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Rhaetian microfacies, stratigraphy and facial development in the Tatra Mts

ABSTRACT: The paper comprises results of sedimentary-facial and stratigraphic analysis of the sub-tatric (Križna) Rhaetian of the Tatra Mts. Sedimentary sequence and detailed characteristics of the deposits are presented, whereas a rich foraminifer fauna (over 30 species) allows to distinguish in these deposits the Lower (*pokornyi & friedli* Zone) and Upper Rhaetian (*hantkeni* Zone) and to discuss the "Keuper"/Rhaetian and Rhaetian/Liassic boundaries. Attention is paid to the megalodontid fauna comprising *i.a.* the two new species, *Conchodon goeteli* sp. n. and *Rhaetomegalodon tatricus* sp. n. Described are also two new coprolite species, *Bactryllium ornatum* sp. n. and *B. elongatum* sp. n., most probably attributable to the investigated megalodontids. On the basis of a succession in facies and their lateral changes, the development of the Rhaetian sedimentary basin in reconstructed. Finally, the Rhaetian deposits of the Tatra Mts are correlated with contemporaneous strata from other parts of the Tethys Ocean.

INTRODUCTION

The present paper deals with microfacial analysis, stratigraphy, and sedimentology of the sub-tatric (Križna) Rhaetian of the Tatra Mts. The studies comprised all the representative exposures of the Rhaetian in both Polish and Slovakian parts of the mountains (*cf.* Fig. 1).

The Rhaetian strata have been the subject of interest for more than century. They were recognized and briefly characterized by Zejszner (=Zeuschner) as early as 1852 and 1856, and later by Uhlig (1897). Subsequently, the strata termed as the Rhaetian were often used as a valuable stratigraphic marker and they still have that value.

The studies carried out by Goetel (1911, 1917) greatly contributed to the knowledge of the sub-tatric Rhaetian. They brought a detailed paleontological analysis of rich faunistic material and a reconstruction of paleogeography of those strata from the Western Carpathians. These strata were subsequently discussed in papers dealing with lithology, stratigraphy, or tectonics of the sub-tatric series (Kuźniar 1913; Štastný 1926; Sokołowski 1948; Głazek 1959, 1962a,b, 1963; Borza 1959; Mišik & al. 1960; Kochanová 1967; Bac 1971) as well as compilatory papers (Passendorfer 1951, 1961; Andrusov 1959; Sokołowski 1959).

Assignation of these strata to the Rhaetian, despite detailed analyses of some faunistic groups (Goetel 1917), was hitherto uncertain. There are serious doubts concerning both lower and upper boundaries of that stage. Normally, these boundaries were delineated on the basis of lithological premises. The Rhaetian name in the Tatra Mts has commonly been referred to a lithological series of dark-gray massive limestones with intercalations of black slates and yielding fairly rich faunistic material. The lithological series overlies the Carpathian "Keuper" (*cf.* Goetel 1917, Turnau-Morawska 1953) and it is overlaid by Lower Liassic sandstone and slates (*cf.* Goetel 1917, Sokołowski 1948, Guzik 1959d).

A detailed characteristics of that series is the subject of the present paper. The sections were sampled in the course of fieldworks in years 1968—1972 (*cf.* Figs 3—5, 7—9). The samples collected were used to prepare over 500 thin sections. Moreover, some of them were dissolved with acetic acid to free microfauna. Analysis of thin sections made it possible to characterize sedimentary succession and to trace facial changes, as well as to recognize a rich foraminifer fauna which enabled stratigraphic subdivision of that series.

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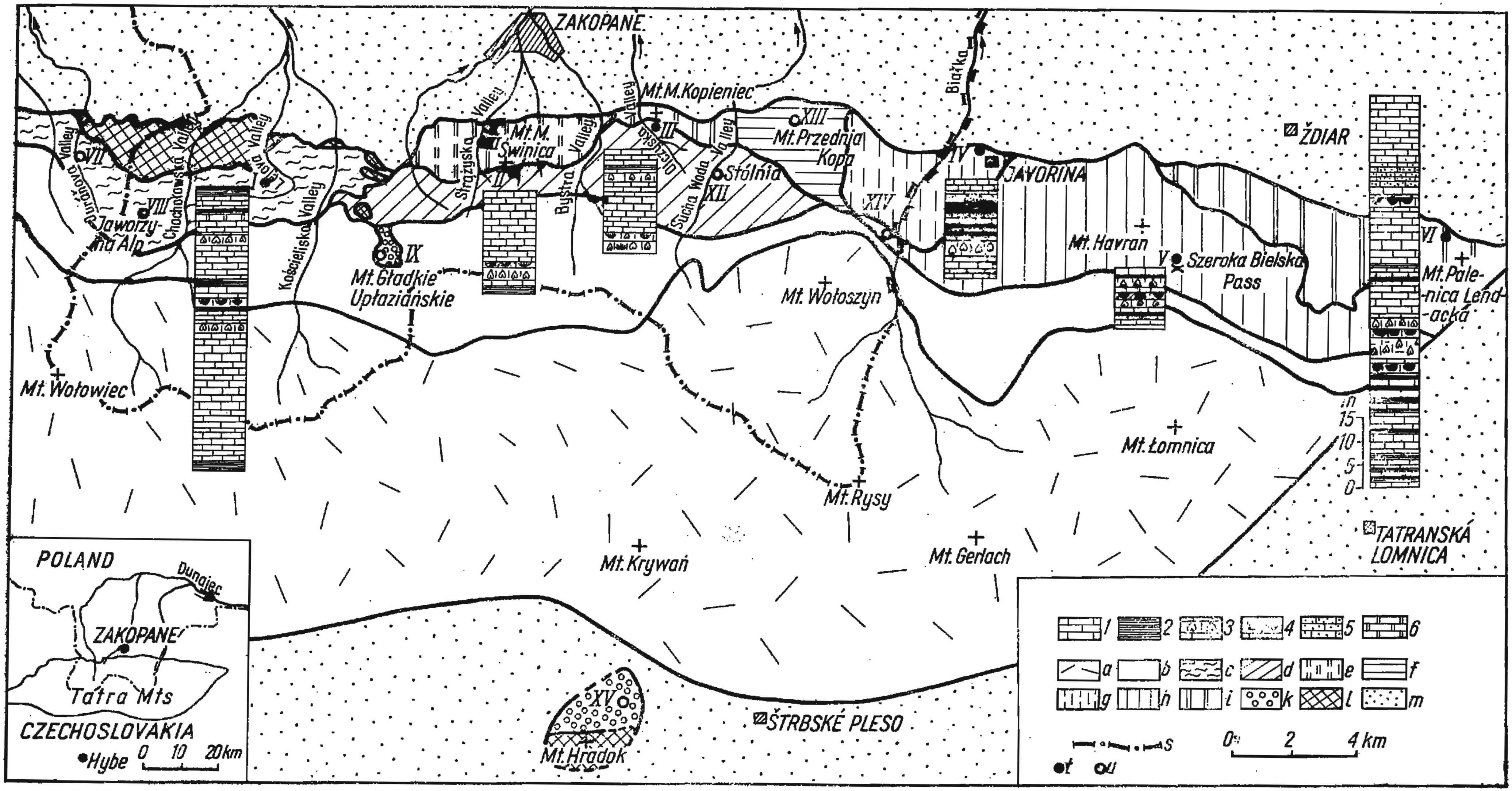
Załącznik 1

Situation of the sub-tatric (Križna) Rhaetian sections (*I—XV*) in a tectonic sketch-map of the Tatra Mts



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Rhaetian lithology: *1* limestones, *2* shales, *3* *Megalodon* limestones, *4* coral limestones, *5* sandy limestones, *6* dolomites
Tectonic units: *a* crystalline core of the Tatra massif, *b* high-tatric series, *c—k* sub-tatric (Križna) series — *c* Bobrowiec unit, *d* Suchy Wierch unit, *e* Mała Świnica unit, *f* Kopy Sołtysie unit, *g* Skałki (Gęsia Szyja) unit, *h* Havran unit, *i* Palenica (Bujači) unit, *k* undivided series; *l* sub-tatric (Choč) series
m inner Carpathian flysch, *s* state frontier, *t* detailly studied Rhaetian sections (*I—VI*), *u* comparative Rhaetian sections (*VII—XV*)

CHARACTERISTICS OF THE DEPOSITS

The Rhaetian strata occupy relatively large area of outcrops of the sub-tatric series in the Tatra Mts. They are exposed along northern and occasionally on southern slopes of the Tatra Mts (*cf.* Fig. 1 and Uhlig 1911). They are highly variable in thickness which ranges from 10 to 80 meters. This variability results either from local sedimentary gaps and erosion, or from tectonic factors.

Detailed analysis of the sub-tatric (Križna) Rhaetian is based on some selected sections (*cf.* Figs 1, 3—5, 7—9). Sequence of deposits, characteristics of inorganic, biosedimentary, and organic components, as well as characteristics of facies of all these sections, will be given below.

In order to perform microfacial analysis it was necessary to take into account modern classifications and terminology of carbonate rocks (*cf.* Folk 1959, 1962; Leighton & Pendexter 1962; Chilingar, Bissell & Fairbridge 1967; Füchtbauer 1970; Bathurst 1971) presented in the Polish literature by Kutek (1969). In the present paper carbonate rocks are described by the terms referring to classifications proposed by Folk (1959, 1962) and Leighton & Pendexter (1962). All the basic terms used in mircofacial analysis of carbonate rocks from the Alpine Triassic (see *e.g.* Flügel 1972a, Mišik 1972) are also taken into account.

Detailed sections (I—VI)

Lejowa Valley (I)

Over the area of Lejowa Valley the Rhaetian strata are best exposed on NE slopes of Mt. Wierch Spalenisko (Figs 1 and 2). Outcrops of the Rhaetian strata in that area were mapped by Guzik K., Guzik S. & Sokołowski (1958), Guzik (1959c), Gaździcki (1969, Table 1), Bac (1971, Figs 3—4), and their brief characteristics was given by Goetel (1917) and Gaździcki (1969, 1970). The section analysed was traced along the line Mt. Wierch Spalenisko — Huty Lejowe Alp (Fig. 2) at the altitude of 1,040—1,155 m a.s.l.; strike and dip equal 135°/30°N. Those strata belong to the Bobrowiec tectonic unit (*cf.* Bac 1971). They directly overlie the so-called "Keuper", underlie Liassic strata, and are represented by series of dark gray limestones with occasional intercalations of black slates, about 58 m thick (Fig. 3). The section comprises 42 layers [1] brief characteristics of which are as follows.

Layer 1. — Light-gray dolomites of the uppermost "Keuper" are directly overlaid (in sedimentary continuity) by marly shales with fine organic debris (Pl. 8, Fig. 1). These marls yield some admixture of organic matter and silt-fraction quartz grains. Foraminifers *Frondicularia woodwardi* are occasionally found.

[1] The layers distinguished comprise characteristic lithological members which were separated by macroscopic analysis during the fieldwork; their detailed characteristics are presented in Figs 3—5, and 7—9.

Layers 2—6. — Series of well-bedded, somewhat sandy organodetrital limestones. In the lower part of the series they are represented by pelmicrites, and in the upper — by biopelsparrudites composed of brachiopod, gastropod, and crinoid debris, and pellets and quartz grains. Algae (*Acicularia* sp.), spores (*Globochaete alpina*) and ostracodes are common. Foraminifers fairly common, represented by *Nodosaria* cf. *ordinata* (Pl. 39, Figs 8—9), *Glomospirella? pokornyi*, *Ophthalmidium* sp. (Pl. 38, Fig. 9), *Agathammina austroalpina*, *Trochammina alpina* (Pl. 41, Figs 1—2), *Involutina communis*, and *Earlandia* sp. (Pl. 33, Fig. 4).

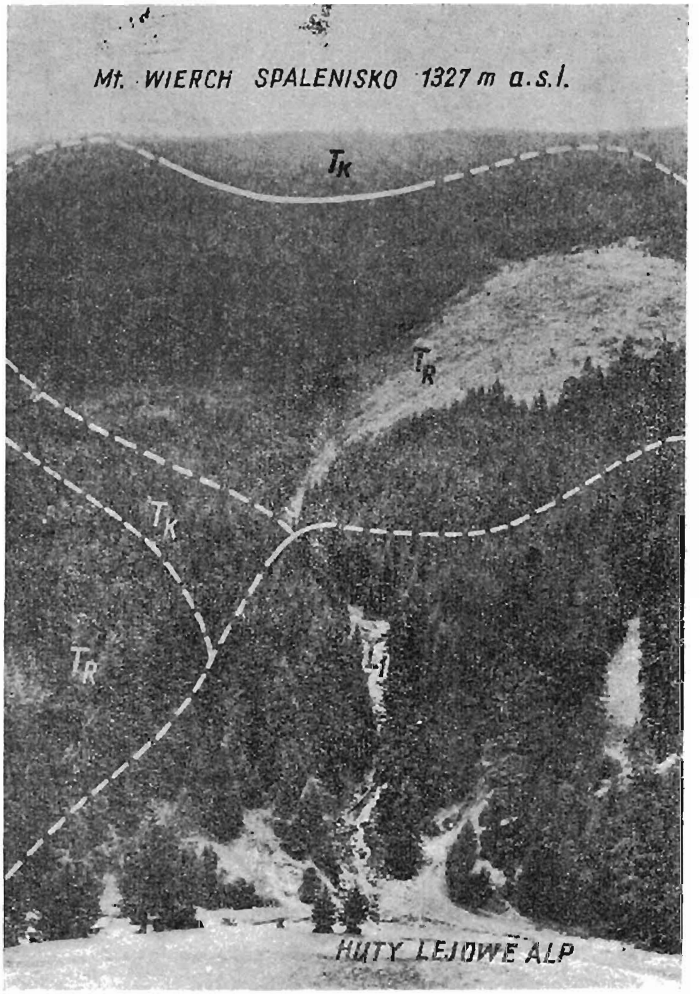
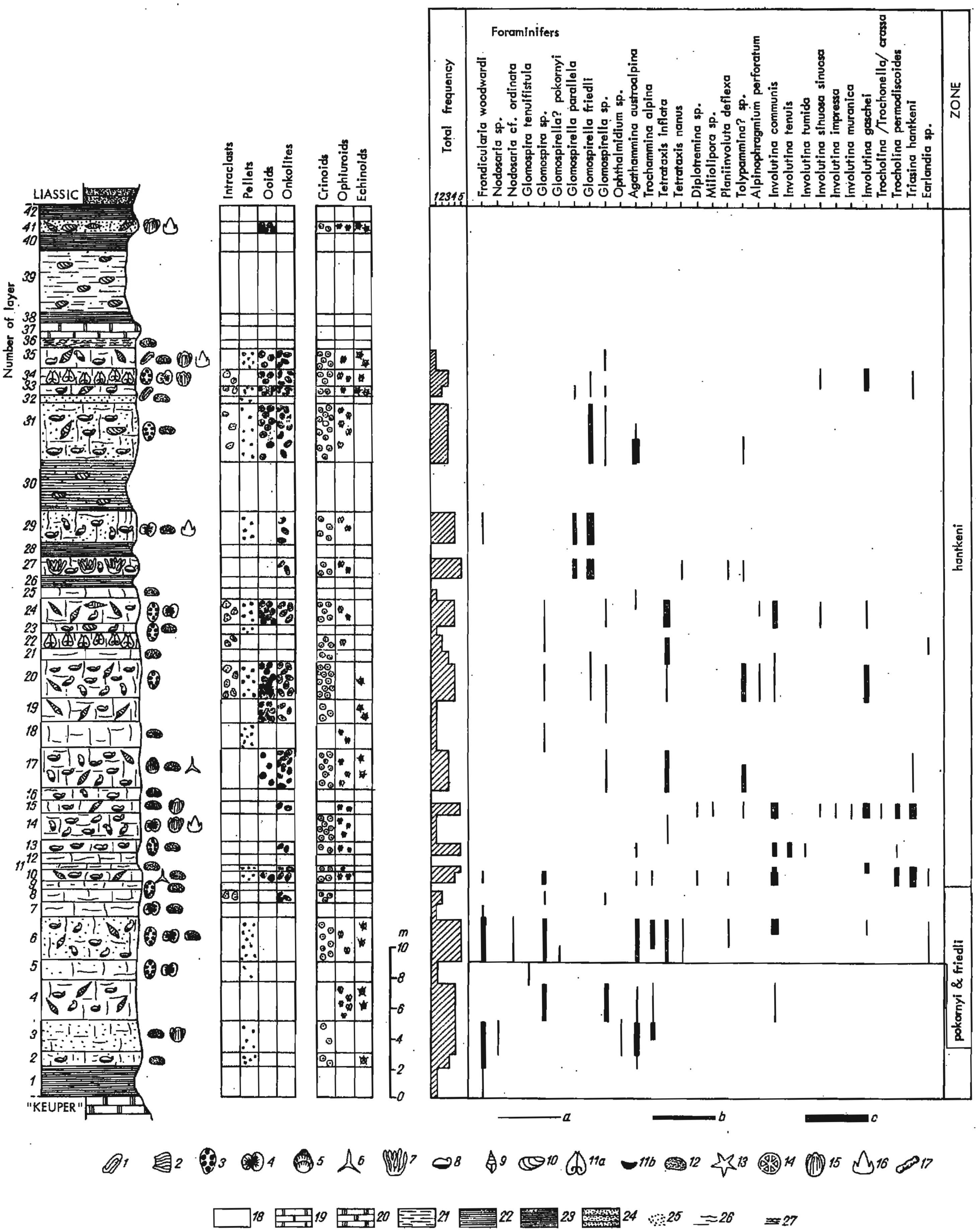


Fig. 2

Occurrence zone of the Rhaetian deposits on the NE slopes of Mt. Wierch Spalenisko in the Lejowa Valley; the investigated section (*I* in Text-fig. 1, *cf.* Text-fig. 3) exposed along the ravine from Mt. Wierch Spalenisko towards Huty Lejowe Alp

T_K — "Keuper", T_R — Rhaetian, L_1 — Lower Liassic

Detail section of the Rhaetian deposits in the Lejowa Valley (*I* in Text-fig. 1): the section comprises lithology, qualitative occurrence of limestone components as well as frequency and distribution of foraminifers



Organic components: *1 Girvanella*, *2 Pysnoporidium*, *3 Acicularia*, *4 Globochaete*, *5 Solenopora*, *6* sponge spicules, *7* corals, *8* rachiopods *Rhaetina gregaria* (Suess), *9* gastropods, *10* palecypods (non megalodontids), *11* megalodontids (*11a* entire shells, *11b* valve debris), *12* ostracods, *13* starfishes, *14* holothurians, *15* fish scales (elasmobranch shagreen), *16* fish teeth, *17* coprolites *Bactryllium*

Lithology: *18* limestones, *19* dolomitic limestones, *20* dolomites, *21* marls, *22* shales, *23* siltstones, *24* sandstones, *25* detrital quartz, *26* bituminous matter, *27* "algal lamination"

Total frequency of foraminifers: *1* 1—4 specimens, *2* 5—10 specimens, *3* 11—20 specimens, *4* 21—35 specimens, *5* more than 35 specimens in thin sections from a definite layer

Distribution of foraminifers presenting number of specimens of a definite species or genus in the layer: *a* rare (1—5 specimens), *b* frequent (6—15 specimens), *c* abundant (more than 15 specimens)

Layers 7—9. — Gray-bluish, massive micritic limestones, sometimes laminated with bituminous matter; some admixture of organodetrital material was found. The lowermost part of the limestones is represented by intrapelsparrudite with large intraclasts (Pl. 8, Fig. 2). Foraminifers *Frondicularia woodwardi* and *Glomospira* sp. are occasionally found.

Layers 10—17. — Series of well-bedded, bluish-gray organodetrital limestones with numerous intercalations of brachiopod lumachelle with *Rhaetina gregaria*; some admixture of gastropod-crinoid debris appears typical of these layers. Microscopically, the limestone may be termed as biosparites composed of brachiopod debris coated with onkolitic envelopes, and as crinoid biosparites (Pl. 8, Fig. 3). Within layer *17*, some subordinate intercalations of onkolitic limestones are found. Among organic fragments, algae (*Acicularia* sp.) and spores (*Globochaete tatrica*; see Pl. 32, Fig. 5) predominate. Foraminifers of the family Involutinidae are fairly common; they are primarily represented by *Triasina hantkeni* (see Pl. 48, Figs 1—2), *Trocholina permodiscoides* (see Pl. 46, Figs 4—5, 7—8), and *Involutina communis* (see Pl. 44, Figs 1—5). Sponge spicules, ostracodes, and fish teeth are also common.

Layers 18—21. — Bluish-gray, thick-bedded organodetrital limestones, the lower part of which is represented by micrite and pelmicrite limestones, the upper part — by biointrapelmicrite composed of brachiopod, gastropod, crinoid debris with onkolitic crusts, and intraclasts and pellets (Pl. 8, Fig. 4). Foraminifers are represented by *Glomospira* sp., *Glomospirella friedli*, *Tetrataxis inflata*, *Tolypammina*? sp., *Involutina communis*, and *I. gaschei*.

Layer 22. — Gray, massive thick-bedded *Megalodon* limestone. The surface of this layer displays numerous heart-shaped sections of megalodontids of the species *Conchodon infraliasicus* (cf. Gaździcki 1971; Pl. 2). Single irregular intraclasts were found. Foraminifers *Glomospira* sp. and *Tetrataxis inflata* (see Pl. 41, Figs 4—6) and brittle star vertebrae occur in subordinate amounts.

Layers 23—25. — Bluish-gray oolitic-crinoid limestones with intraclasts and onkolites. Various ooids differ in size, ranging from 0.4 to 0.6 mm in diameter. Onkolites, up to 1.2 mm in size, are usually formed around brachiopod, gastropod, and echinoderm debris. Algae (*Acicularia* sp. and *Globochaete alpina*), foraminifers (*Tetrataxis inflata*, *Involutina communis*, and *I. sinuosa sinuosa*), and ostracodes are common.

