains' specimens should be placed into the *Ivanovia*, because these are laminar and non-branching forms. This seems to be confirmed by the fact that the specimens do not show primarily calcified medullae and visible internal structure, similarly as in other *Ivanovia* forms known previously from the literature. On the other hand, the medulla of the *Anchicodium* retains the traces of the primary filamentous structure *(Fig. 1,* Plate I, *Fig. 4).*

The *Ivanovia* specimens of the Bükk Mountains are generally two or three times thicker as the 0,5 mm thickness recorded by CHVOROVA for the species *Ivanovia tenuissima.* Their micritic crust is hardly separable from the similarly micritic matrix. However, the characteristic columnal structure of the cortex — in spite of the considerable recrystallization — is recognizable in some cases (Plate II, *Figs. 2—3*). The lenght of the small micritic columnals inserting the sparitic medulla is about 0,08—0,10 mm. However, this feature do not allow specific identification.

Localities: Eastern side of the Bánvölgy (NW to the Dédes Castle); deeper part of the main lens of Nagyberenás; No. 1 railway cutting of Nagyvisnyó (7/1955. P. SZABÓ); western side of the summit of Taróf̋.

Distribution: This genus has been recorded from the Moscow Basin, from the USA and Yugoslavia sor far.

Age: Middle Carboniferous — lower part of the Upper Carboniferous (Atokan — Des Moinesian — Missourian). In Hungary: Upper Moscovian.

PHYLUM: RHODOPHYCOPHYTA PAPENFUSS, 1946

CLASS: RHODOPHYCEAE RUPRECHT, 1851

Family: CORALLINACEAE or SOLENOPORACEAE

Genus: *Archaeolithophyllum* JOHNSON, 1956

Genotype: *A. missouriense* JOHNSON

Archaeolithophyllum cf. *missouriense* JOHNSON

PLATE IV, *Figs. 1—5*

1963. *Archaeolithophyllum missouriensum* — JOHNSON, pp. 6—7; PLATE 2, *Figs. 1—2;* PLATE 3, *Fig. 2*

1964. *Archaeolithophyllum missouriense* — WRAY, pp. 7—8; text-*figs. 3—4;* PLATE 1, *Figs. 1* and *3—7*

1964. *Archaeolithophyllum missouriensum* — KOCHANSKY-DEVIDÉ p. 516; PLATE III, *Fig. 1*

Description: By the original description the thallus is irregular, strongly wavy plate or crust of variable thickness, with common small protuberances (Plate II, *Fig. 4*). On the transversal sections of extremely well preserved specimens the three-layered thallus is visible (Plate III, *Fig. 1*). The thicker central hypothallus, wich is formed curved lines of larger, polygonal cells is covered on the one or both sides by the thinner perithallus consisting of smaller, rectangular cell-layers parallel to the surface. The first case suggests crustose, the second partially attached, non-crustose forms. Sporangia were situated in conceptacles (Plate III, *Figs. 2—3)*.

The shape of the specimens from the Bükk Mts. agree well with this characterization. The thickness of the strongly wavy blades is 0,1 to 0,8 mm, the order of magnitude of the protuberances on the plates (Plate IV, *Fig. 4*) is 0,1 mm. The peri- and hypothallus are somewhat distinct, but their internal structure — because of the recrystallization — usually cannot be studied. The hypothallus is replaced by sparitic or microsparitic material (Plate IV, *Fig. 1*). Algal fragments retaining the traces of the original cellular structure are very rare (Plate IV, *Fig. 2*). In some cases, however, even the conceptacles are visible too (Plate IV, *Fig. 5*).

Remarks: The specimens from the Bükk Mountains are identical in shape to the species *Archaeolithophyllum missouriense* JOHNSON; these are symmetrical, i. e. non-crustose forms. Although the diameter of the conceptacles is significantly smaller (100—230 μ) than that of given by JOHNSON, J. H. (585—990 μ), their shape show closest resemblance to the *A. missouriense* from the hitherto known non-crustose *Archaeolithophyllum* species.