Layers 26—30. — Series of bluish-gray limestones and dark clay slates. The lower part of the series is represented by organogenic limestones with single bushy colonies of corals *Retiophyllia* sp. (Pl. 19, Fig. 3) in life position. The upper part of this series is formed of thick-bedded organodetrital limestones with numerous brachiopods *Rhaetina gregaria*. The brachiopods are sometimes of rock-building importance. Microscopically, the limestones may be termed as brachiopod-foraminifer biomicrites (Pl. 8, Fig. 5). Among organic fragments, foraminifers of the species *Glomospirella friedli* (Pl. 36, Figs 1—2), *Tetrataxis nanus* (Pl. 41, Figs 11—12) and *Planiinvoluta deflexa* (Pl. 43, Fig. 7) and brittle star vertebrae (Pl. 15, Figs 4, 6) predominate. Dark clay slates yield admixture of bituminous matter and sometimes fine debris of pelecypod shells; they are often impregnated with iron compounds.

Layers 31—33. — Bluish, thick-bedded, somewhat sandy organodetrital limestones. Biooosparrudites composed of brachiopod debris and subordinate ooids (Pl. 8, Fig. 6) and biopelsparrudites composed of pelecypod and brachiopod debris, pellets, ooids, and quartz grains (Pl. 9, Fig. 1), predominate here. Organic fragments are very often covered by onkolitic coatings or encrustations. Numerous foraminifers are represented by *Agathammina austroalpina* (Pl. 40, Figs 4—6) and *Glomospirella friedli*.

Layer 34. — Blue-gray thick-bedded massive *Megalodon* limestone. Their surfaces display numerous sections of shells of *Conchodon infraliasicus* in life position (*cf.* Gaździcki 1971). Microscopically, the limestone may be termed as biointrapelmicrite composed of gastropod, brachiopod, and crinoid debris, intraclasts, and pellets (Pl. 9, Fig. 2). Spores (*Globochaete alpina*; Pl. 32, Figs 1—2) and foraminifers (*Glomospirella friedli*) are sometimes found.

Layers 35—37. — Series of carbonate deposits. Its lower part is represented by biomicrite composed of brachiopod debris coated with onkolitic envelopes (Pl. 9, Fig. 3), the middle part — by micritic limestone with "algal lamination" (Pl. 9, Fig. 4), and the upper part — by dolomitic limestone completely devoid of organic fragments. Foraminifers were recorded only from the lower part of the series; they are represented by *Glomospirella* sp., *Involutina gaschei*, and *Triasina hantkeni.*

Layers 38—42. — A series of brown-gray, somewhat ferruginous marls and siltstones (Pl. 9, Fig. 6), sometimes rich in pelecypod debris, and intercalated by oolite limestone layer which may be termed as well-sorted oosparite (Pl. 9, Fig. 5). No foraminifers were found.

Layer *42* is overlaid by quartzitic sandstones in sedimentary continuity. According to previous lithostratigraphic subdivisions that quartzitic bed represents the base of the Lower Liassic section (*cf.* Goetel 1917). Analysis of limestone intercalations occurring above that quartzitic layer showed occurrence of abundant foraminifer fauna with predomination *"Vidalina" leischneri*, the characteristic Lower Liassic species.

Mt. Mała Świnica (II)

Here the Rhaetian strata are exposed between Czerwona Pass and Mt. Mała Świnica (*cf.* Text-fig. 1; Pl. 1, Fig. 1; and Uhlig 1911; Guzik & Kotański 1963, Table 1; Kibitlewski 1972, Fig. 1). They form a few separate tectonic slices and represent the Suchy Wierch tectonic unit (*see* Iwanow 1965). The Rhaetian strata exposed here were studied by Goetel (1917). In the section analysed (Fig. 4), there are tectonic gaps between "Keuper" and Rhaetian, and between Rhaetian and Liassic. The Rhaetian series is c. 20 m thick; its strike and dip equal 90°/50°N. Within the section 19 layers are distinguished.

Layers 1—3. — A series comprising thin-bedded gray organodetrital limestones with black slate intercalations. Microscopically, the limestones may be termed as gastropod-brachiopod biomicrites (Pl. 10, Fig. 1). No foraminifers were found.

Layers 4—6. — Well-bedded dark-gray limestones, with layers up to 15 cm thick, on the average. The lower part of the limestones yields single megalodontids and gastropods, the upper part — very numerous brachiopods among which *Rhaetina gregaria* predominates. Microscopically, the limestones may be termed as brachiopod biomicrites (Pl. 10, Fig. 2). Algae *Girvanella minuta* and *Solenopora* sp. are occasionally found. Foraminifers, very abundant, are represented by *Glomospira* sp., *Glomospirella? pokornyi*, *G. friedli*, and *Tolypammina?* sp.

Layers 7—10. — A series, about 3 m thick, comprising organogenic limestones with black slate intercalations. The lower part of the series is represented by coral limestones yielding branched colonies of *Retiophyllia paraclathrata* Roniewicz (*cf.* Pl. 1, Fig. 2), the upper part is characterized by mass occurrence of brachiopods, *Rhaetina gregaria*, in certain layers. There are also some intercalations of crinoid biopelsparrudite (Pl. 10, Fig. 3). Microfauna is represented by associations of spores *Globochaete* sp. (Pl. 33, Fig. 5), single foraminifers (*Glomospirella? pokornyi*, *G. friedli*, and *Tetrataxis inflata*), and ostracodes.

Layers 11—12. — A series of thick-bedded massive bluish-gray organodetrital limestones. Macrofauna is represented by single brachiopods and gastropods.

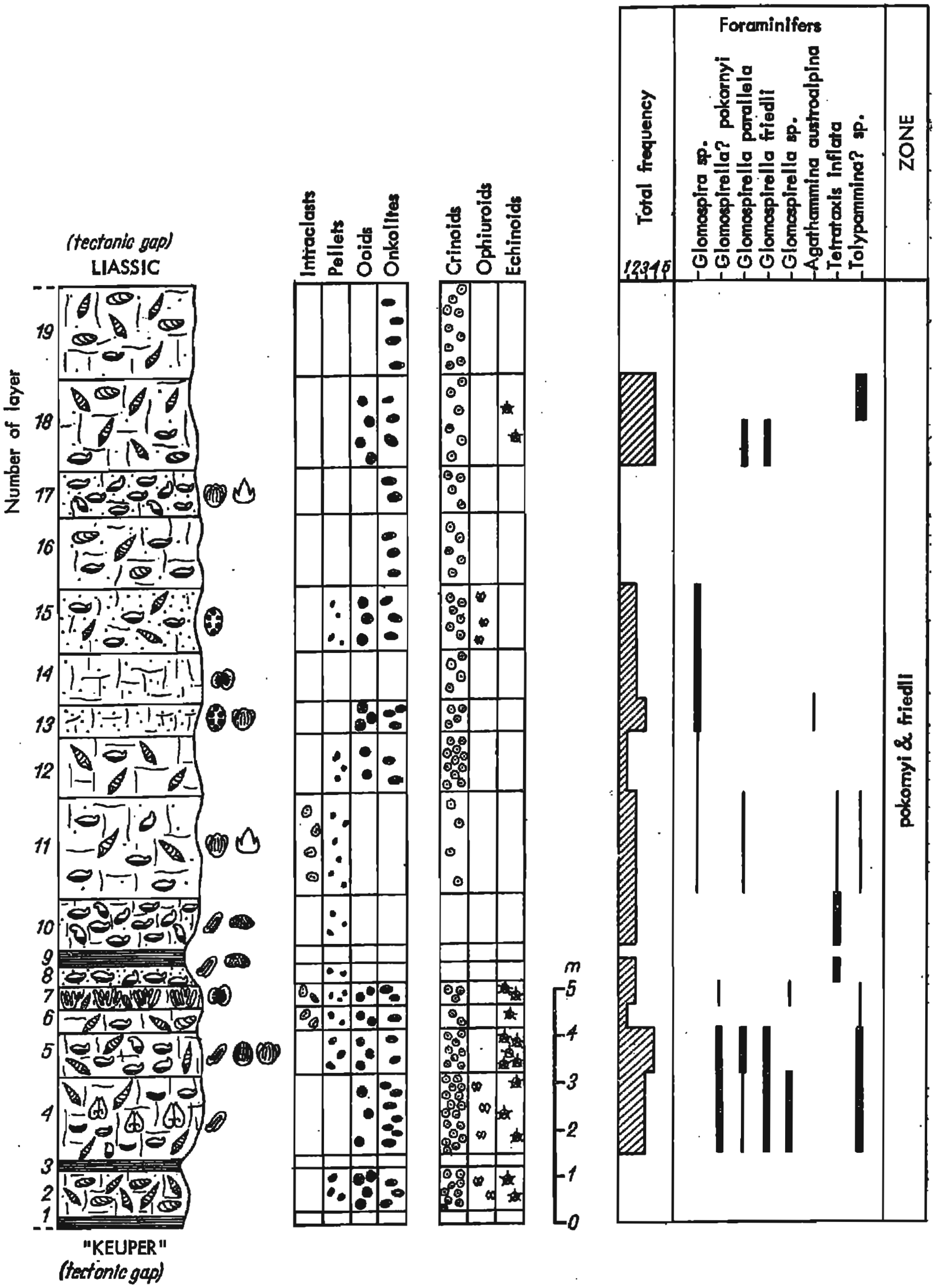


Fig. 4

Detail section of the Rhaetian deposits at Mt. Mała Świnica (*II* in Text-fig. 1); explanations the same as for Text-fig. 3

Microscopically, these limestones may be termed as biosparrudite composed of brachiopod and gastropod debris, in places coated with onkolitic envelops (Pl. 10, Fig. 4). Foraminifers are represented by *Glomospira* sp., *Glomospirella parallela*, and *Tolypammina?* sp. Some fish teeth and elasmobranch shagreen (*"Nurrella"* sp.) were found.

Layers 13—15. — Bluish-gray, well-bedded, somewhat sandy limestones. Fine brachiopod-gastropod debris occurs only in the upper part of these limestones. In the lower part of the series micritic limestone predominates (Pl. 10, Fig. 5). Algae *Acicularia* sp. and spores *Globochaete alpina* are common; whereas foraminifers (mostly *Glomospira* sp.) occur in somewhat smaller amounts.

Layers 16—17. — A series of bluish-gray thick-bedded organodetrital limestones. Microscopically, they may be termed as brachiopod-gastropod biomicrites containing bioclasts with onkolitic crusts, and fine quartz grains. No foraminifers were found.

Layers 18—19. — Bluish-gray massive organodetrital limestones. The lower part of this series yields brachiopods and gastropods, the upper part — mostly pelecypods. Microscopically, these limestones may be termed as biointrapelsparrudite composed of onkolitized bioclasts, intraclasts, and pellets (Pl. 10, Fig. 6). Foraminifers represented by *Glomospirella parallela*, *G. friedli*, and *Tolypammina?* sp. (Pl. 42, Figs 1, 7), are fairly common in the lower part of the series, disappearing in its upper part.

Mt. Mały Kopieniec (III)

Here the Rhaetian strata are exposed on SW slopes of Mt. Mały Kopieniec (Text-fig. 1 and Pl. 6, Fig. 1). These strata belong to the Suchy Wierch tectonic unit (*cf.* Guzik & Kotański 1963). Outcrops of Rhaetian strata in that region were mapped by Uhlig (1911) and Guzik & Kotański (1963, Table 1) and the strata were described by Goetel (1917). The section analysed, 23 m thick (Fig. 5), was traced at the altitude of 995—1,015 m a.s.l.; strike and dip equal 115°/30°N. Contact between the Rhaetian and "Keuper" is poorly exposed. The Rhaetian/Liassic boundary is of sedimentary nature (*cf.* Goetel 1917, Pl. 11). Twenty layers are distinguished.

Layer 1. — Sandstones and red slates of the "Keuper" are overlaid by thin-bedded (up to 10 cm thick) gray limestones. The limestones may be termed as biopelsparrudites composed of brachiopod and crinoid debris, often with onkolitic crusts and oolitic coatings, and with pellets (Pl. 7, Fig. 1). Foraminifers are represented by *Glomospirella? pokornyi*, *Glomospirella parallela*, and *Frondicularia woodwardi*.

Layers 2—5. — A series of thick-bedded *Megalodon* limestones (Pl. 6, Fig. 2), about 5 m thick. The limestones are intercalated by slates, brachiopod lumachelles with predominating *Rhaetina gregaria* (Pl. 23, Fig. 3), and coral limestones with *Retiophyllia* sp. (*cf.* Gaździcki 1971). The limestones yield rich megalodontid fauna, comprising *Conchodon infraliasicus* (Pl. 25), *C. goeteli* sp. n. (Pl. 27), *Rhaetomegalodon incisus*, and *R. tatricus* sp. n. (Pl. 26, Figs 1—3). Algae are represented by *Girvanella minuta*, *Acicularia* sp., *Solenopora* sp.; foraminifers — by *Glomospirella friedli* and *Tetrataxis inflata*. There occur also some ostracodes and numerous coprolites, *Bactryllium ornatum* sp. n. (Pl. 52, Figs 1*a*, 2—6) and *B. elongatum* sp. n. (Pl. 52, Figs 1*b*, 7). The *Megalodon* limestones may be generally termed as biointrapelmicrites composed of brachiopod, gastropod, and crinoid debris with onkolitic crusts, as well as of intraclasts and pellets, and as pelmicrites rich in coprolites (mostly *Bactryllium* sp.; see Pl. 7, Fig. 2).

Layers 6—10. — A series of thick-bedded sandy limestones with single brachiopods and gastropods. They may be termed as biooomicrites with numerous

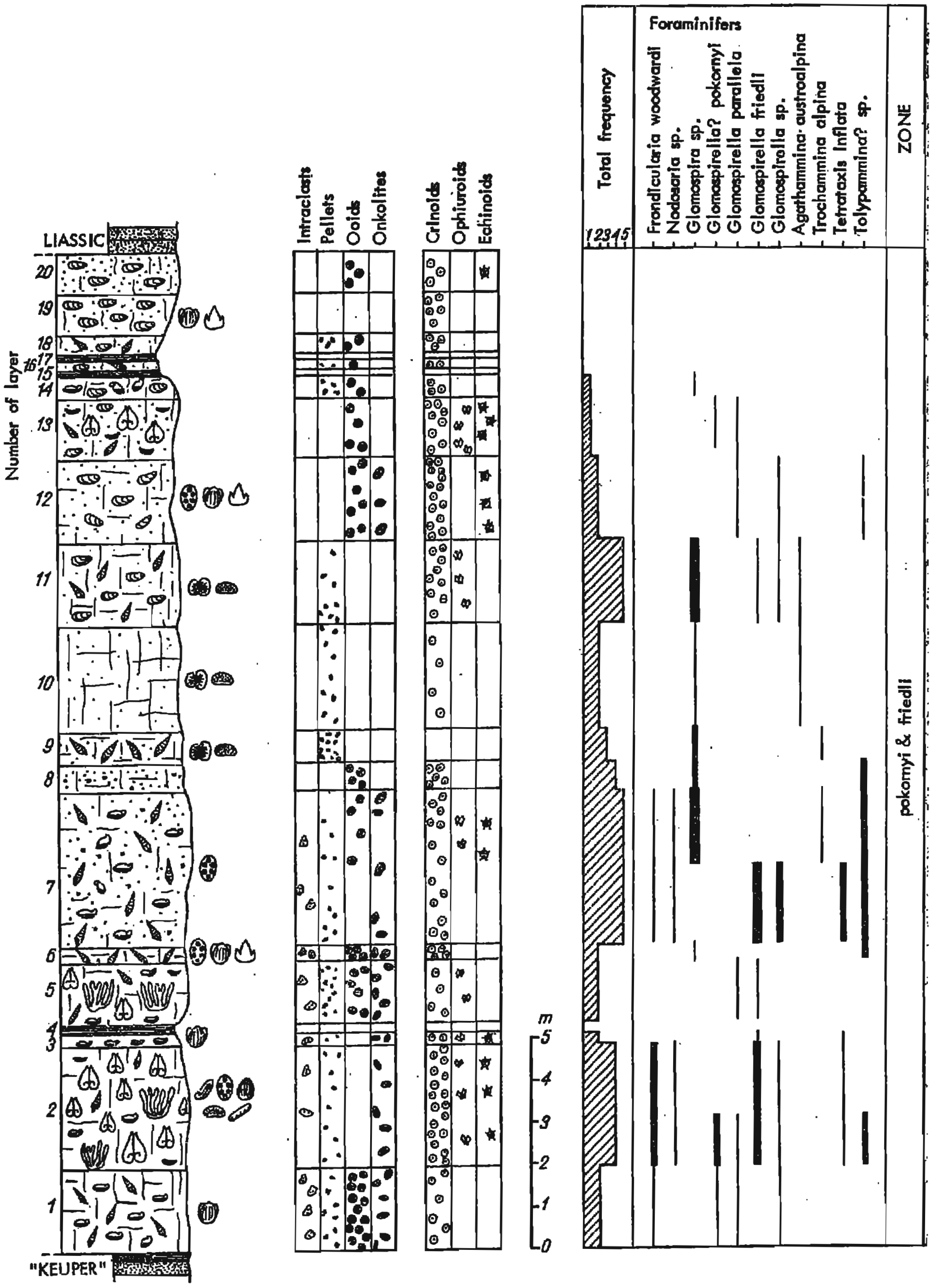


Fig. 5

Detail section of the Rhaetian deposits at Mt. Mały Kopieniec (*III* in Text-fig. 1); explanations the same as for Text-fig. 3

quartz grains (Pl. 7, Fig. 3). Foraminifers are represented by *Glomospira* sp., *Glomospirella friedli*, *Tetrataxis inflata*, and *Tolypammina?* sp.

Layer 11. — Bluish-gray, organodetrital limestones, which may be termed as biopelsparcnites composed of pelecypod and brachiopod debris (often with onkolitic crusts), pellets, and large fragments of pelecypod shells (Pl. 7, Fig. 4). *Glomospira* sp. is fairly common.

Layers 12—13. — A series of thick-bedded sandy limestones. Its lower part yields numerous pelecypods, among which *Pecten* sp. and *Placunopsis* sp. predominate; the upper part yields single megalodontids, which are observable in shell-sections displayed by surfaces of limestone layers. Innumerous foraminifers are represented by *Glomospirella parallela* and *Glomospirella* sp.

Layers 14—18. — Bluish-gray thin-bedded limestones rich in pelecypod shell debris, intercalated by slates. The limestones may be termed as pelecypod-crinoid biomicrites (Pl. 7, Fig. 5). Foraminifers *Glomospira* sp. are occasionally found.

Layers 19—20. — A series of sandy (pelecypod) lumachelle limestones (Pl. 7, Fig. 6), about 2 m thick with *Lopha haidingeriana* (Pl. 23, Fig. 5) predominating here. Single fish teeth and elasmobranch shagreen ("*Nurrella*" sp.) occur here, but there are no foraminifers.

The layer *20* is overlaid in sedimentary continuity by a series of Lower Liassic sandstones with some slaty intercalations. Basal surfaces of the sandstones sometimes display numerous sole markings related to life activities of starfishes and ophiuroids (*see* Pl. 24).

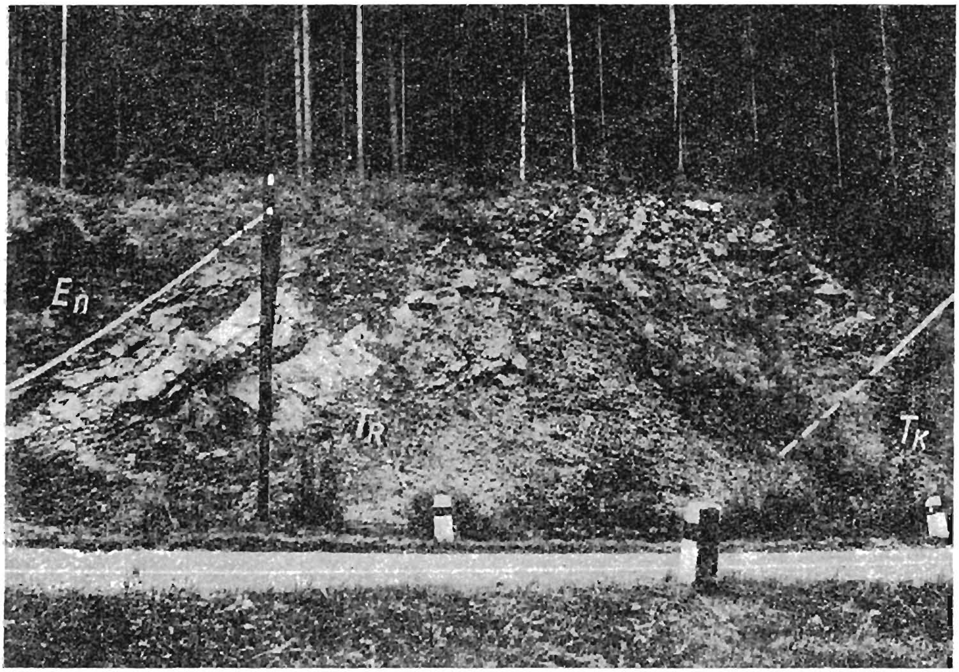
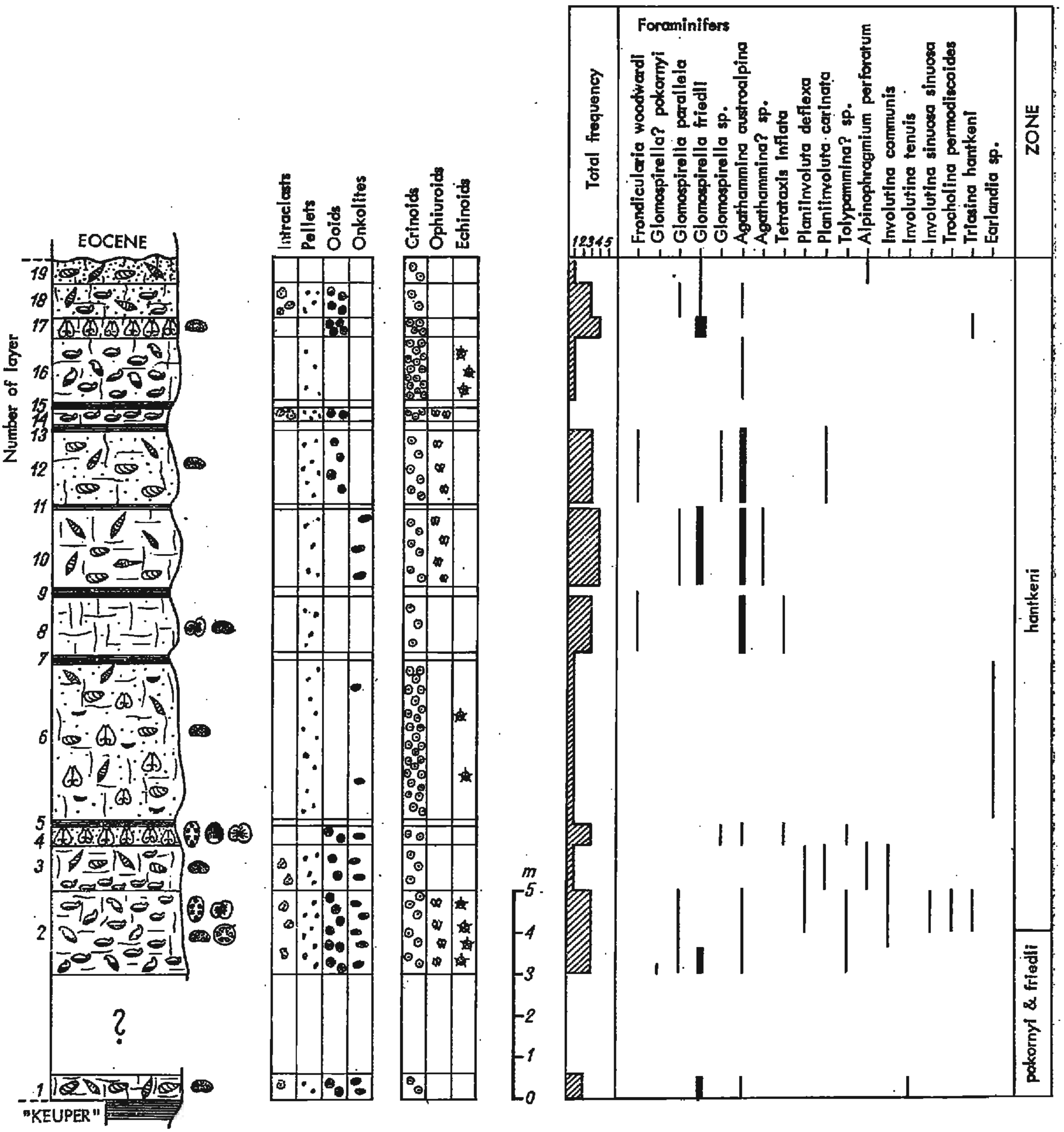


Fig. 6

Exposure of the Rhaetian deposits along the roadcut near Javorina (Łysa Polana — Tatranská Lomnica highway, section *IV* in Text-fig. 1, presented in details in Text-fig. 7)

T_K — "Keuper", T_R — Rhaetian, E_n — Nummulite Eocene



Detail section of the Rhaetian deposits at Javorina (*IV* in Text-fig. 1); explanations the same as for Text-fig. 3

Javorina (IV)

Outcrops of Rhaetian strata in the region of Javorina were mapped by Uhlig (1911), Andrusov (1950, Table 5), and Fusán & *al.* (1963). The most complete section of the Rhaetian is here displayed by the roadcut near Javorina (Figs 1 and 6). The section analysed comprises about 20 m of Rhaetian strata, the strike and dip being equal 100°/40°N (Fig. 7). Contact with the "Keuper" is poorly visible but its sedimentary nature may be inferred. The uppermost Rhaetian is discordantly overlaid by the Nummulite Eocene. The Rhaetian strata belong to the Skalki (Gęsia Szyja) tectonic unit (*cf.* Andrusov 1950). Within this section 19 layers are distinguished.

Layer 1. — Greenish-red slates of the uppermost "Keuper" are ovelaid in sedimentary continuity by the first layer of dark-blue Rhaetian limestone. The limestone may be microscopically characterized as biooosparenite composed of pelecypod-gastropod debris, ooids, and pellets. Foraminifers occurring here are represented by *Glomospirella friedli*, *Agathammina austroalpina*, and *Involutina tenuis*.

Layers 2—3. — A series of bluish-gray, well-bedded limestones. Brachiopods, mostly *Rhaetina gregaria*, are numerous in the lower part of that series; upwards they are replaced by gastropods and pelecypods. Microscopically, these limestones may be termed as mostly brachiopod-pelecypod biomicrites (Pl. 14, Fig. 1), and partly as intrapelmicrites. The lower part of the series yields foraminifers *Glomospirella? pokornyi* and *G. friedli*, whereas its upper part — representatives of Involutinidae including *Involutina communis*, *Trocholina permodiscoides*, and *Triasina hantkeni* (Pl. 49, Fig. 1).

Layers 4—6. — A series of thick-bedded, sometimes somewhat sandy *Megalodon* limestones, about 4 m thick. Surfaces of layers display numerous sections of megalodontid shells referable to the genus *Conchodon*. The lower part of the series is intercalated by a layer of dark clay slates about 20 cm thick. Admixture of detrital quartz somewhat increases towards the top of the series. The upper part of the series is also enriched in crinoid debris (Pl. 14, Fig. 2). Algae, *Solenopora* sp. (Pl. 31, Figs 1—4) and *Acicularia* sp., are fairly common; foraminifers (mostly *Earlandia* sp.) are scarce.

Layers 7—13. — A series of well-bedded limestones about 6 m thick. The series is a few times intercalated with clay slate layers, 20—30 cm thick. The slates are completely devoid of organic fragments. The lower part of the limestone series is represented by pelmicrite (Pl. 14, Fig. 3), the middle and upper parts — by biopelsparenite composed of pelecypod-gastropod and crinoid debris, pellets, and innumerous ooids. Foraminifers are primarily represented by *Glomospirella friedli*, *G. parallela*, *Agathammina austroalpina*, and *Tetrataxis inflata*.

Layers 14—16. — Bluish-gray organodetrital limestones with numerous brachiopods (mostly *Rhaetina gregaria*); intercalation of dark slates 20 cm thick. Microscopically, these limestones are mostly represented by biopelmicrites composed of brachiopod and crinoid debris with onkolitic crusts, as well as of pellets. Foraminifers are represented by *Agathammina austroalpina*.

Layer 17. — *Megalodon* limestone layer over 0.5 m thick. The surface of the layer displays numerous sections and fragments of shells of *Conchodon infraliasicus*. This limestone is represented by biosparenite composed of pelecypod--crinoid debris and ooids. Among foraminifers, *Glomospirella friedli* and *Triasina hantkeni* predominate. Sparitized ostracodes are fairly common.

Layers 18—19. — Limestones, represented mostly by pelecypod biomicrite with very fine quartz grains (Pl. 14, Fig. 5) and biooosparenite composed of pelecypod debris, ooids and innumerous quartz grains (Pl. 14, Fig. 6). In the uppermost part of the Rhaetian the contribution of detrital quartz markedly increases, whereas foraminifers almost completely disappear. Single forms of *Glomospirella friedli* and *Alpinophragmium perforatum* were found here. The top part of that section is partly eroded and discordantly overlaid by the Nummulite Eocene.

Szeroka Bielska Pass (V)

The Rhaetian strata are exposed here on southern slopes of Mt. Płaczliwa Skała (Ždziarska vidla) in the area of Szeroka Bielska Pass (Široké sedlo) Text-fig. 1 and Pl. 2, Figs 1—2). The outcrops were mapped by Uhlig (1911) and subsequently by Sokołowski (1948, Pls 13—14), and the Rhaetian strata were briefly characterized by Sokołowski (1948), Borza (1959), Mišik & *al.* (1960), and Kochanová (1967). These strata belong to the Havran tectonic unit (*cf.* Mahel, Buday & *al.* 1968; Książkiewicz 1972); strike and dip equal 90°/30°N. Contacts of the Rhaetian strata with the "Keuper" and Liassic are of sedimentary nature. The strata slightly exceed 10 m in thickness (Fig. 8). Seventeen layers are distinguished.

Layers 1—3. — Reddish-violet and gray slates of the uppermost "Keuper" are overlaid in sedimentary continuity by thin bedded, dark-gray, slightly sandy limestones with black slate intercalations. The limestones are mostly represented

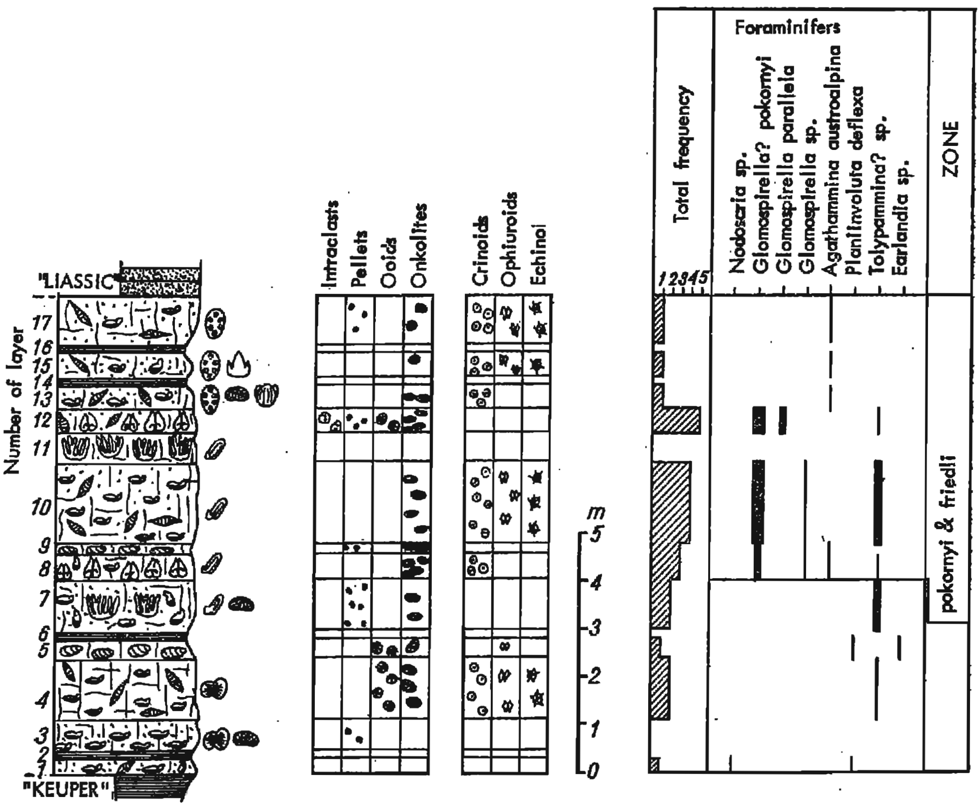
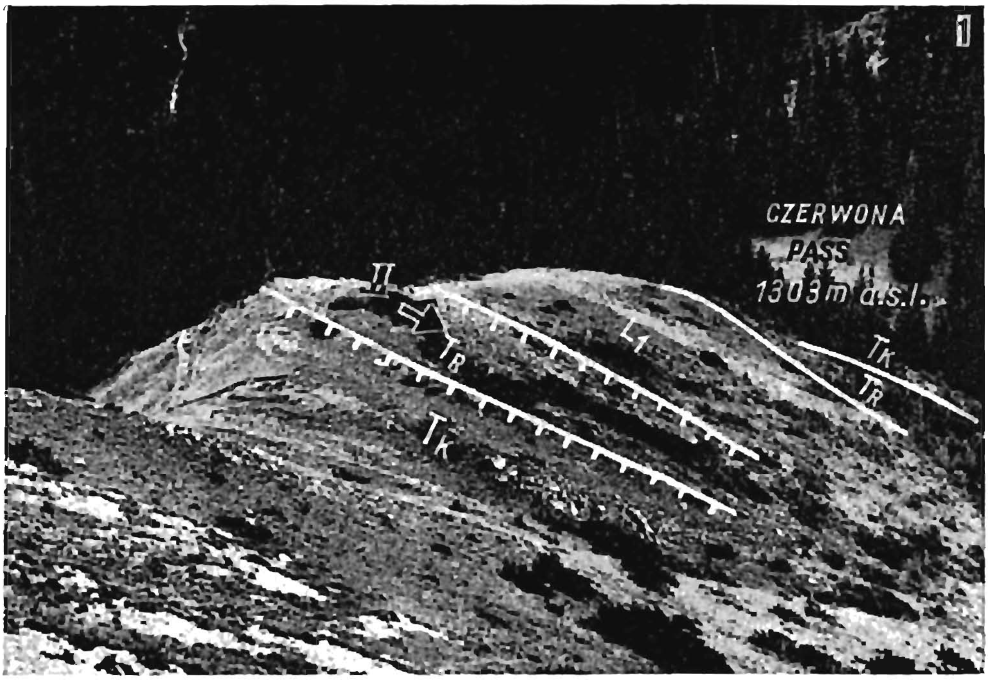


Fig. 8

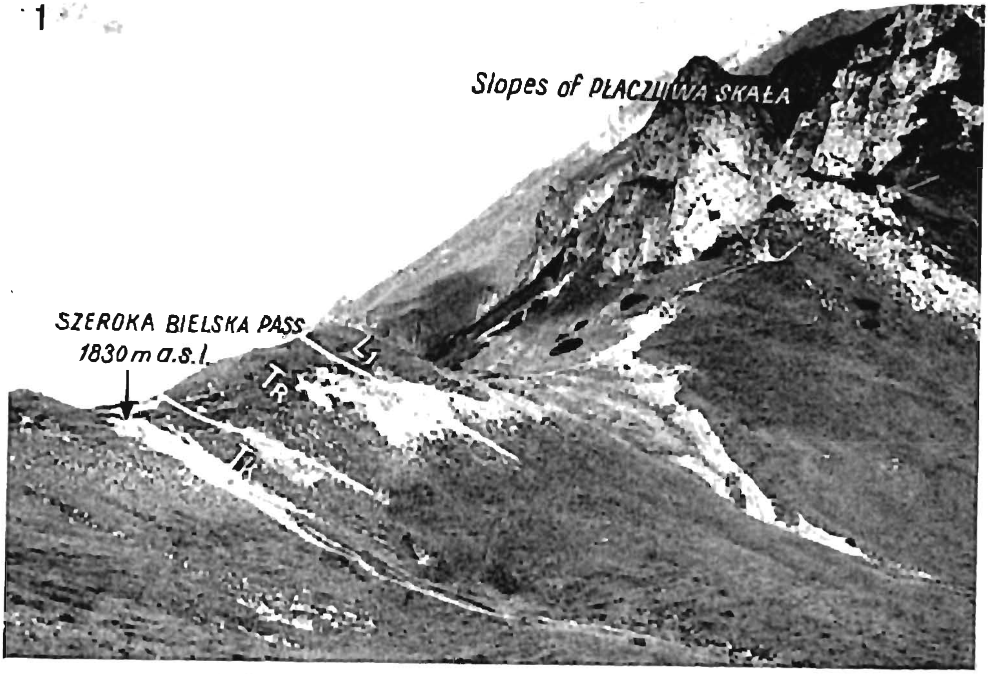
Detail section of the Rhaetian deposits at Szeroka Bielska Pass (V in Text-fig. 1); explanations the same as for Text-fig. 3



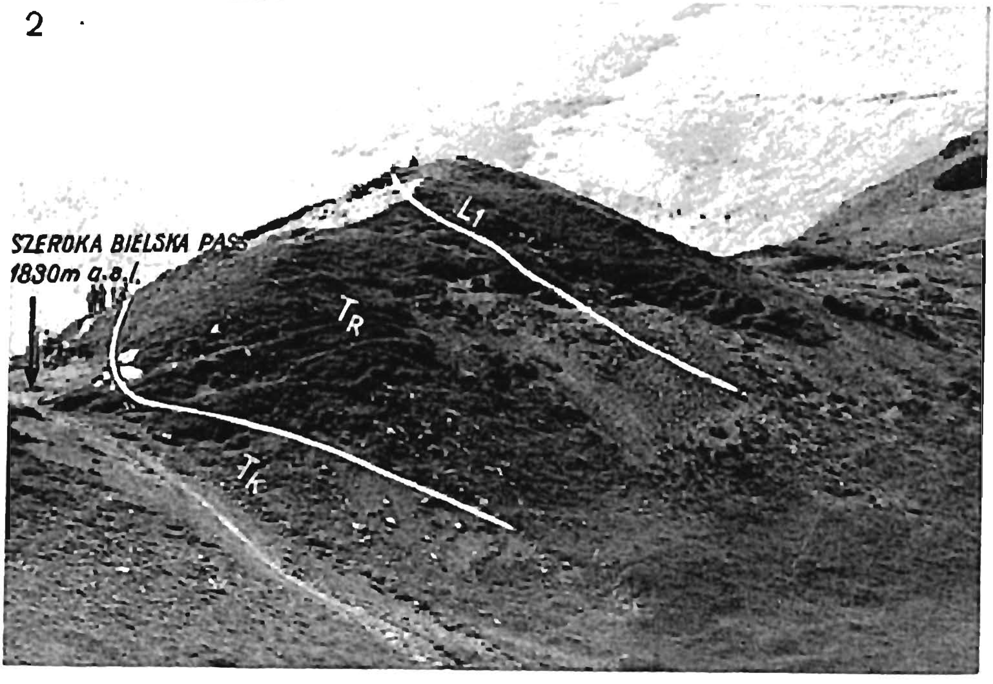
1 — Exposures of the Rhaetian deposits (T_R) between Czerwona Pass and Mt. Mała Świnica; the investigated section (*II* in Text-fig. 1, presented in Text-fig. 4) situated in a tectonic slice between the "Keuper" (T_K) and Lower Liassic (L_1).

2 — Fragment of a branched colony of *Retiophyllia paraclathrata* Roniewicz from layer 7 in Mt. Mała Świnica section (*II*).

1



2

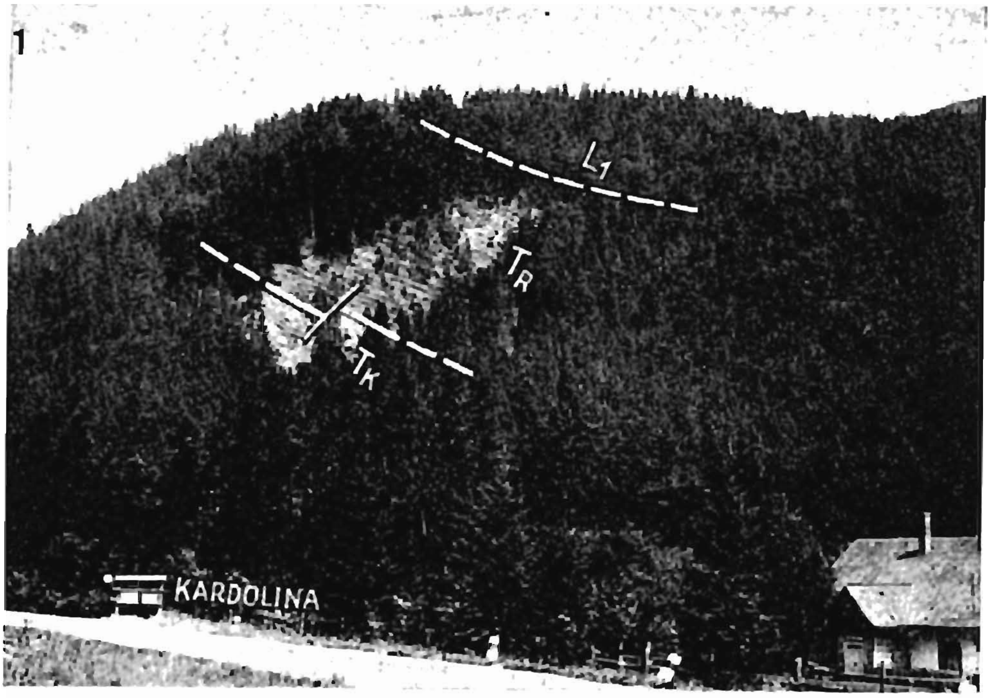


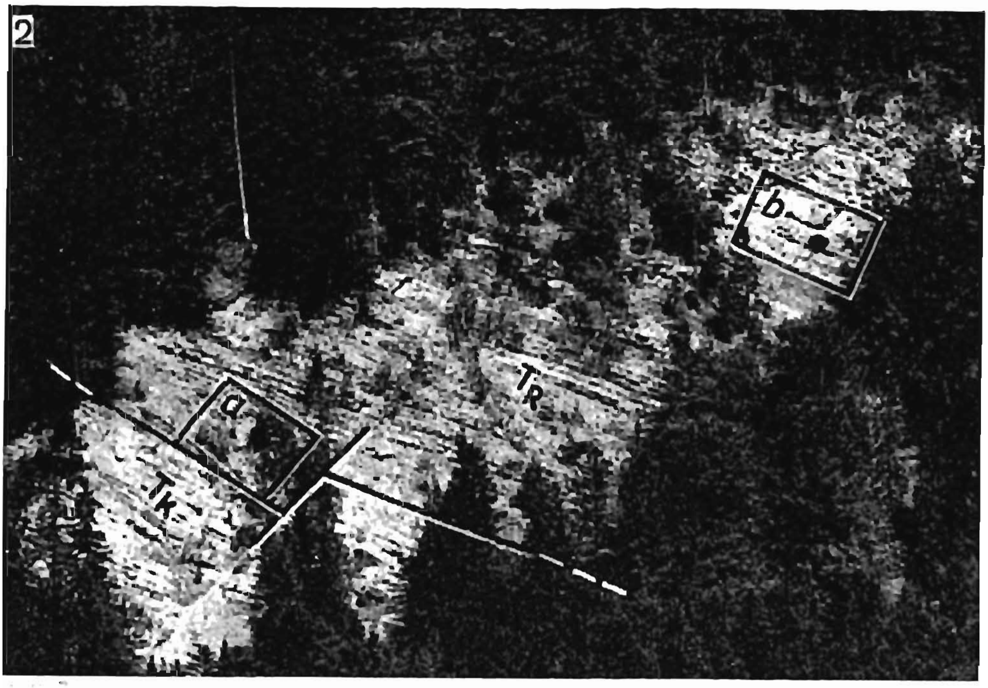
1 — Southern slopes of Mt. Płaczliwa Skała (Żdiarska vidla) and Szeroka Bielska Pass with the Triassic-Liassic sequence (T_K — "Keuper", T_R — Rhaetian, L_1 — Lower Liassic).