Plate I

1—2. *Oligoporella* ? sp. — Deeper part of the main lens of Nagyberenás. 5/1970. B. K. Bükk Mts. — Upper Moscovian.
1. Slightly oblique longtudinal section. *2.* Slightly oblique cross section.

3. *Eugonophyllum johnsoni* KONISHI et WRAY. Transversal section in slide, with a well-kept cortical structure. — Holder formation, Otero County, New Mexico, USA. — After KONISHI, K.—WRAY, J. L. [1961] and JOHNSON, J. H. [1963, Plate 18, Fig. 8.]
4. *Anchicodium funile* JOHNSON, in thin section. — Wakarusa limestone, Brown County, Kansas, USA. — Late Pennsylvanian. — After JOHNSON, J. H. [1946, Plate 7, Fig. 1 and 1963, Plate 17, Fig. 4].
5. *Ivanovia* sp. Nearly transversal section in slide. — Hermosa formation, New Mexico, USA. — Pennsylvanian. — After JOHNSON, J. H. [1963, Plate 20, Fig. 3].

Plate II

1. *Ivanovia* sp. Polished surface. — Western side of the summit of Tarófő. Collected by F. LEGÁNYI. Bükk Mts. — Upper Moscovian.

2—3. *Ivanovia* sp. Transversal section in slide, with spoors of columnar structure of the cortex (arrows). — Nagyvisnyó. Western side of the railway cutting No. 1 Bükks Mts. — Upper Moscovian.

4. *Archaeolithophyllum missouriense* JOHNSON. Polished surface. — Captain Creek limestone, Wilson County, Kansas, USA, — Pennsylvanian. — After WRAY, J. L. [1964].

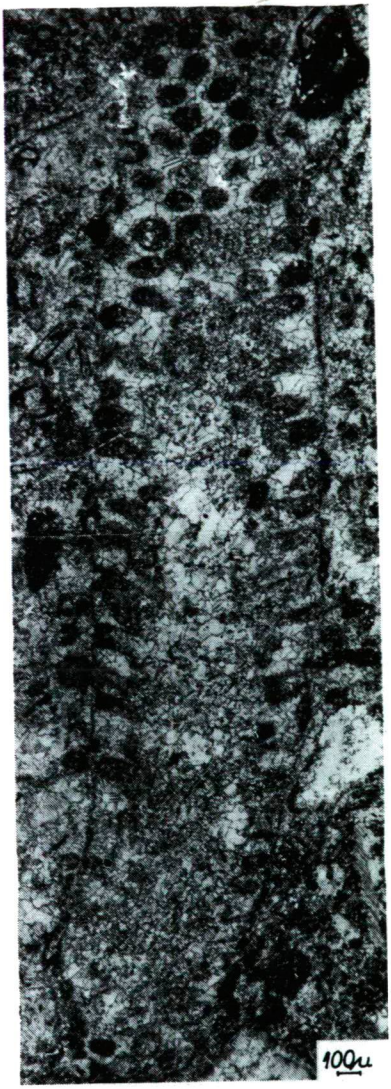
Plate III

1. *Archaeolithophyllum missouriense* JOHNSON. Transversal section in slide. — *h:* hypothallium, *p:* perithallium. — Collinsville, Illinois, USA. — Pennsylvanian. — After JOHNSON, J. H. [1956, Plate 14, Fig. 3].
2. *Archaolithophyllum delicatum* JOHNSON. Highly arched conceptacle in slide. — Collinsville limestone, Collinsville, Madison County, Illinois, USA. — Pennsylvanian. — After JOHNSON, J. H. [1956, Plate 14, Fig. 6].
3. *Archaeolithophyllum missouriense* JOHNSON. Two conceptacles surrounded by perithallic tissue, in slide. — Carroll County, Missouri, USA. — Pennsylvanian. — After JOHNSON, J. H. [1956, Plate 14, Fig. 1].