2 — Close-up view of the preceding photo: localization of the investigated section at Szeroka Bielska Pass (*V* in Text-fig. 1, presented in Text-fig. 8).

1 — Top surface of the coral-limestone layer with *Astraeomorpha crassisepta* Reuss and *Retiophyllia* sp. at Szeroka Bielska Pass (section *V*, layer *11*).

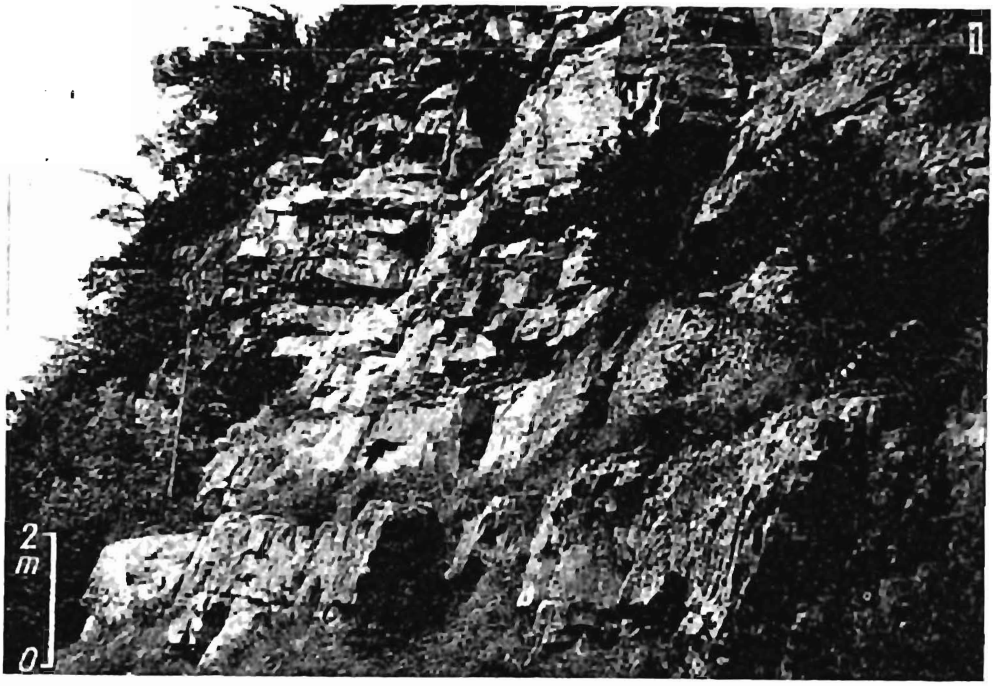
2 — Top surface of the *Megalodon*-limestone layer with *Conchodon infraliasicus* Stoppani at Szeroka Bielska Pass (section *V*, layer *12*).





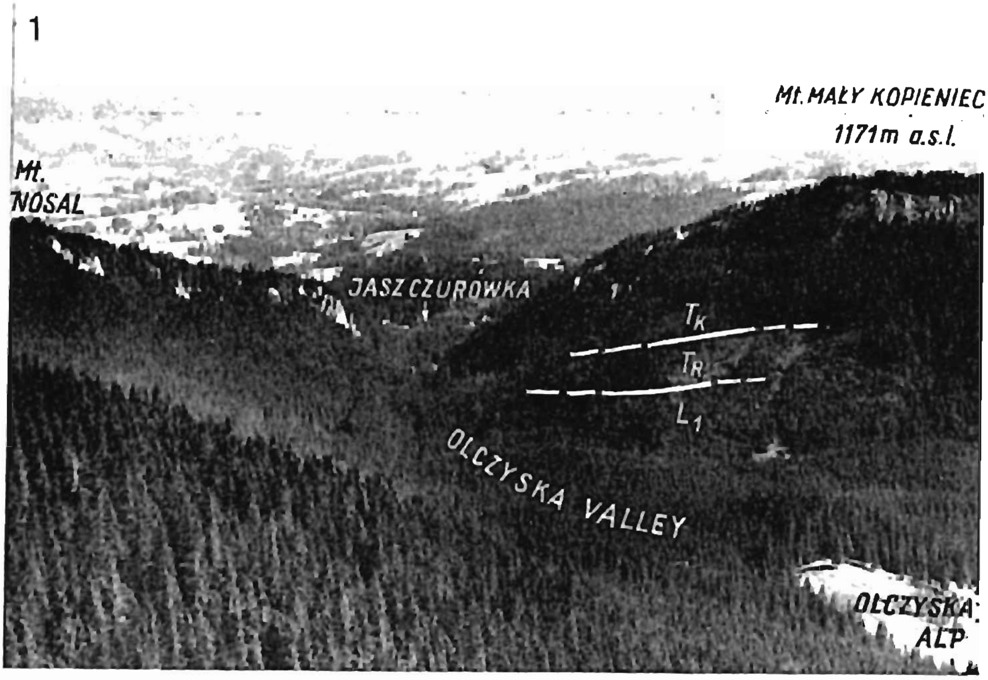
1 — South-western slopes of Mt. Palenica Lendacka near Kardolina (Łysa Polana — Tatranská Lomnica highway) with the Triassic-Liassic sequence (T_K — "Keuper", T_R — Rhaetian, L_1 — Lower Liassic).

2 — Close-up view of the preceding photo: localization of the investigated section at Mt. Palenica Lendacka (*VI* in Text-fig. 1, presented in Text-fig. 9). Rectangled are the parts presented in: *a* — Pl. 5, Fig. 2; *b* — Pl. 5, Fig. 1.



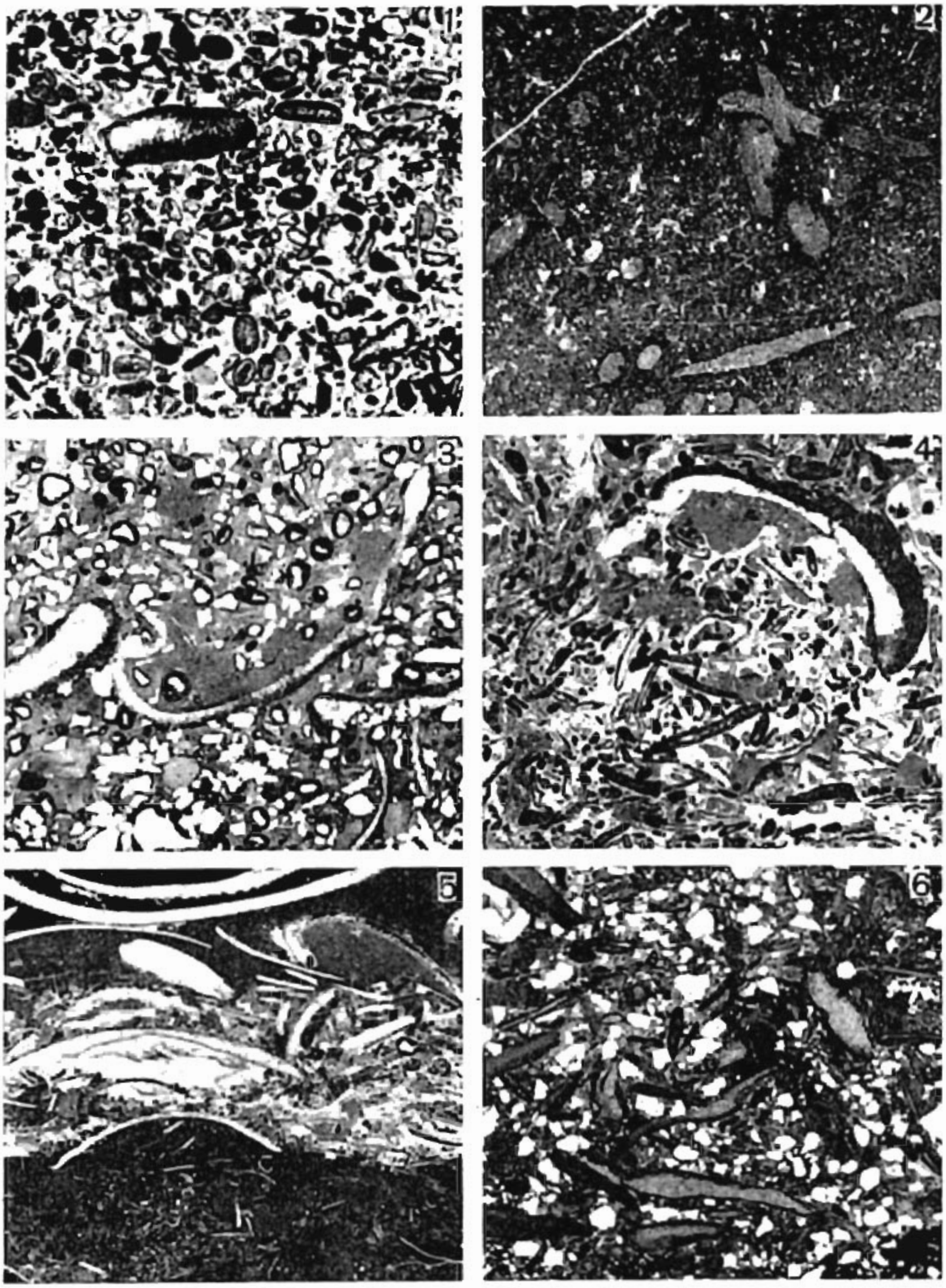
1 — Exposure of thick-layered (*c.* 1.5 m) organodetrital limestones in the upper part of Mt. Palenica Lendacka section (*b* in Pl. 4, Fig. 2).

2 — Thin-layered limestones with shale intercalations overlying dolomites (*d*) in the lowermost part of Mt. Palenica Lendacka section (*a* in Pl. 4, Fig. 2).



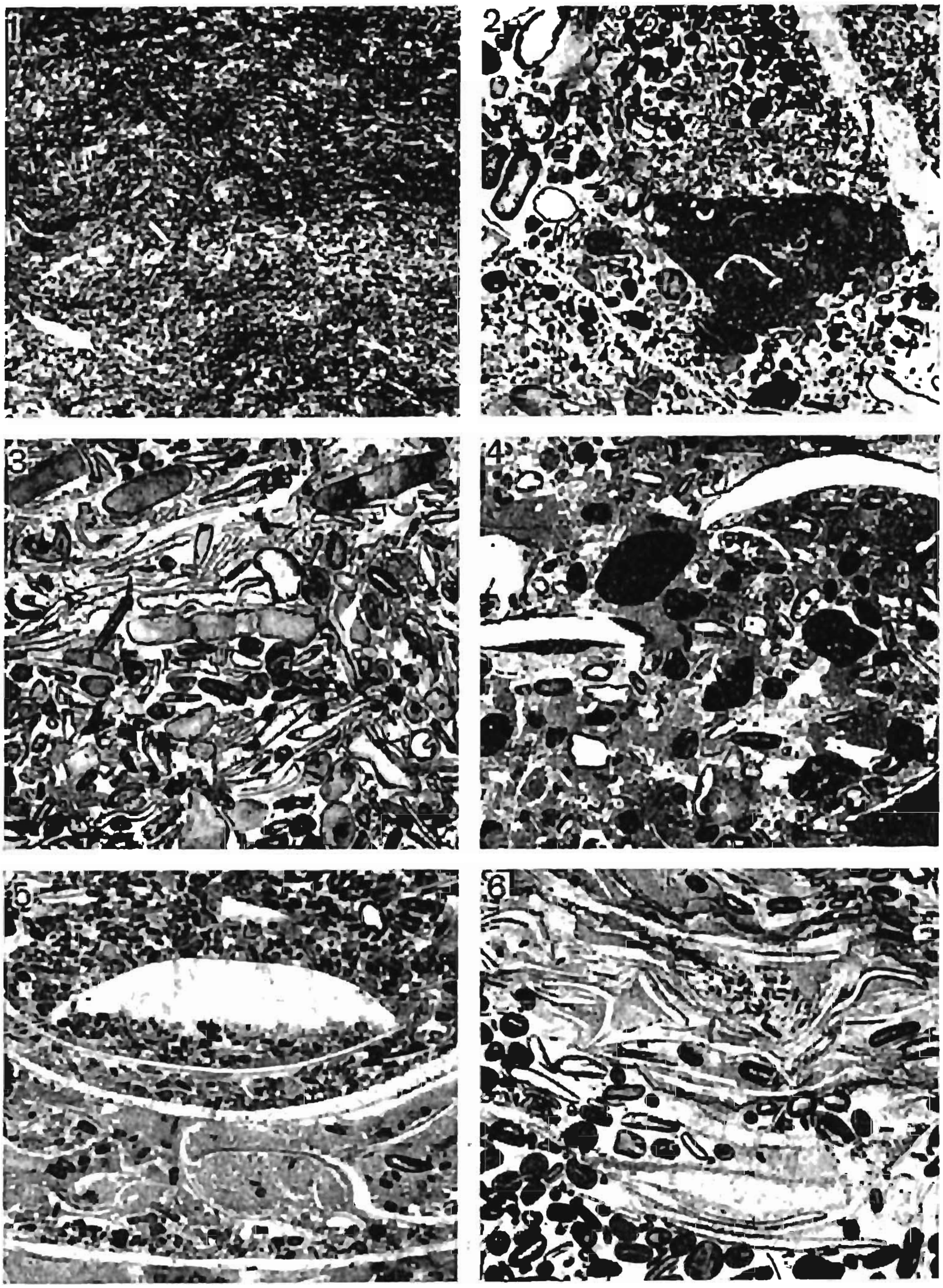
1 — Occurrence zone of the Rhaetian deposits in the reversed, Triassic-Liassic sequence (T_K — "Keuper", T_R — Rhaetian, L_1 — Lower Liassic) on south-western slopes of Mt. Mały Kopieniec (section *III* in Text-fig. 1, presented in Text-fig. 5).

2 — *Megalodon*-limestones in Mt. Mały Kopieniec section (*III*, layer 2): a rich assemblage of the megalodontids collected from a thin marly intercalation (arrowed).



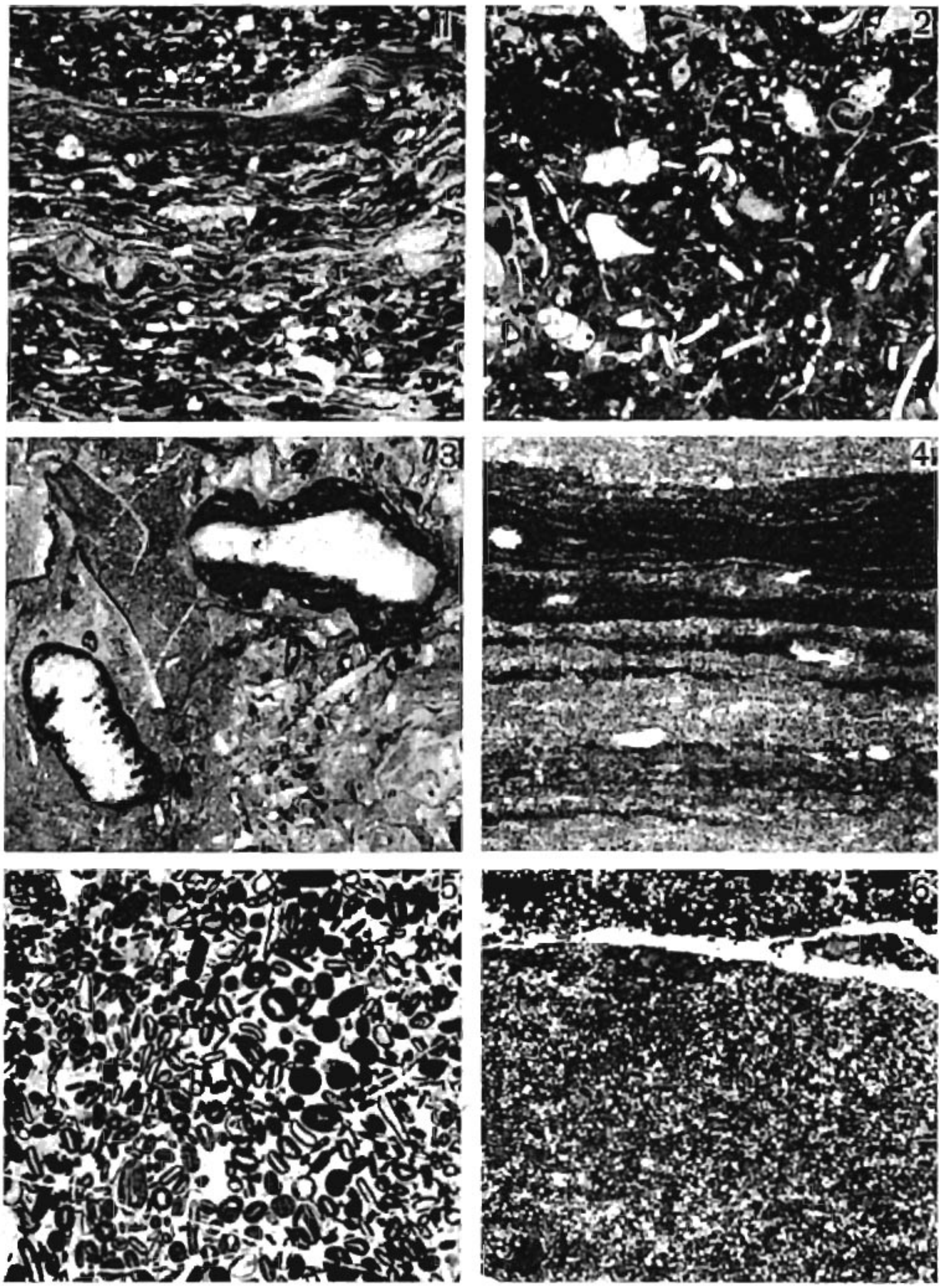
Mt. Mały Kopieniec section (*III*), × 7

1 — Biopelsparrudite composed of brachiopod and crinoid debris, partly with onkolitic crusts and oolitic coatings, and with pellets; layer *1*.
2 — Pelmicrite with numerous coprolites *Bactryllium* sp.; layer *2*.
3 — Biooomicrite with numerous quartz grains; layer *8*.
4 — Biopelsparenite composed of pelecypod and brachiopod debris (often with onkolitic crusts), pellets and greater fragments of pelecypod valves; layer *11*.
5 — Pelecypod-crinoid biomicrite; layer *14*.
6 — Sandy, lumachelle (pelecypod) limestone; layer *20*.



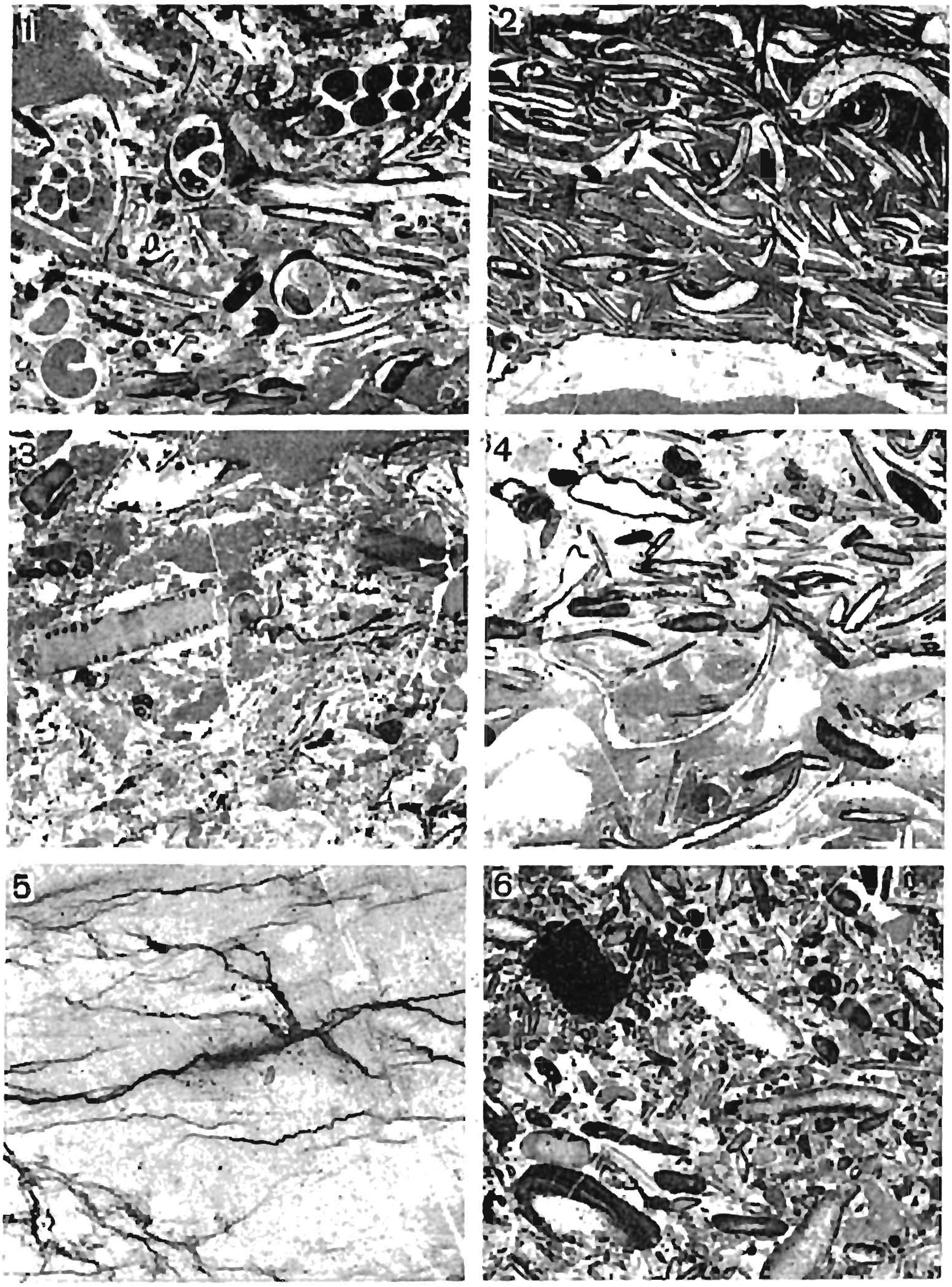
Lejowa Valley section (*I*), × 7

1 — Marly shale with fine organic debris; layer *1*.
2 — Intrapelsparrudite with greater intraclasts; layer *8*.
3 — Crinoid biosparite; layer *17*.
4 — Biointrapelmicrite composed of brachiopod, gastropod and crinoid debris with onkolitic crusts, as well as of intraclasts and pellets; layer *20*.
5 — Brachiopod-foraminifer biomicrite; layer *29*.
6 — Biooosparrudite composed of brachiopod debris and subordinate ooids; layer *31*.