Plate IV

1. *Archaeolithophyllum* cf. *missouriense* JOHNSON. Thin section of a strongly recrystallized individual. — South of Mályinka, 450 m from Mártuskő in ENE direction. 52/1955. B. K. Bükk Mts. — Upper Moscovian.
2. *The same.* Thin section of a slightly recrystallized individual. — Deeper part of the main lens of Nagyberenás. 5/1970. B. K. Bükk Mts. — Upper Moscovian.
3. *The same.* Polished surface. — Nagyvisnyó. Railway cutting No. 1 Bükk Mts. — Upper Moscovian.
4. *The same,* with protuberances raised above body of the plant. Transversal section in slide. — Deeper part of the main lens of Nagyberenás. 5/1970. B. K. Bükk Mts. — Upper Moscovian.
5. *The same.* Image of a conceptacle in slide. — South of Mályinka, 450 m from Mártuskő in ENE direction. 52/1955. B. K. Bükk Mts. — Upper Moscovian.

6—7. *Osagia* sp. Thin section. — Deeper part of the main lens of Nagyberenás. 5/1970. B. K. Bükk Mts. — Upper Moscovian.



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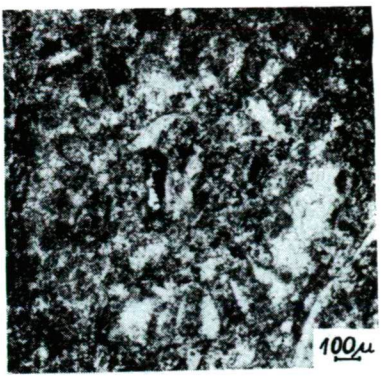

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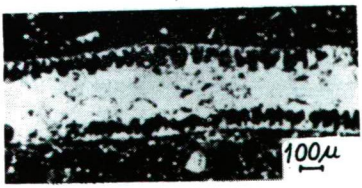

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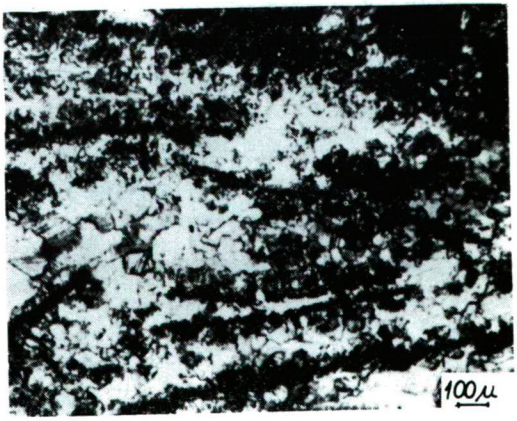

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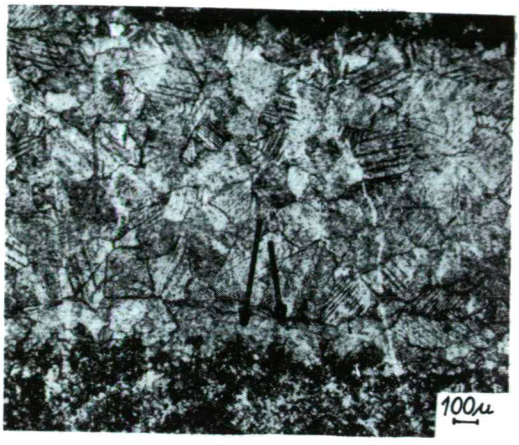

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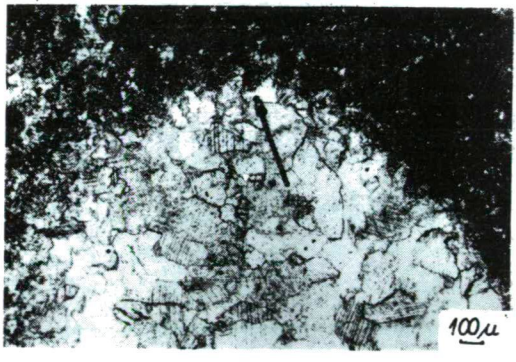