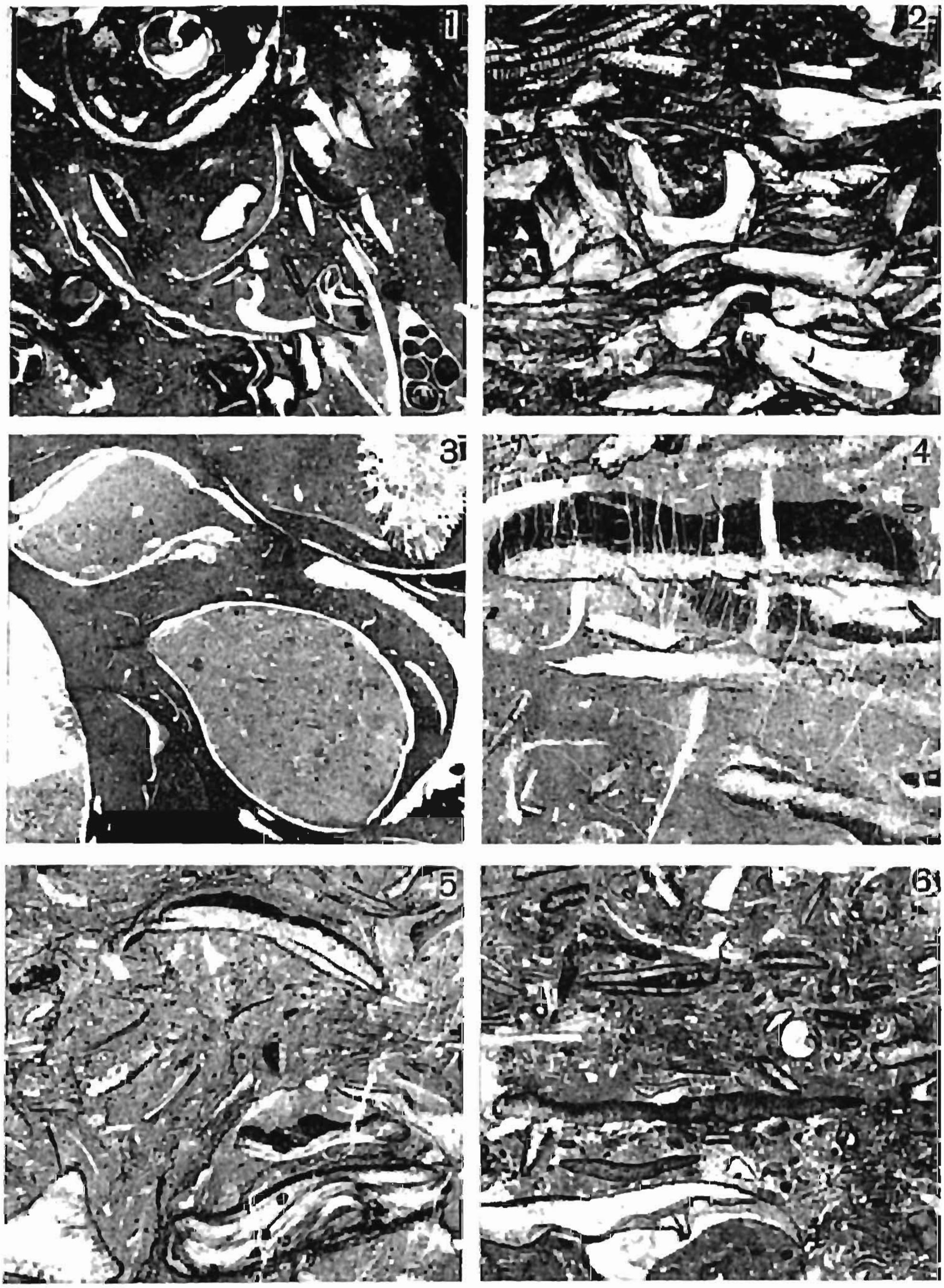
Lejowa Valley section (*1*, cnt'd), × 7

1 — Biopelsparrudite composed of pelecypod and brachiopod debris, pellets, ooids and quartz grains; layer *33*.
2 — Biointrapelmicrite composed of gastropod, brachiopod and crinoid debris, intraclasts and pellets; layer *34*.
3 — Biomicrite composed of brachiopod debris coated with onkolitic envelopes; layer *35*.
4 — Micritic limestone with "algal lamination"; layer *36*.
5 — Well-sorted oosparite; layer *41*.
6 — Siltstone; layer *42*.



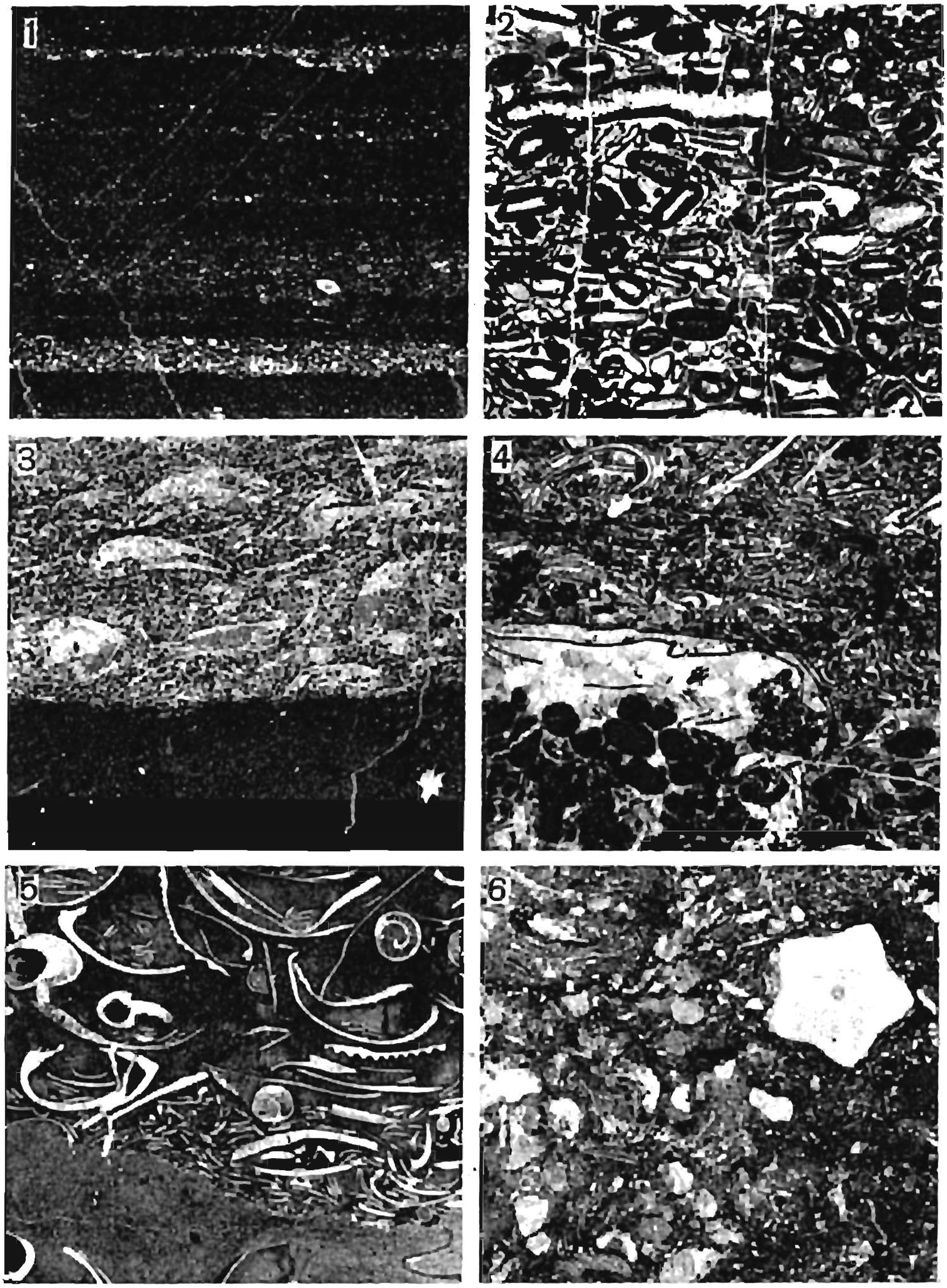
Mt. Mała Świnica section (*II*), × 7

1 — Gastropod-brachiopod biomicrite; layer 2.
2 — Brachiopod biomicrite; layer 4.
3 — Crinoid biopelsparrudite; layer 7.
4 — Biosparrudite composed of brachiopod and gastropod debris, in places coated with onkolitic envelopes; layer 11.
5 — Micritic limestone (cut by stylolites); layer 14.
6 — Biointrapelsparrudite composed of onkolitized bioclasts, intraclasts and pellets; layer 19.



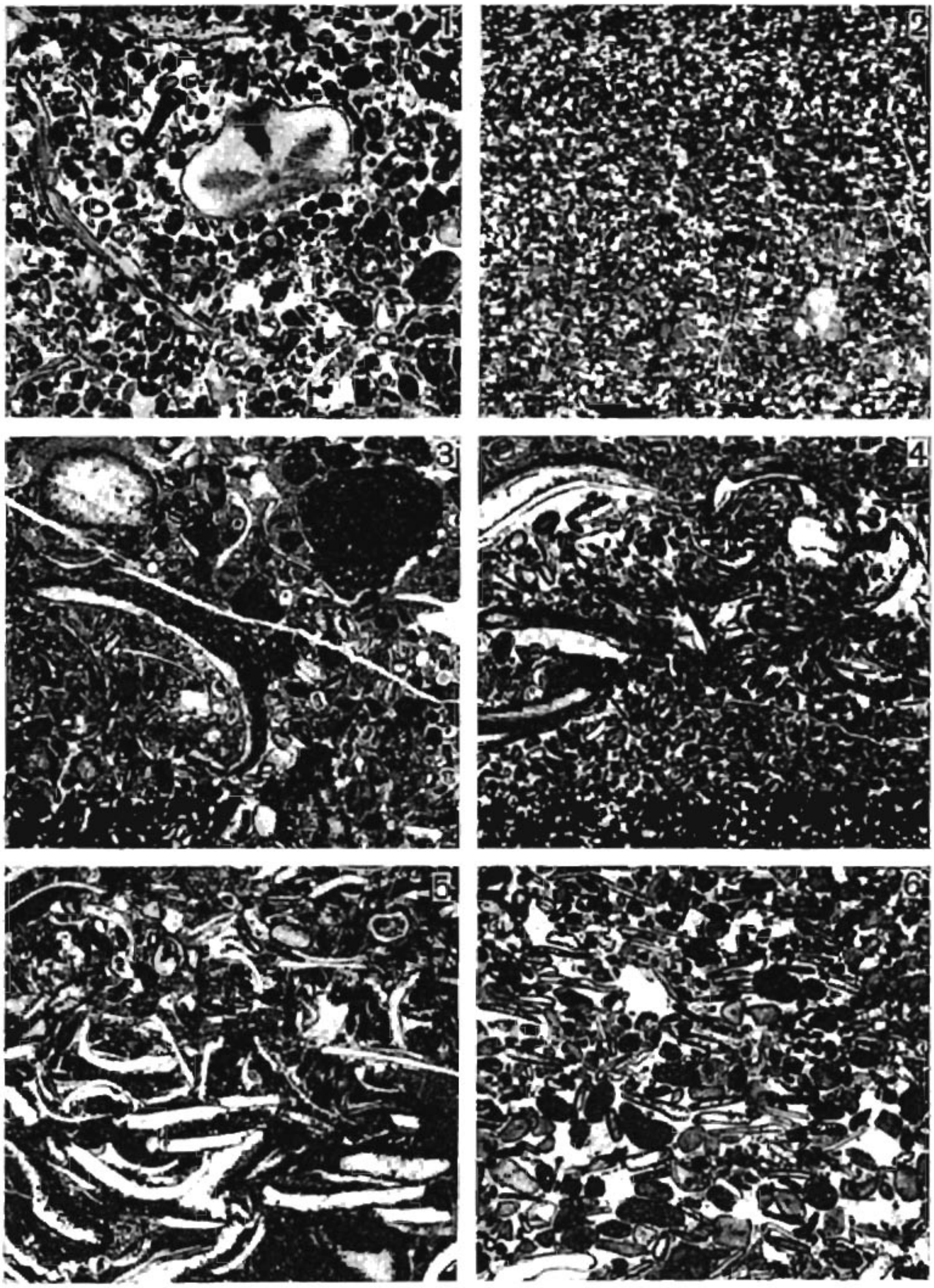
Szeroka Bielska Pass section (*V*), × 7

1 — Gastropod-brachiopod biomicrite; layer 4.
2 — Pelecypod-brachiopod biomicrite; layer 7.
3 — Brachiopod-coral biomicrite; layer 7.
4 — Biomicrite containing greater pelecypod debris with onkolitic crusts; layer 8.
5 — Brachiopod biomicrite containing bioclasts with onkolitic crusts, and small quartz grains; layer 10.
6 — Biopelmicrite composed of brachiopod, gastropod and crinoid debris, as well as of pellets; layer 13.



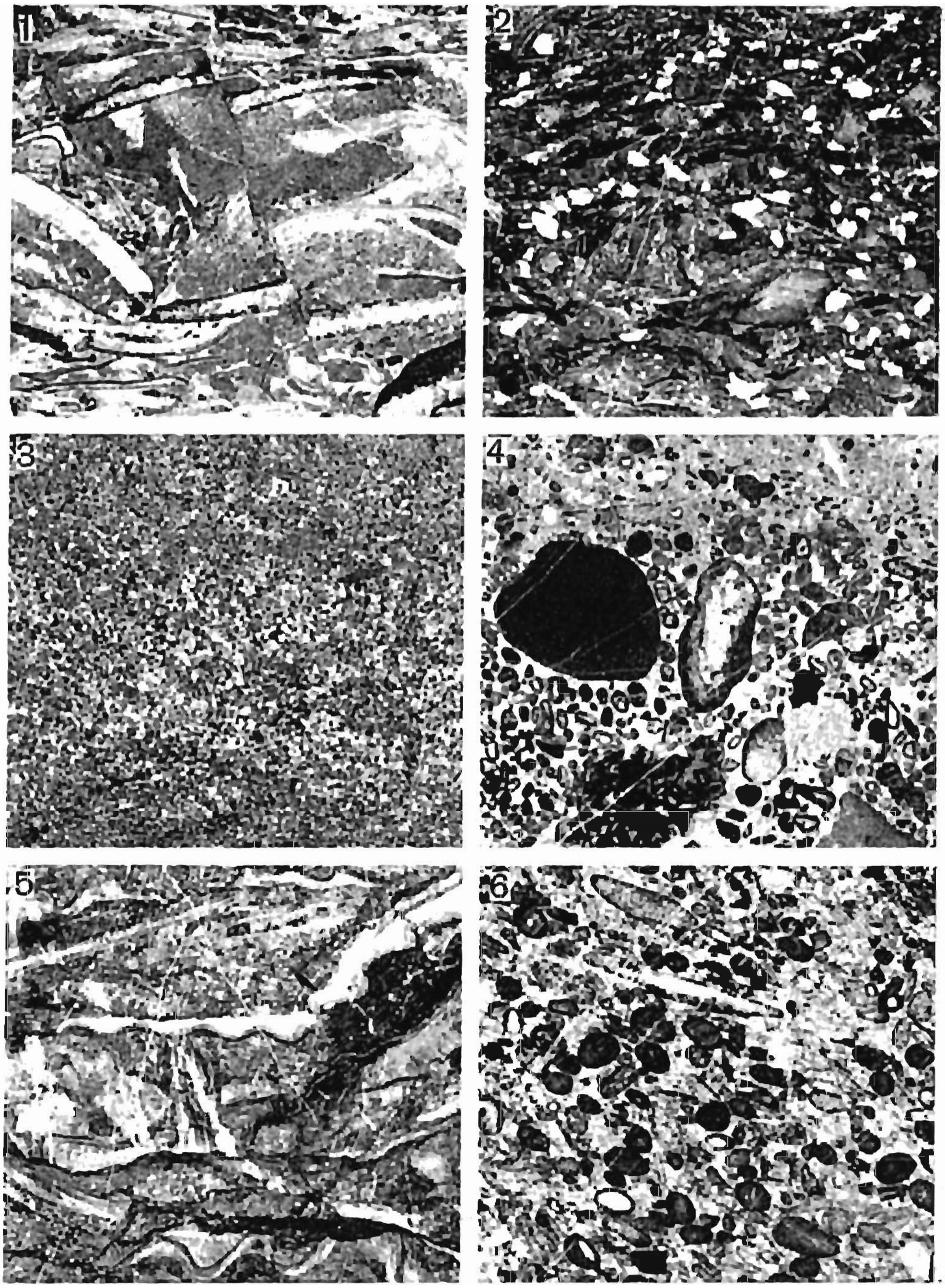
Mt. Palenica Lendacka section (*VI*), × 7

1 — Laminated limestone composed of calcarenite/calcilutite rhytms; layer *7*.
2 — Bioosparenite composed of brachiopod debris and well-sorted ooids; layer *8*.
3 — Micritic limestone with rare brittle-star vertebrae, sharply overlaid with brachiopod biopelmicrite; layer *15*.
4 — Biopelsparenite composed of strongly crushed bioclasts (mostly brachiopod debris), and fecal pellets at the bottom; layer *16*.
5 — Pelecypod biomicrite; layer *18*.
6 — Crinoid biopelmicrite with *Pentacrinus* ossicles; layer *37*.



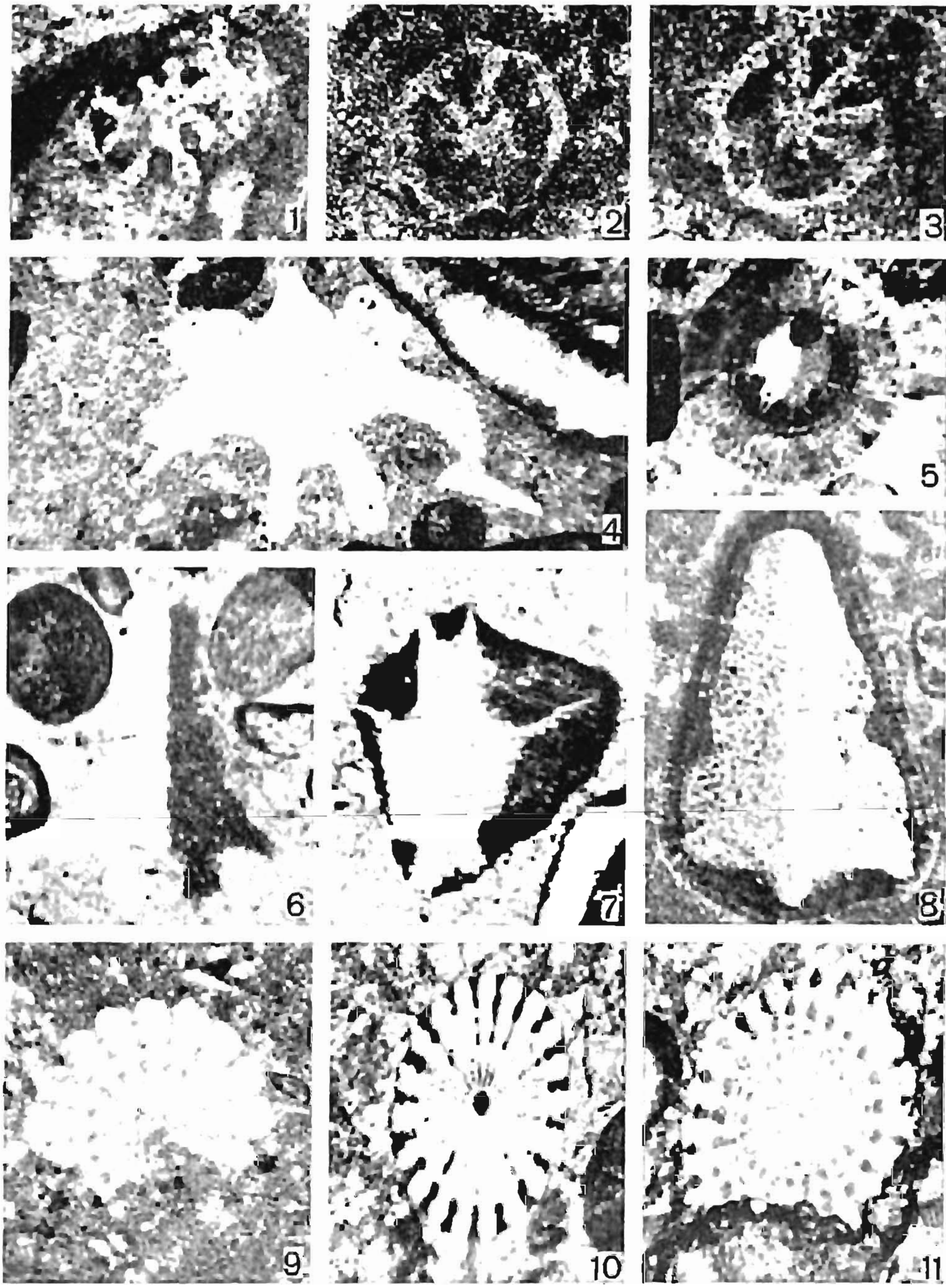
Mt. Palenica Lendacka section (*VI*, cnt'd), × 7

1 — Biointrapelsparenite composed of pelecypod and crinoid (*Pentacrinus*) debris, small intraclasts, pellets, and few ooids; layer *39*.
2 — Silty biomicrite; layer *40*.
3 — Biointramicrite composed of brachiopod, crinoid, algal (*Solenopora*) debris with onkolitic crusts, as well as of intraclasts and pellets; layer *41*.
4 — Brachiopod biooosparenite; layer *42*.
5 — Biopelmicrite composed of brachiopod and crinoid debris with onkolitic crusts, as well as of pellets; layer *43*.
6 — Crinoid biopelsparenite; layer *44*.

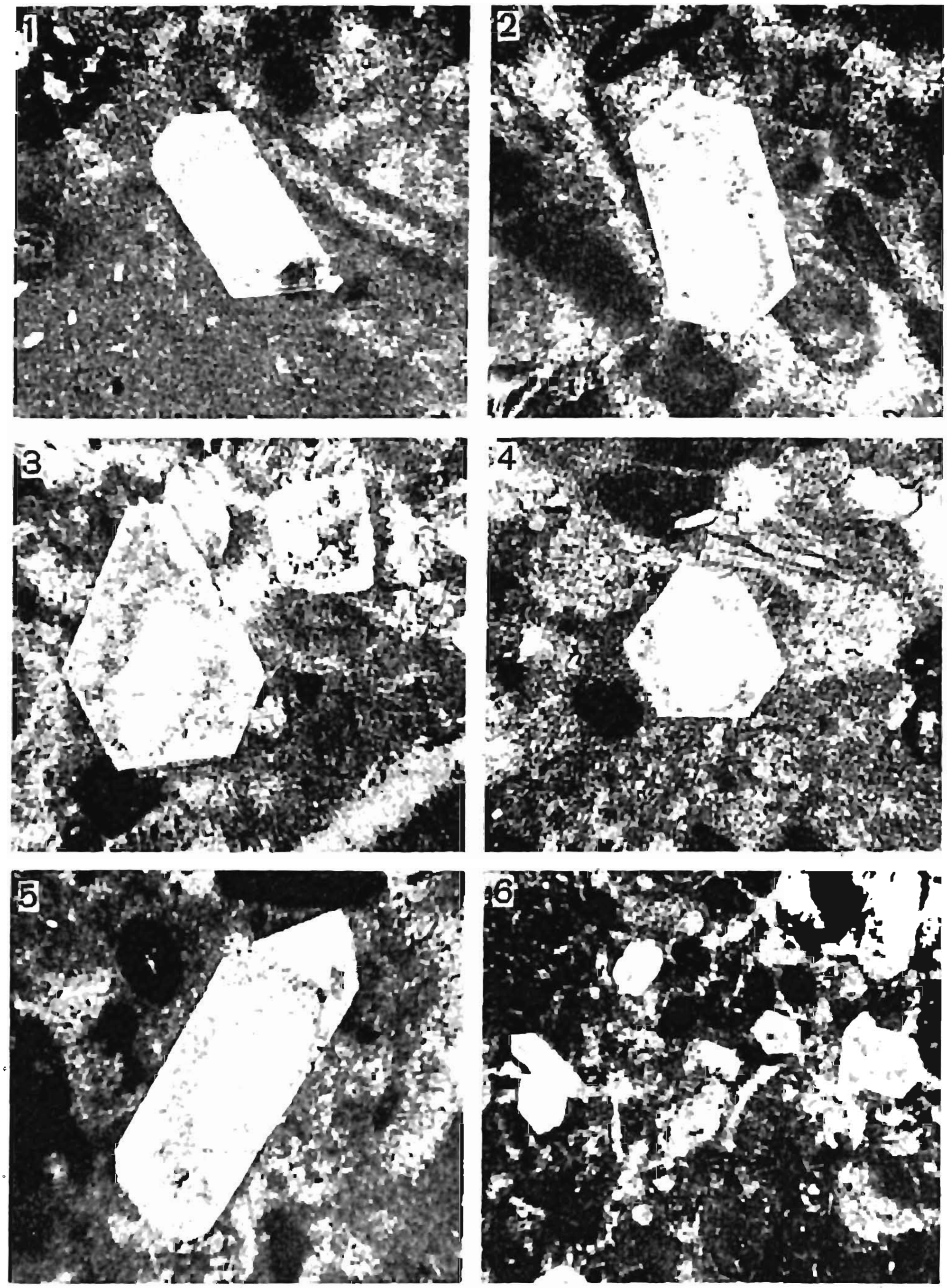


Javorina section (*IV*), × 7

1 — Brachiopod biomicrite (cut by a small microfault); layer *3*.
2 — Sandy, crinoid biopelmicrite; layer *6*.
3 — Pelmicrite; layer *8*.
4 — Oointrabiomicrite; layer *14*.
5 — Pelecypod biomicrite with very fine quartz grains; layer *19*.
6 — Biooosparenite composed of pelecypod debris, ooids and few quartz grains; layer *19*.



1-3 — Holothurian sclerites *Theelia* sp. in thin sections; Javorina (*IV*, layer *2*), × 120.
4-8 — Brittle star vertebrae, probably of *Ophiolepis bertrandi* Lanquine, in thin sections, × 40: *4* loose vertebra, Lejowa Valley (*I*, layer *27*); *5* vertebra as an ooid core, nicols crossed, Lejowa Valley (*I*, layer *41*); *6* loose vertebra, nicols crossed, Lejowa Valley (*I*, layer *27*); *7* vertebra with onkolitic envelope, nicols crossed, Strążyska Valley (*XI*); *8* vertebra with oolitic coating, nicols crossed, Lejowa Valley (*I*, layer *20*).
9-11 — Echinoid prickles in transverse sections; Lejowa Valley (*I*, layers *17* and *33*), × 70.



1-5 — Idiomorphic crystals of authigenic quartz in biopelsparite; Lejowa Valley, × 80.
6 — Biopelsparite with numerous idiomorphic crystals of authigenic quartz; Lejowa Valley, × 40.

by brachiopod-gastropod biomicrites yielding single foraminifers, *Nodosaria* sp. and *Planiinvoluta deflexa*.

Layers 4—5. — Dark-gray, sometimes thick-bedded limestones very rich in organic remains. The lower part of the series is formed of gastropod-brachiopod biomicrite (Pl. 11, Fig. 1), the upper part — of pelecypod lumachelle. Foraminifers are represented by *Tolypammina?* sp. only.

Layer 6. — Intercalation of black clay slates devoid of any organic fragments.

Layer 7. — Dark-gray well-bedded brachiopod-coral limestones with *Rhaetina gregaria* and *Retiphyllia* sp. (*see* Pl. 11, Figs 2—3). The limestones also yield algae *Girvanella minuta*, foraminifers *Tolypammina?* sp. and single sparitized ostracodes.

Layer 8. — *Megalodon* limestone layer 0.5 m thick, represented by biomicrite composed of pelecypod and crinoid debris coated with onkolitic envelopes (Pl. 11, Fig. 4). Foraminifers *Glomospirella? pokornyi* are very numerous. Single algae (*Girvanella minuta*) occur.

Layers 9—10. — Pelecypod lumachelle with *Lopha haidingeriana*, passing upwards into brachiopod-gastropod biomicrite containing onkolite-encrusted bioclasts and fine quartz grains (Pl. 11, Fig. 5). Foraminifers, very numerous, are represented by *Glomospirella? pokornyi*, *Glomospirella* sp., and *Tolypammina?* sp.

Layer 11. — Coral-limestone layer 0.40 m thick, it yields *Astraeomorpha crassisepta* and *Retiophyllia* sp. (Pl. 3, Fig. 1).

Layer 12. — *Megalodon* limestone layer 0.50 m thick; it yields *Conchodon infraliasicus* (Pl. 3, Fig. 2) and very numerous foraminifers represented by *Glomospirella? pokornyi* (see Pl. 34, Figs 1 and 3) and *G. parallela.*

Layers 13—17. — A series of dark-gray, well-bedded limestones with black clay slate intercalations, about 3 m thick. Lower part of the series is represented by biopelmicrite composed of brachiopod, gastropod, and crinoid debris, and of pellets (Pl. 11, Fig. 6). The biopelmicrite passes upwards into sandy gastropod-crinoid biopelmicrite. Algae (*Acicularia* sp.) are fairly common, whereas foraminifers (*Agathammina austroalpina*), ostracodes, and small fish teeth are occasionally found.

Layer *17* is overlaid by a series of sandstones with gray slate intercalations. During the fieldwork this series was assigned to the Lower Liassic on the basis of lithological premises. However, microfauna found in limestone intercalations occurring in the series comprises foraminifers *Glomospirella friedli*, characteristic of the Rhaetian. Thus, this sandstone-slaty series overlaying layer *17* should be assigned to the Rhaetian. Further studies are necessary for precise delineation of the Rhaetian/Hettangian boundary.

Palenica Lendacka (VI)

Rhaetian outcrops in the area of Mt. Palenica Lendacka were mapped by Uhlig (1911) and more recently by Fusán & *al.* (1963). Rhaetian strata outcrop here on SW slopes of Mt. Palenica Lendacka near Kardolina (Text-fig. 1, and Pl. 4, Figs 1—2). They were reported by Uhlig (1897), Goetel (1917), and Kochanová (1967), but a detailed description of the section is still lacking. The present study showed that it is the best section of the Rhaetian in the Tatra Mts. The Rhaetian strata exposed here are *c.* 80 m thick and belong to the Palenica (Bujačí) unit (Borza 1959; Mahel, Buday & *al.* 1968). Contacts of the Rhaetian with the underlying "Keuper" and overlying Liassic are of sedimentary nature. The section studied (Fig. 9) was traced at the altitude of 900—960 m a.s.l. The strike and dip equal 20—30°/27°E. Fourty nine layers are distinguished within the section.

Layer 1. — Light-colored, massive dolomites of the uppermost "Keuper" (*cf.* Pl. 4, Figs 1—2; Pl. 5, Fig. 2) are overlaid in sedimentary continuity by gray dolomitic limestone layer 0.30 m thick. This limestone layer yields single foraminifers identified as *Frondicularia woodwardi* and *Agathammina austroalpina.*

Layers 2—10. — A series of dark-gray limestones with light-colored dolomite and black slate intercalations, about 6 m thick. They are mostly laminated limestones composed of calcarenite/calcirudite rhythms (Pl. 12, Fig. 1), and biooosparenites composed of brachiopod, gastropod, and crinoid debris with admixture of well-sorted ooids (Pl. 12, Fig. 2). Foraminifers, very numerous, are represented by *Agathammina austroalpina* (Pl. 40, Figs 1—3, 7) and single involutinids.

Layers 11—18. — A series primarily composed of well-bedded (up to 0.30 m thick) dark-gray limestones with slate intercalations, about 10 m thick. The limestones yield numerous brachiopods (mostly *Rhaetina gregaria*) and pelecypods (*Homomya lariana*; see Pl. 20, Fig. 5; and *Rhaetavicula contorta*). Microscopically, the limestones may be termed as micritic limestones with rare brittle star vertebrae, brachiopod biopelmicrites (Pl. 12, Fig. 3), and biopelsparenites composed of strongly crushed bioclasts (mostly brachiopod debris) and fecal pellets at the base (Pl. 12, Fig. 4), as well as pelecypod biomicrites (Pl. 12, Fig. 5). Foraminifers, very numerous, are represented by *Agathammina austroalpina, Ophthalmidium* sp. (Pl. 38, Fig. 8), and *Tolypammina* aff. *gregaria* (Pl. 42, Fig. 5). Fish teeth are also common.

Layers 19—23. — Bluish-gray organodetrital limestones with dark slate intercalations. The limestones are mostly represented by biosparrudide composed of brachiopod, crinoid, and gastropod debris sometimes coated with onkolitic envelopes, and of pellets. Single foraminifers, *Frondicularia woodwardi* and *Nodosaria* sp., were found.

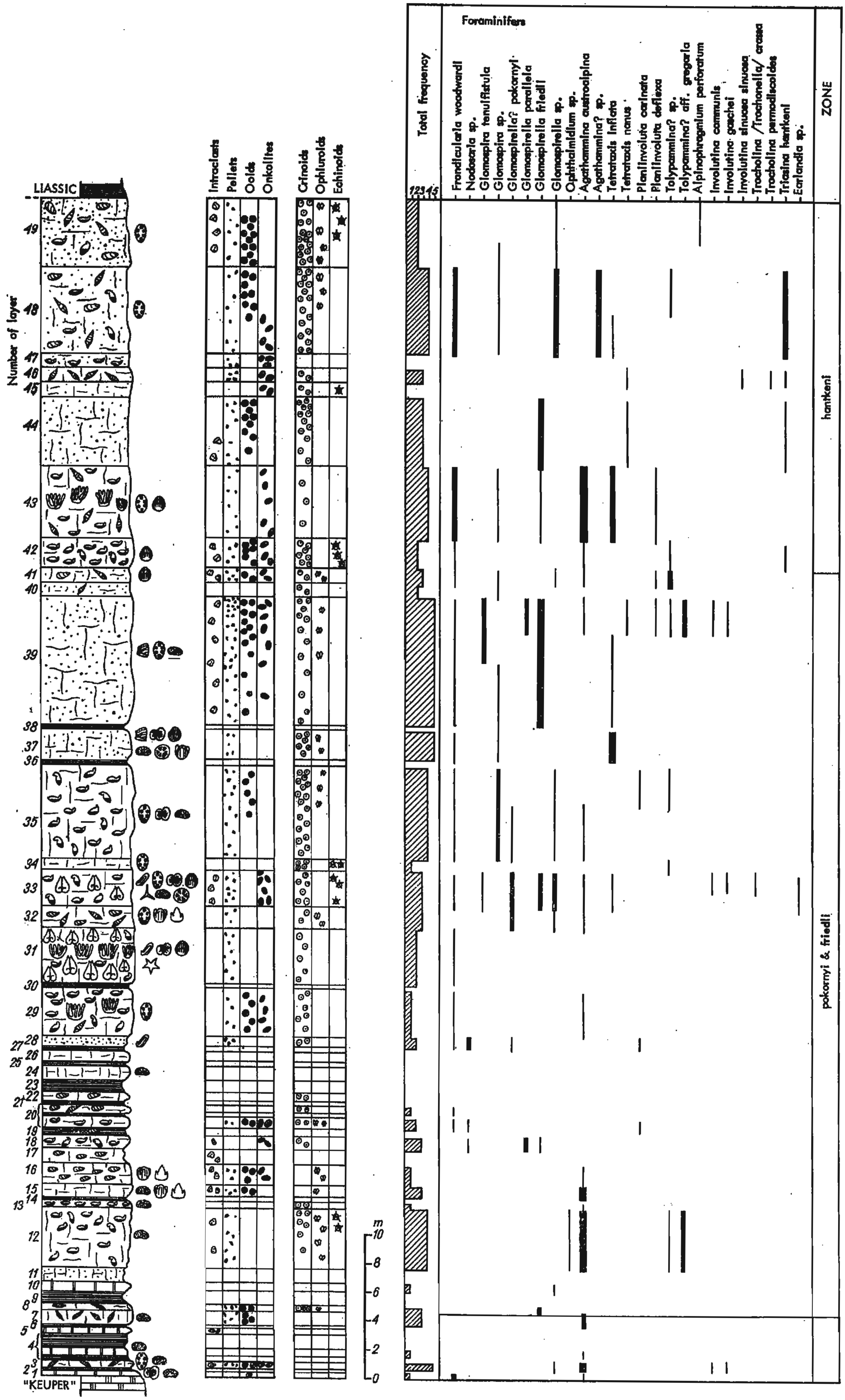
Layers 24—28. — A series of thin-bedded limestones with dark slate intercalations. These limestones are represented by micrite and pelmicrite limestones. The contribution of detrital quartz markedly increases in the upper part of the series. Single algae, *Girvanella minuta*, were also found there.

Layers 29—36. — A series of commonly thick-bedded, bluish-gray, organogenic limestones with slate intercalations, about 20 m thick. The limestones yield numerous brachiopods (*Rhaetina gregaria*; see Pl. 20, Figs 3—4), pelecypods (*Conchodon infraliasicus*), corals (*Pamiroseris rectilamellosa*; see Pl. 18), single gastropods (? *Zygopleura* sp.; see. Pl. 20, Fig. 2), and occasional starfishes. Algae (*Girvanella minuta* and *Solenopora* sp.) and spores (*Globochaete alpina*) are fairly common here. Sponge spicules, ostracodes, holothurian sclerites, and fish teeth are occasionally found. Foraminifers are represented by *Glomospirella? pokornyi, G. friedli, Agathammina austroalpina, Planiinvoluta carinata* (Pl. 42, Fig. 6) and single involutinids.

Layers 37—41. — A series of thick-bedded and somewhat sandy limestones (*cf.* Pl. 5, Fig. 1), about 15 m thick. They are mostly developed as crinoid biopelmicrites with *Pentacrinus* ossicles (Pl. 12, Fig. 6), biointrapelsparenites composed of pelecypod and crinoid debris, small intraclasts, pellets, and ooids (Pl. 13, Fig. 1), as well as by biointramicrites (Pl. 13, Fig. 3) and silty biomicrites (Pl. 13, Fig. 2). Foraminifers, very numerous, are represented by *Glomospira tenuifistula, Glomospirella friedli, Agathammina austroalpina, Tetrataxis inflata* (Pl. 41, Fig. 7), and *Frondicularia woodwardi.* Algae are represented by *Acicularia* sp. and *Pycnoporidium? eomesozoicum.*

Layers 42—43. — A series of gray organodetrital and organogenic limestones. Its lower part yields numerous brachiopods (*Rhaetina gregaria*), whereas the upper part — corals with predominating species *Astraeomorpha crassisepta* (Pl. 19, Fig. 2), and single gastropods (*Zygopleura* sp.). The limestones may be termed as brachiopod biooosparenites (Pl. 13, Fig. 4) and biopelmicrites, composed of brachiopod and crinoid debris with onkolitic crusts and of some pellets (Pl. 13, Fig. 5). Algae

Detail section of the Rhaetian deposits at Mt. Palenica Lendacka (*VI* in Text-fig. 1): explanations the same as for Text-fig. 3



are represented by *Solenopora* sp. and *Acicularia* sp. Foraminifers are numerous, represented by *Frondicularia woodwardi*, *Glomospira* sp., *Glomospirella* sp., *Agathammina austroalpina*, *Tetrataxis inflata*, and *Planiinvoluta deflexa*.

Layers 44—49. — A series of commonly thick-bedded, gray sandy limestones, about 20 m thick. Brachiopods and gastropods are fairly common; pelecypods occur in subordinate amounts. The limestones may be termed as biopelsparrudites composed of pelecypod and brachiopod debris, ooids, and quartz grains, and as crinoid biopelsparenites (Pl. 13, Fig. 6). Foraminifers, primarily represented by *Triasina hantkeni* (Pl. 49, Fig. 2), *Agathammina?* sp. (Pl. 40, Fig. 8), and *Frondicularia woodwardi* are very common. Algae *Acicularia* sp. occur in subordinate amounts.

The layer *49* is overlaid by a typical Lower Liassic series comprising gray marly slates and coarse-grained sandstones.

Comparative sections (VII—XV)

Juráňova Valley (VII)

Rhaetian outcrops in the area of Juráňova Valley were mapped by Bac (1971, Figs 2—4). The Rhaetian strata belong to the Bobrowiec tectonic unit (*cf.* Fig. 1 and Bac 1971). Contacts with the underlying "Keuper" and overlying Liassic are of sedimentary nature. The Rhaetian strata are poorly exposed, which makes it difficult to distinguish lithological members or to trace lithological boundaries. The Rhaetian is represented by 20 m series of dark-gray, and occasionally bluish limestones with black slate intercalations. Lumachelles with *Lopha haidingeriana* and *Pecten* sp., and crinoid limestones are fairly common. Intercalations of hematite ooids are sometimes found (*cf.* Kúšik 1959). Thin-section analysis showed that pelecypod biosparrudites, crinoid biosparites, and oosparites predominate. Foraminifers are represented by *Ammodiscus* sp. (Pl. 51, Figs 1—4), *Glomospirella* sp., *Frondicularia woodwardi*, and *Austrocolomia* sp. (Pl. 39, Fig. 12). Other organic fragments found include holothurian sclerites of the genus *Theelia*, moulds of small gastropods (Pl. 51, Figs 5—6), and elasmobranch shagreen ("*Nurrella*" sp.).

Jaworzyna Alp (VIII)

Rhaetian strata of the Bobrowiec tectonic unit are also exposed in the central part of Jaworzyna Alp (*cf.* Fig. 1; Guzik 1959a; and Bac 1971, Fig. 3). Here, a series of dark-gray Rhaetian limestones, up to 15 m thick, gradually replaces "Keuper" dolomites. Dark-gray limestone intercalation become progressively thicker and more common upwards, and finally thick limestone layers with subordinate black slate intercalations prevail. Similar contact between the "Keuper" and Rhaetian was found at Mt. Palenica Lendacka (*cf.* Fig. 9). The basal part of the Liassic is represented by gray slates with sandstone and spotted limestone intercalations (*cf.* Bac 1971).