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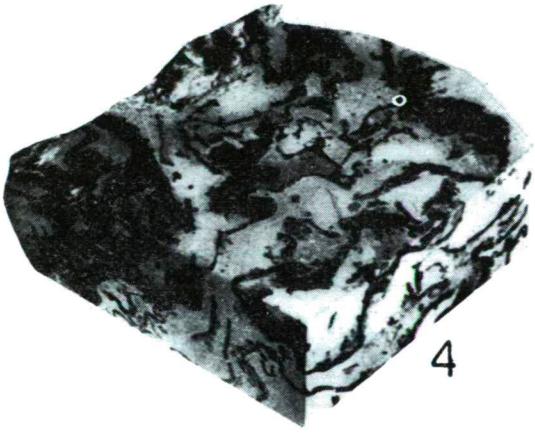

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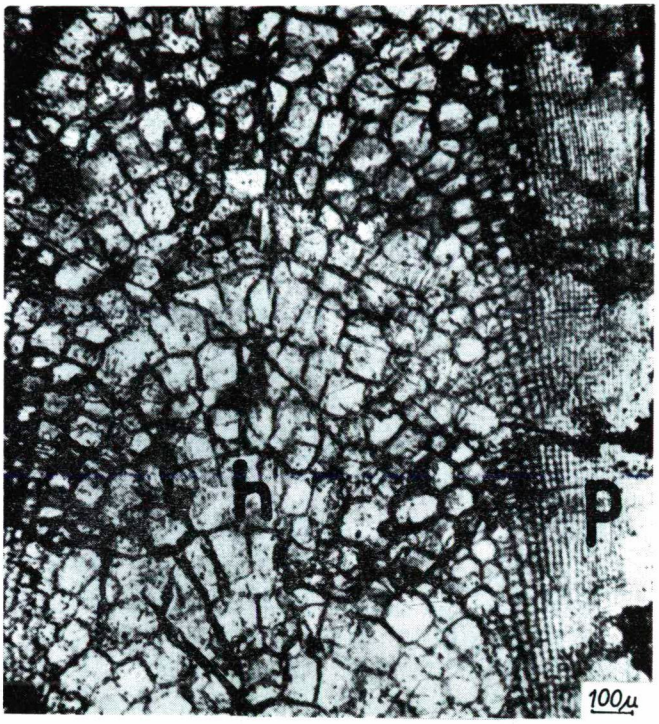

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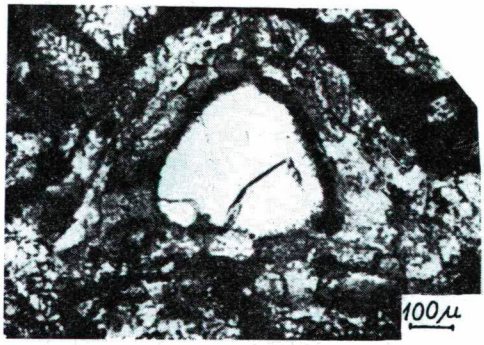

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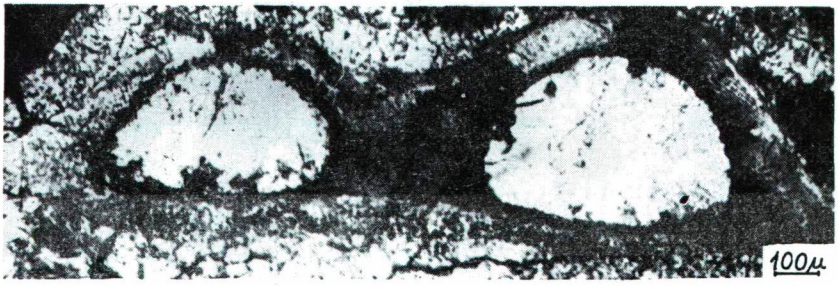