The Rhaetian strata are represented by biopelsparrudites composed of pelecypod and brachiopod debris, pellets, quartz grains, crinoid biosparite, and intrapelsparrudite with large intraclasts. Foraminifers are fairly numerous, and usually represented by *Glomospira* sp., *Glomospirella friedli*, *Austrocolomia* sp., *Planiinvoluta deflexa*, and *Involutina gaschei*. Algae, represented by *Girvanella minuta* and *Solenopora* sp., occur in subordinate amounts.

Mt. Gładkie Upłaziańskie (IX)

Rhaetian strata are here exposed in a narrow belt, about 10 m wide and stretching along SW slopes of Mt. Gładkie Upłaziańskie (*cf.* Fig. 1; Guzik 1959c; Kotański 1965, Table 1). Contacts of the Rhaetian with underlying "Keuper" and overlying Liassic are of sedimentary nature. The Rhaetian is represented by dark-gray limestones with occasional slate intercalations. Microscopically, the limestones may be termed as brachiopod biomicrites containing bioclasts with onkolitic crusts, and as sandy crinoid biopelmicrites. Foraminifers are very common, and they are represented by *Glomospira tenuifistula*, *Glomospirella? pokornyi*, *G. friedli*, *Glomospirella* sp., *Alpinophragmium perforatum* (Pl. 43, Fig. 3), *Agathammina?* sp. (Pl. 40, Fig. 9). Algae, mostly *Solenopora* sp., are markedly less numerous. Among other organic fragments, brittle star vertebrae and holothurian sclerites are found.

Strążyska Valley (X—XI)

Rhaetian strata are represented twice in the profile of Strążyska Valley (*cf.* Fig. 1; Uhlig 1911; Kotański 1963, Fig. 6; and Guzik & Kotański 1963, Table 1), the repeated series being related to two separate tectonic slices. The Rhaetian of the locality Strążyska Valley (X) belong to the Samkowa Czuba tectonic unit, and those of the locality Strążyska Valley (*XI*) — to the Grześkówki tectonic slice (*cf.* Guzik & Kotański 1963).

Locality (X). A series of dark-gray organodetrital and organogenic limestones, about 3 m thick, the top part of which yields numerous megalodontids, mostly of the species *Conchodon infraliasicus*. Microscopically the limestones may be termed as biointrapelmicrites composed of brachiopod, gastropod, and crinoid debris with onkolitic crusts, as well as of intraclasts and pellets. Some of the limestones may also be termed as pelecypod-crinoid biomicrite. These rocks yield single algae *Girvanella minuta*, and spores *Globochaete alpina*; there are also some foraminifers, as *Frondicularia woodwardi* and *Glomospira* sp.

Locality (XI). A series of well-bedded bluish-gray limestones, about 4 m thick, the lower part of which is built of crinoid limestones, the upper part — of megalodontid limestones. The limestone layers are 10—50 cm thick; strike and dip equal 105°/50°N. Microscopically they may be termed as crinoid biosparites and biointrapelmicrite composed of brachiopod, gastropod, and crinoid debris, intraclasts and pellets. These rocks yield single foraminifers of the families Ammodiscidae and Involutinidae. The Rhaetian strata are overlaid by a series of Liassic slates and sandstones with limestone intercalations. The limestone intercalations yield numerous foraminifers, such as *"Vidalina" lesischneri*, *Involutina farinacciae*, *I.* cf. *liassica*, *I.* cf. *turgida* (Pl. 47, Figs 4—5, 7—8; Pl. 50), characteristic of the Lower Liassic (*leischneri* Zone) (*cf.* Fig. 12).

Stólnia (XII)

Rhaetian strata are here exposed on SW slopes of Stólnia hill (*cf.* Fig. 1; and Halicki 1955, Fig. 1; Guzik & Kotański 1963, Table 1; Kwiatkowski 1971, Figs 3 and 9). They comprise dark-blue organodetrital limestones up to 10 m thick. Microscopically they may be termed as biopelsparrudites composed of brachiopod and crinoid debris, partly with onkolitic crusts and oolitic coatings and with pellets. Lower part of this limestone series yields numerous subangular grains of detrital quartz, up to 0.2 mm in diameter. Foraminifers *Frondicularia woodwardi* and *Planiinvoluta deflexa* (Pl. 43, Figs 4—5) are occasionally found.

Mt. Przednia Kopa (XIII)

Rhaetian strata are exposed close to the summit of Mt. Przednia Kopa (*cf.* Fig. 1, and Uhlig 1911) and represented by dark-gray massive limestones with *Rhaetina gregaria*. Microscopically, the limestones may be termed as brachiopod-

-crinoid biomicrites containing bioclasts with onkolitic crusts and fine quartz grains. The limestones yield spores *Globochaete alpina*, and foraminifers *Glomospira tenuifistula* and *Frondicularia woodwardi*. Ostracodes and brittle star vertebrae are fairly common here.

Polana pod Wołoszynem (XIV)

Rhaetian strata were exposed here (*cf.* Fig. 1) by earth works (Głazek 1962b; 1963, Figs 1—2); they are represented by thin series of dark-blue organodetrital limestones with black slate intercalations. The series comprises numerous intercalations of pelecypod lumachelles with *Rhaetavicula contorta, Lopha haidingeriana, Conchodon infraliasicus* (Pl. 28), some gastropods, and brachiopods identified as *Rhaetina gregaria*. Foraminifers, represented by common species *Frondicularia woodwardi*, are occasionally found. Single small fish teeth were also found.

Mt. Hradok (XV)

This is the only exposure of the sub-tatric (Križna) Rhaetian on southern slopes of the Tatra Mts. The Rhaetian rocks are represented here by waste found along foot-path towards Mt. Hradok (*cf.* Fig. 1). Geological boundaries in that area were mapped by Uhlig (1911) and Šťastný (1926, Fig. 1).

Microscopically, the Rhaetian rocks may be termed as oolite limestones (oosparite). Ooids attain up to 0.4 mm in size. There occur also some biopelmicrites composed of brachiopod, gastropod, and crinoid debris, as well as of pellets. The rocks yield numerous algae (*Solenopora* sp.), foraminifers (*Tetrataxis humilis, Trochammina alpina, Austrocolomia* sp.), holothurian sclerites, moulds of small gastropods (Pl. 51, Figs 7—8), fish teeth (Pl. 51, Figs 9—10), and elasmobranch shagreen ("*Nurrella*" sp.; Pl. 51, Figs 11—13).

CHARACTERISTICS OF MACROFAUNAL ASSEMBLAGES

Paleontological characteristics of macrofauna of the sub-tatric Rhaetian of the Tatra Mts was perviously given by Goetel (1917) and Kochanová (1967), that is why only a brief review of predominating macrofaunal assemblages is given here. Megalodontids are only an exception, as that group is of remarkable importance for both stratigraphy of the Mediterranean Rhaetian and reconstruction of environmental conditions. It is admitted that the majority of forms presented by Goetel (1917) require revision, but such a task is beyond the scope of the present study.

Sponges

Calcareous sponges are occasionally found in the strata studied. They are represented by single forms of knobby-like appearance and completely sparitized skeleton (*cf.* Radwański 1968, Pl. 5, Fig. 2).

Hydrozoans

Hydrozoans are also very rare in the strata studied. Small lichenoid colonies of hydrozoans were found in dark-gray organogenic limestones from Mt. Mały

Kópieniec (section *III*, layer *2*). The forms identified here are somewhat similar to those reported from the high-tatric Rhaetian (Radwański 1968, Pl. 4, Fig. 1).

Corals

Corals are common and highly characteristic components of the sub-tatric Rhaetian (*cf.* Figs 3—5, 8—9). They form coral limestones known under the name of *Lithodendron* limestones. Some forms were previously described by Goetel (1917). The corals are the subject of a separate study by E. Roniewicz (1974, *this volume*).

The corals usually occur in dark-gray, thick-bedded limestones, with layers 0.5—1.5 m thick. They form a number of separate branched corallites of the biohermal character (*cf.* Pl. 1, Fig. 2). The branched corallites attain up to 0.30 m in diameter.

The coral colonies are commonly accompanied by algae, foraminifers, brachiopods, gastropods, and ostracodes. *Megalodon* assemblages most often occur nearby or together with coral colonies (*see* Figs 8—9 and 5, respectively), which indicates similar environmental requirements and a relation to the subtidal zone (*cf.* Fischer 1964, Czurda & Nicklas 1970).

In that coral assemblage, the species ***Retiophyllia clathrata*** (Emmrich) and ***R. paraclathrata*** Roniewicz predominate (Pl. 1, Fig. 2; Pl. 17, Figs 1—2; Pl. 19, Fig. 5). The other common forms include ***Pamiroseris rectilamellosa*** (Winkler, 1861) (*cf.* Pl. 18, Figs 1—4) and ***Astraeomorpha crassisepta*** Reuss, 1854 (*cf.* Pl. 19, Fig. 5). Those forms appear to be closely similar to Norian-Rhaetian corals of the Northern Limestone Alps, Central Alps, and Pamirs (*cf.* E. Roniewicz 1974).

Polychaetes

Polychaetes are represented by rare serpulids. They were reported from the sub-tatric Rhaetian under the names *Serpula* sp. and *?Serpula* aff. *socialis* Goldfuss, 1931, by Goetel (1917). These forms are represented by clusters of thin calcareous tubes up to 1 mm in diameter, similar to those reported from the high-tatric Rhaetian by Radwański (1968, Pl. 5, Fig. 1; Pl. 8, Fig. 1).

Polychaetes are also represented by boring forms. Traces of their activity are sometimes noted in megalodontid shells from Lejowa Valley (section *I*, layer *34*). The borings are shaped as single tubular blind channels with circular cross-section, attaining 2—3 mm in diameter (*cf.* Radwański 1959, Fig. 9). The boring polychaetes presumably may be attributed to ***Potamilla reniformis*** (O. F. Müller, 1771), common in littoral facies of the high-tatric Liassic (Radwański 1959), and to some extent, in similar littoral facies of the high-tatric Rhaetian where they bored in corals (Radwański 1968). The borings morphologically correspond also to those formed by recent representatives of this cosmopolitan and conservative species (*vide* Radwański 1969).

Brachiopods

Brachiopods are common in the majority of layers (*cf.* Figs 3—5, 7—9). In places, they are the main organic rock-building elements and they form brachiopod limestones (Pl. 11, Fig. 3; Pl. 23, Figs 1—4). Representatives of the families Terebratulidae, Rhynchonellidae, and Spiriferidae prevail in the assemblage (Goetel

1917). The species *Rhaetina gregaria* (Suess, 1854) (*cf.* Pl. 20, Figs 3—4; Pl. 21, Fig. 2*a*), common in the Mediterranean Rhaetian (*cf.* Arthaber 1906, Goetel 1917, Allasinaz 1962, Belloni 1963, Entcheva 1972), also predominates here. *Zugmayerella cf. koessenensis* (Zugmayer), 1880 (*cf.* Pl. 20, Fig. 1) is another most common species.

Analysis of sections of brachiopod layers (Pl. 23, Figs 1—4) shows that brachiopods do not occur in life position but are redeposited. They were presumably redeposited in zones of lower water agitation. Brachiopod shells can often be used as geopetal fabrics (Pl. 23, Figs 1—4) showing base or top of a layer they occur in (*cf.* Shrock 1948, Shamov & Hecker 1966, Schöll & Wendt 1971).

Gastropods

Gastropods with small trochospirally elongated shells are quite common in the majority of layers (*cf.* Figs 3—5, 7—9). They sometimes occur in masses (*cf.* Pl. 10, Fig. 1; Pl. 11, Fig. 1), and are usually preserved as internal moulds 2—5 cm long and consisting of about 6 whorls. They are very close to the representatives of the genus *Zygopleura* Cossman, 1909, occurring in masses in the Dachstein Limestone of the Northern Limestone Alps (Zapfe 1962). Similar forms were reported from the high-tatric Rhaetian (Radwański 1968). A few other gastropod species were found previously by Goetel (1917).

Pelecypods

Complete pelecypod shells and their fragments are fairly common (*cf.* Figs 3—5, 7—9); sometimes they even form lumachelles (*cf.* Pl. 14, Fig. 5; Pl. 22, Figs 1—2, Pl. 23, Fig. 5; and Pl. 28). Pelecypod shells are usually strongly recrystallized and thus difficult to identify. The most common are: *Homomya lariana* (Stoppani, 1860—1865) (*cf.* Pl. 20, Fig. 5), *Rhaetavicula contorta* (Portlock, 1843) (*cf.* Pl. 21, Fig. 2*b*), *Myophoria inflata* Emmrich, 1853 (*cf.* Pl. 21, Fig. 2*c*), *Gervillia* sp. (*cf.* Pl. 21, Fig. 2*d*), *Chlamys* sp. (*cf.* Pl. 22, Figs 1*a*, 2), *Placunopsis* sp. (*cf.* Pl. 22, Fig. 1*b*), and *Lopha haidingeriana* (Emmrich, 1853) (*cf.* Pl. 23, Fig. 5). The majority of those forms are widely known from contemporaneous strata of other parts of the Alpine-Carpathian geosyncline, and some of them, e.g. *Rhaetavicula contorta*, are regarded as being characteristic of the Rhaetian stage (*cf.* Allasinaz 1962, Pearson 1970, Wiedmann 1972).

Pelecypods of the sub-tatric Rhaetian were the subject of detailed studies by Goetel (1917) and Kochanová (1967), so only their brief characteristics will be given; the megalodontids are the only exception, on the account of their importance for both stratigraphy and reconstruction of environmental conditions.

PELECYPODS OF THE FAMILY MEGALODONTIDAE

The occurrence of megalodontids represented by the species *Conchodon infraliasicus* Stoppani was recognized in the Rhaetian of the Tatra Mts by Goetel (1917; *cf.* also Andrusov 1959, and Kochanová 1967). Some introductionary remarks concerning occurrence, taxonomy, and preservation of this species were also presented by the present author (Gaździcki 1971).

The author's new collection of megalodontids from the sub-tatric Rhaetian of the Tatra Mts comprises over 40 specimens preserved as more or less incomplete internal moulds.

In paleontological descriptions, the author follows suggestions made by Moore, Lalicker & Fischer (1952) and Zapfe (1964), as well as by other authors (Schafhäutl 1863; Stoppani 1865; Hoernes 1880; Tausch 1892; Frech 1904, 1909; Vigh 1914; Kutassy 1934; Zapfe 1969; S. Végh 1964; E. Végh-Neubrandt 1960, 1969).

The Tatric megalodontids are assigned to four species, two of them being new, viz.: *Conchodon infraliasicus* Stoppani, *C. goeteli* sp. n., *Rhaetomegalodon incisus* (Frech), and *R. tatricus* sp. n.

Family **Megalodontidae** Morris & Lycett, 1853

Genus *CONCHODON* Stoppani, 1865
(=*LYCODUS* Schafhäutl, 1863) [2]

Conchodon infraliasicus Stoppani, 1865
(Pl. 25, Figs 1—8)

1863. *Lycodus cor* mihi; Schafhäutl, p. 376, Pl. 72, Figs 2—3; Pl. 73; Pl. 74, Fig. 1; Pl. 75, Figs *a*—*b*.
1865. *Conchodon infraliasicus* Stopp.; Stoppani, pp. 240—246, Pl. 38, Figs 3—5; Pl. 39, Figs 1—3; Pl. 40, Figs 1—5.
1917. *Lycodus cor* Schafh.; Goetel, p. 190.
1917. *Megalodus* cf. *scutatus* Schafh.; Goetel, p. 191.
1934. *Conchodus infraliasicus* Stopp.; Kutassy, p. 51 [*cum syn.*].
1957. *Conchodus infraliasicus*; Zapfe, Text-fig. 4*a*—*c*.
1960. *Conchodus infraliasicus* (Stopp.); Végh-Neubrandt, p. 109, Text-fig. 83 (*a*—*d*).
1964. *Conchodus infraliasicus* Stopp.: Zapfe, pp. 274—278, Pl. 5, Figs *a*—*b*; Pl. 6, Figs *a*—*b*; Pl. 7, Figs *a*—*f*.
1967. *Neomegalodon (Lycodus) cor* (Schafhäutl, 1863); Kochanová, p. 77.
1970. *Conchodus infraliasicus* Stoppani; Gaździcki, pp. 392—393, Text-fig. 5*a*—*f*.

Material. — Twelve, almost complete specimens varying in age.

Dimensions /mm/:	height	width	thick-ness	lunule height	lunule width	area /total width/
Pl.25: Fig.1a-c	40	40	24	14	12	7
Fig.2a-c	56	44	31	23	20	12
Fig.3a-c	58	47	36	24	23	16
Fig.4a,b	80	-	52	31	27	22
Fig.5a-c	85	64	67	33	33	30
Fig.6	86	64	67	35	35	32
Fig.7	102	-	80	-	-	-
Fig.8a,b	55	50	-	19	-	-

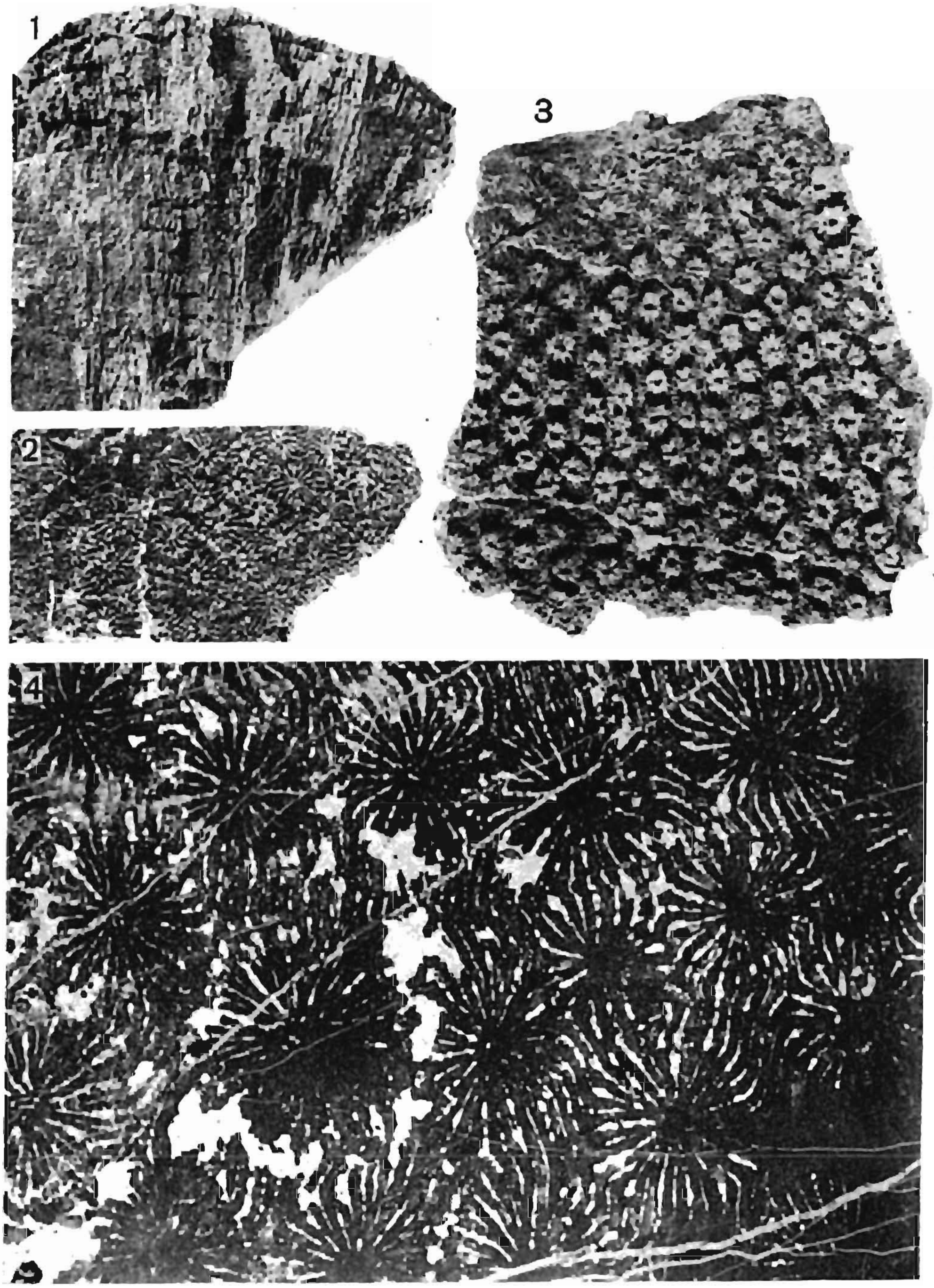
Remarks. — All the features considered by Schafhäutl (1863) and Stoppani (1865) as typical of this species are observable in the specimens studied. Occasionally fragments of hinge (cardinal tooth) are preserved (*cf.* Pl. 25, Fig. 8*a*,*b*).

The specimens occurring in the layer 2 of Mt. Mały Kopieniec section form an ontogenetic series of this species (Pl. 25, Figs 1—7). Representatives of this

[2] *Lycodus* Schafhäutl, 1863 — *nomen praeoccupatum* by Quenstedt in "Der Jura" (1858, p. 241, Taf. 33, Figs 1—2) for a Liassic fish, *Lycodus gigas* (*cf.* Kutassy 1934).