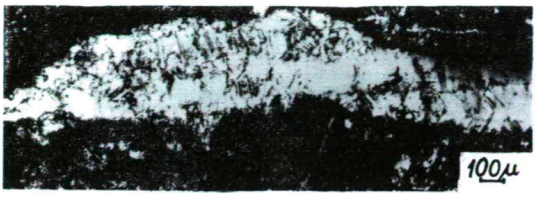
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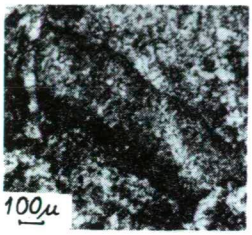
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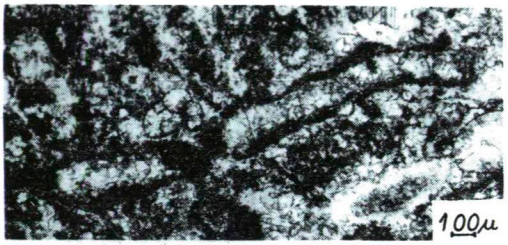
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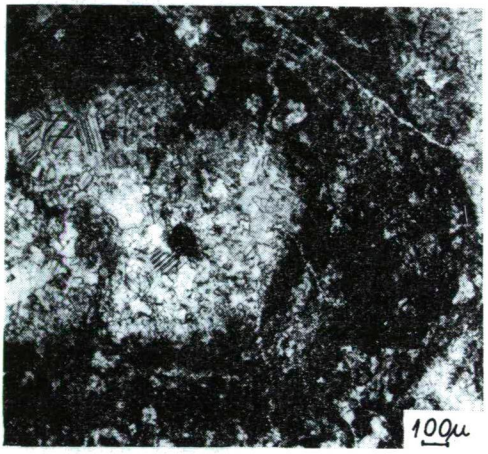
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Localities: No. 1 railway curting of Nagyvisnyó; south to the village Mályinka, 450 m ENE Mártuskő (52/1955. B. K.); Kapubérc; deeper part of the main lens of Nagyberenás.
Distribution: USA; Karawanken (N to Jesenice); Velebite Mountains.)
Age: Upper part of the Middle Carboniferous — uppermost Carboniferous (as of genus: basal Middle Carboniferous to basal Lower Permian).

ALGAE INCERTAE SEDIS

Section Prostromata PIA, 1927

Genus *Osagia* TWENHOFEL, 1919

Genotype: *O. incrustata* TWENHOFEL

Osagia sp.

PLATE IV, *Figs. 6—7*

1946. *Osagia* sp. — JOHNSON, pp. 1102—1104; Plate 2, Figs. 3—5; Plate 4, Figs. 3—5; Plate 5, Figs. 5—6; Plate 10, Fig. 2

1963. *Osagia* sp. — JOHNSON, p. 27; Plate 22, Figs. 2—4

Description: Laminar thallus built up by light tubes and chambers, which are covered by dark, fine algal filaments. The thallus usually encrusts fossil fragments. The shape of the thallus around the internal core resembles corn or bean. In contrast to the largest thallus diameter (5,8 mm) found by JOHNSON, J. H. the main lens of Nagyberenás yielded thallus of 15 mm lenght. Because the thallus diameter depends also on the size of the encrusted fossil (in this case this is a phylloid alga fragment), hence even this measurement cannot be regarded as exceptional (Plate IV, Fig. 7).
Remarks: According to JOHNSON (loc. cit.) the *Osagia* thallus was formed by the symbiosis of filamentous algae similar to *Girvanella* and crustose *Nubecularia* foraminifers. Consequently this is rather a growth-form as an independent species.
Distribution: USA; Yugoslavia; Hungary.
Age: Middle Carboniferous — Lower Permian.

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