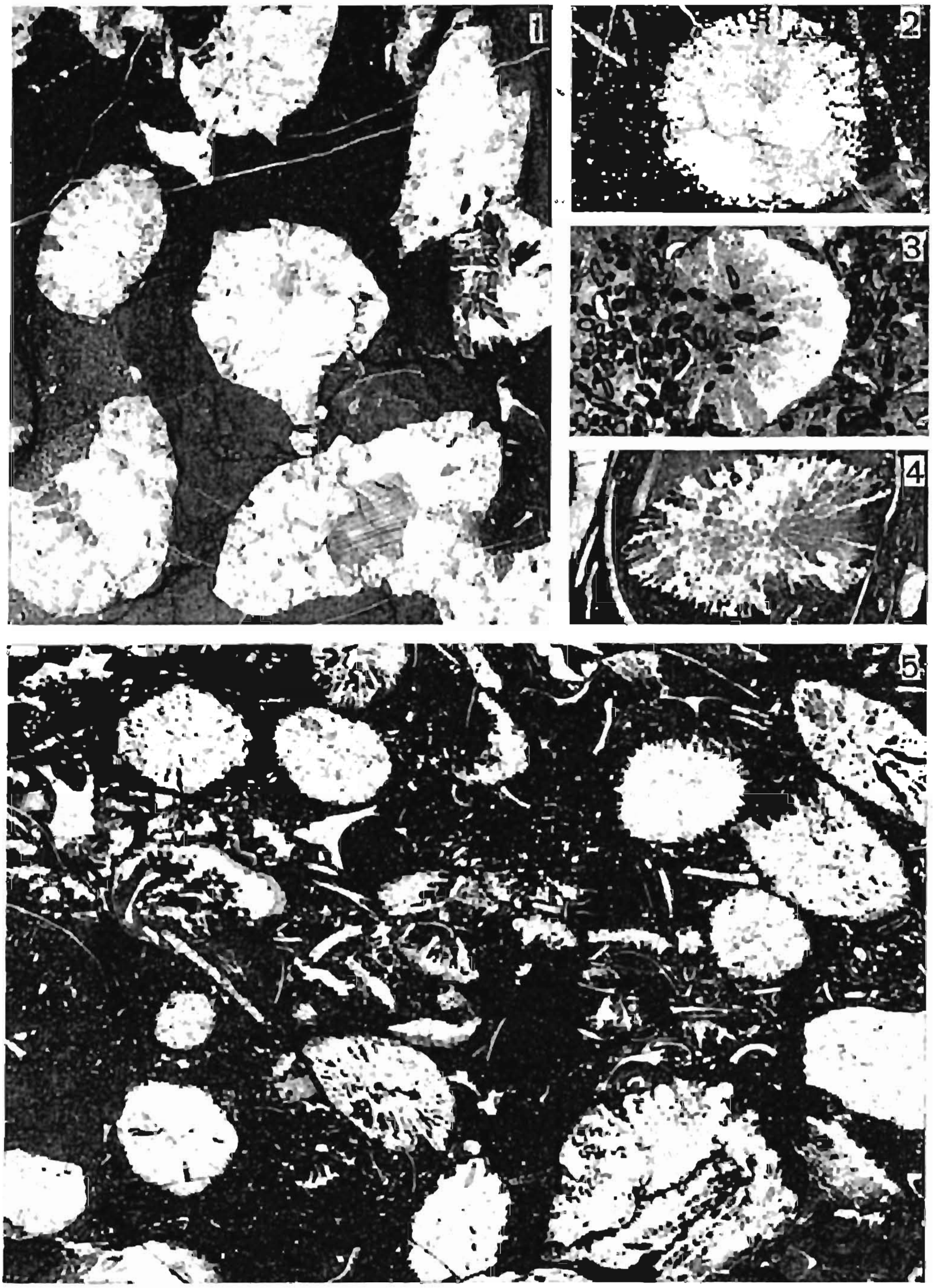
Coral limestone with *Retiophyllia paraclathrata* Roniewicz; Lejowa Valley (scree), nat. size

1 — transverse section, *2* — top surface of the layer



Corals *Pamiroseris rectilamellosa* (Winkler); Mt. Palenica Lendacka (*VI*, layer *31*), nat. size

1 — vertical section, *2-3* — transverse sections (weathered surfaces), *4* — thin sections (× 5)



Coral colonies and their broken branches

1 — Recrystallized colony of *Retiophyllia*, Mt. Mała Świnica.

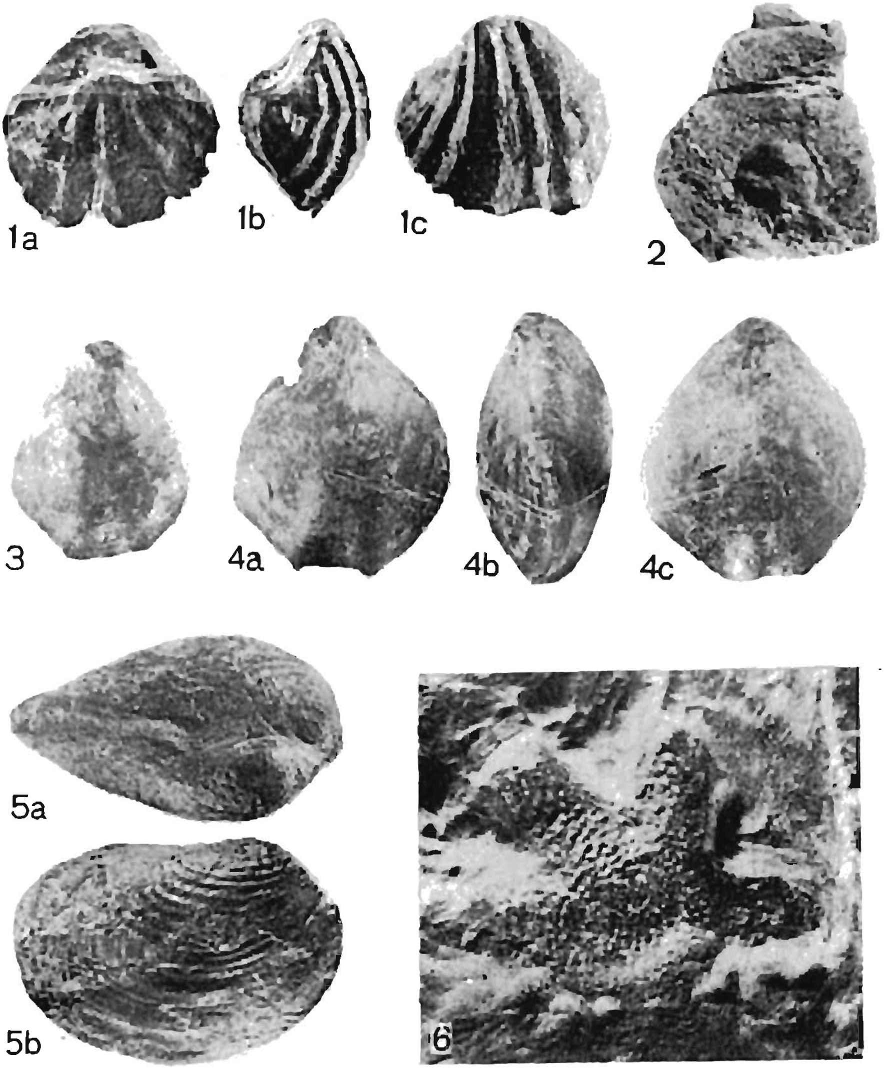
2 — *Astraeomorpha crassisepta* Reuss, Mt. Polenica Lendacko (*VI*, layer 43).

3 — *Retiophyllia* sp., Lejowa Valley (*I*, layer 27).

4 — *Retiophyllia* sp., Szeroka Bielska Pass (*V*, layer 7).

5 — *Retiophyllia paraclathrata* Roniewicz, Lejowa Valley (scree).

All thin sections × 5



1 — Brachiopod *Zugmayerella* cf. *koessenensis* (Zugmayer): *1a* dorsal view, *1b* side view, *1c* ventral view; Mt. Mała Świnica, × 2.

2 — Fragment of gastropod mould (?*Zygopleura* sp.); Mt. Palenica Lendacka (*VI*, layer *32*), nat. size.

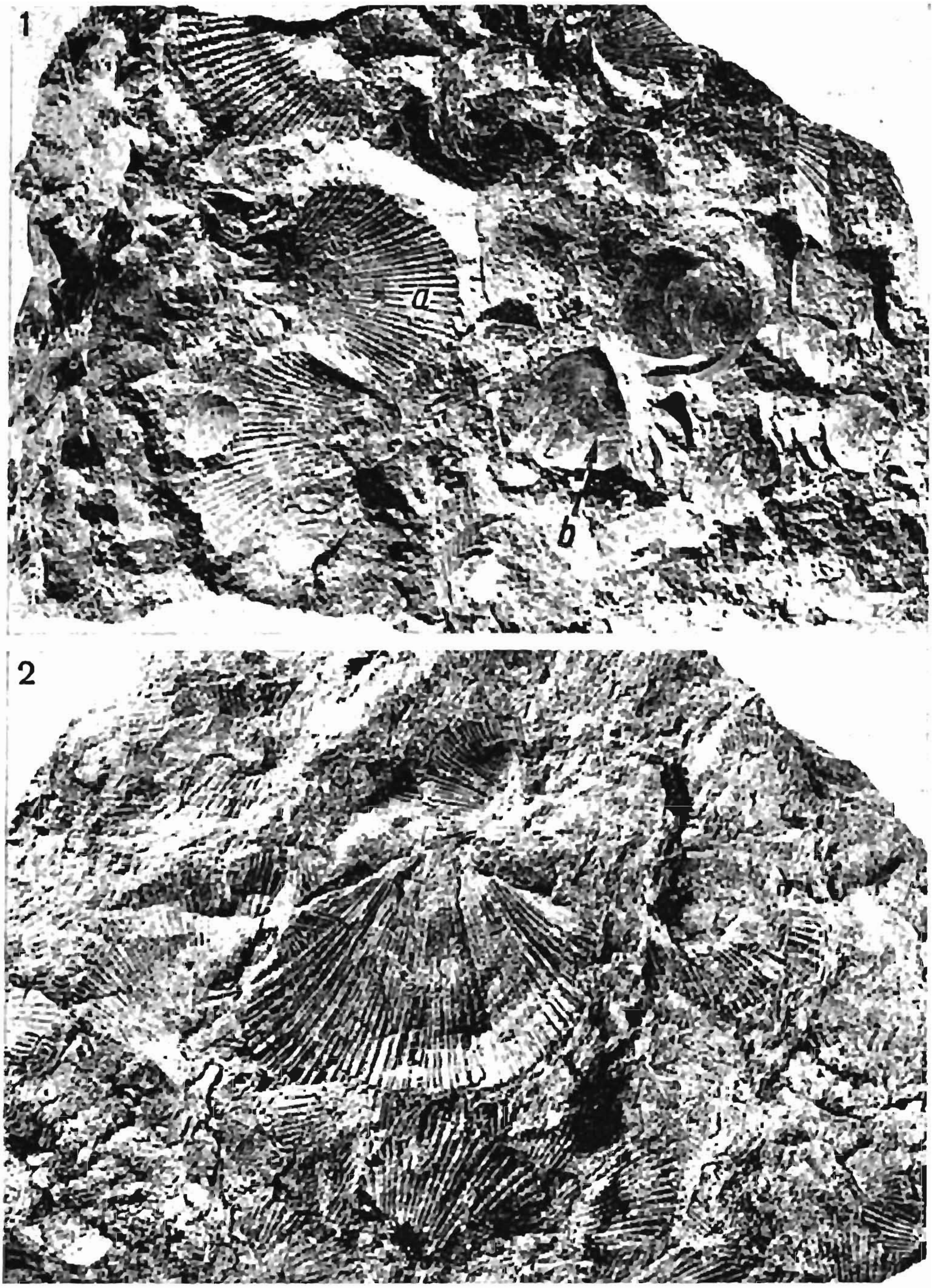
3-4 — Brachiopods *Rhaetina gregaria* (Suess): *3* elongated specimen (dorsal view), *4* average specimen (*4a* dorsal view, *4b* side view, *4c* ventral view); Mt. Palenica Lendacka (*VI*, layer 33), × 1.5.

5 — Pelecypod *Homomya lariana* (Stoppani): *5a* hinge view, *5b* side view; Mt. Palenica Lendacka (*VI*, layer *16*), nat. size.

6 — Fragment of a starfish; Mt. Palenica Lendacka (scree), × 2.

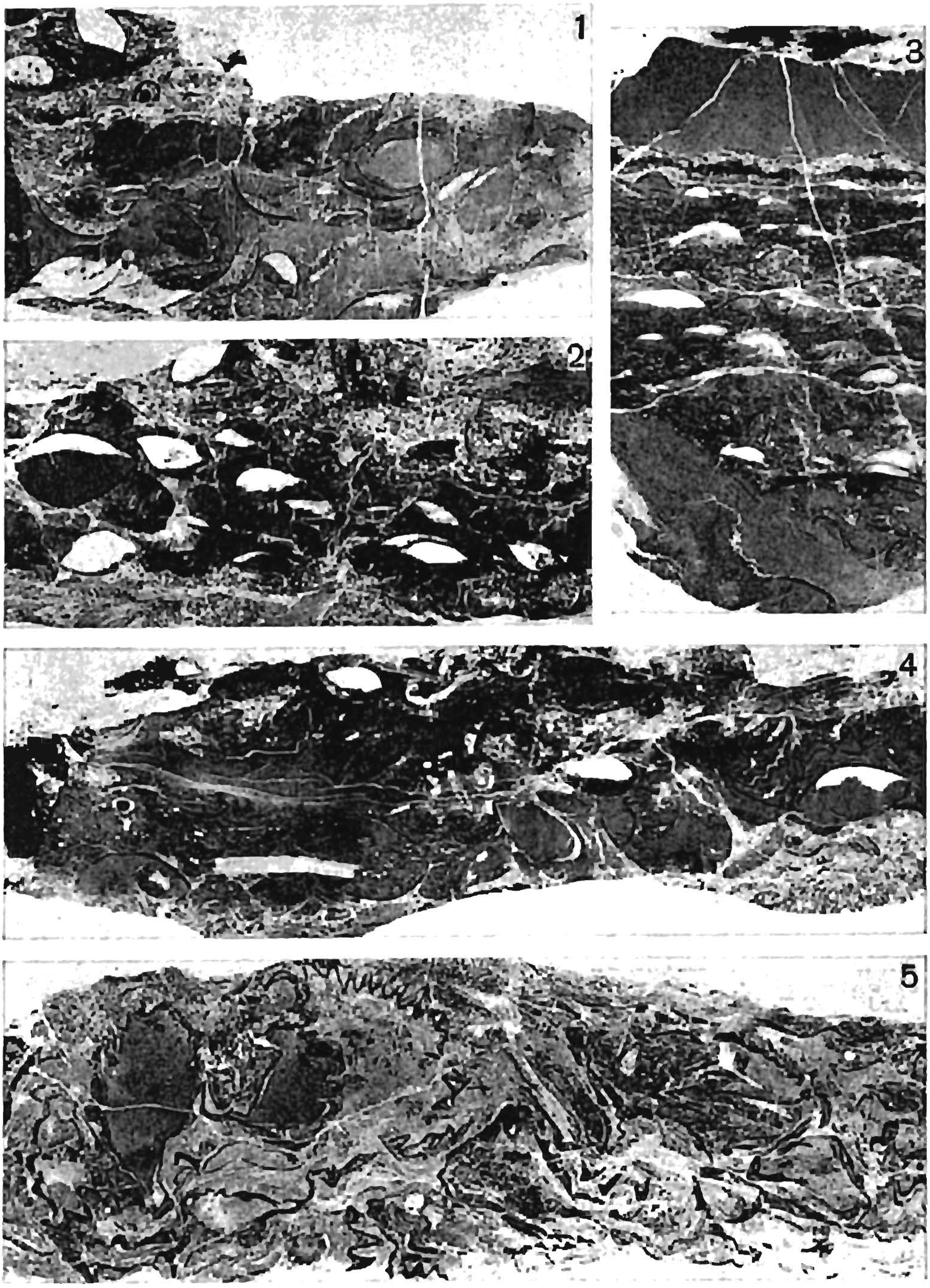
1 — Whole skeletons and isolated arms of brittle stars *Ophiolepis bertrandi* in the *Rhaetina*-bearing marly limestone; Lejowa Valley (scree), × 2.
The specimen collected by Dr. J. Głazek (presented in Głazek & Radwański 1968, Pl. 1, Fig. 1).

2 — Organogenic limestone with: *a* — brachiopod *Rhaetina gregaria* (Suess), and pelecypods — *b* — *Rhaetavicula contorta* (Portlock), *c* — *Myophoria inflata* Emmrich, *d* — *Gervillia* sp.; Mt. Palenica Lendacka (scree), nat. size.



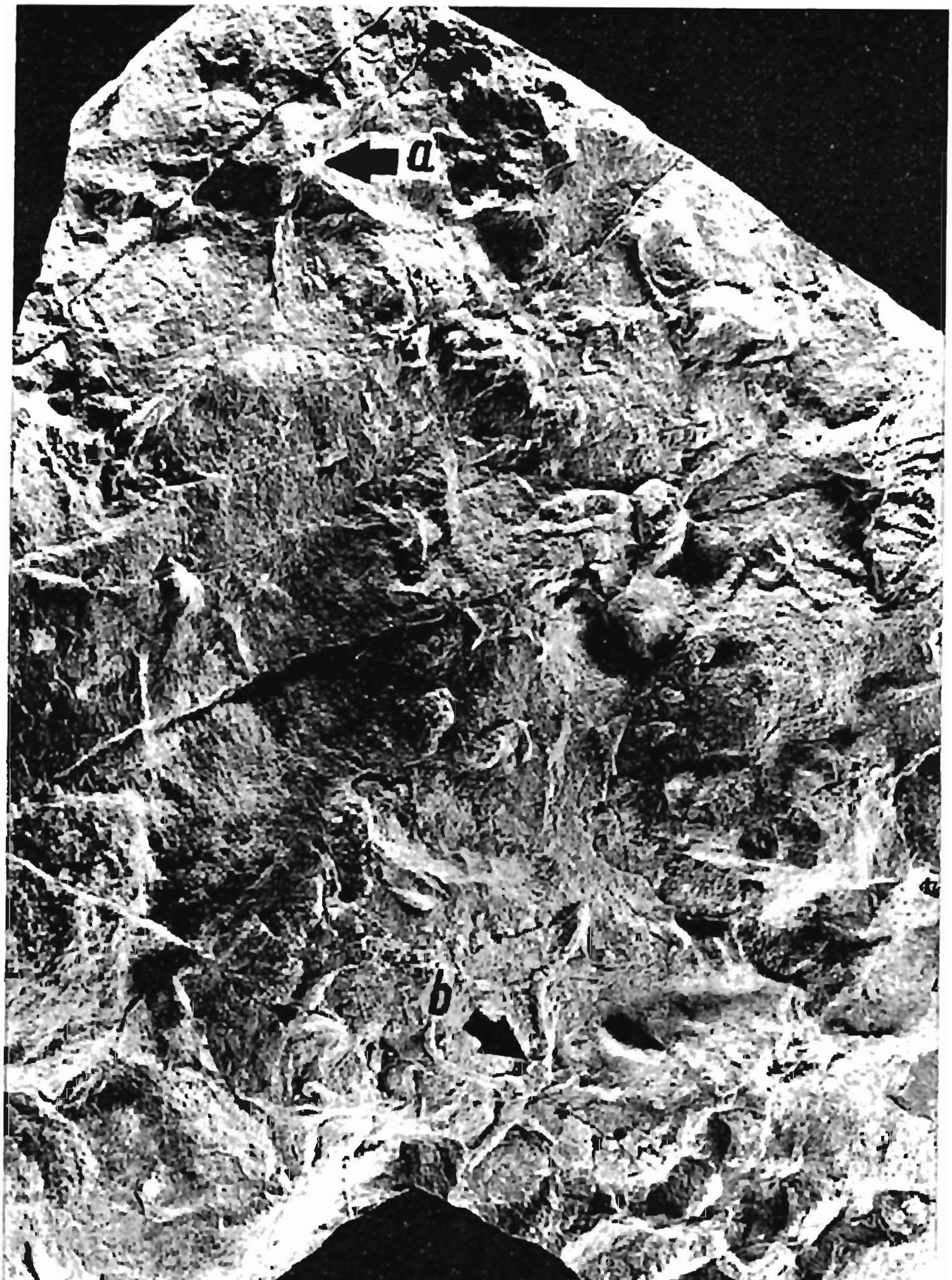
1 — Pelecypod lumachelle with: *a* — *Chlamys* sp., *b* — *Placunopsis* sp.; Lejowa Valley (scree), nat. size.

2 — Pelecypod lumachelle with *Chlamys* sp.; Mt. Mały Kopieniec (scree), nat. size.



1-4 — Vertical sections of *Rhaetina* lumachelles: some shells of *Rhaetina gregaria* (Suess) partly filled with sediment (geopetal fabrics) and secondary calcite.
1—2 and *4* from Lejowa Valley (scree), *3* from Mt. Mały Kopieniec (*III*, layer 3), nat. size.

5 — Vertical section of shelly limestone with *Lopha haidingeriana* (Emmrich); Mt. Mały Kopieniec (*III*, layer *10*), nat. size.



Lower Liassic sandstone with sole markings — counterparts of the resting places of a starfish (*a*) and ophiuroid (*b*); Mt. Mały Kopieniec, × 0.8

The specimen collected by Professor W. Goetel (housed in Geological Laboratory, Institute of Geological Sciences, Polish Academy of Sciences, Cracow) species become progressively more and more rounded during the ontogeny. Juvenile specimens are generally flattened and elongated (see Pl. 25, Figs 1—4). Moreover, the area of juvenile forms is usually shallow and rather flat, rapidly increasing in width and depth along with age of a specimen (cf. Pl. 25, Fig. 5*b*), the same as the beak curvature, progressively increasing (cf. Pl. 25, Figs 1*a* and 7).

Occurrence. — Lejowa Valley (section *I*, layers *22* and *34*), Mt. Mała Świnica (*II*, layer *4*), Mt. Mały Kopieniec (*III*, layers *2* and *16*), Javorina (*IV*, layers *4*, *6*, and *17*), Szeroka Bielska Pass (*V*, layers *8* and *12*), Mt. Palenica Lendacka (*VI*, layers *31* and *33*), Strążyska Valley (*X*), Polana pod Wołoszynem (*XIV*).

The species is also known from the Rhaetian of Spišská Magura in Slovakia (Kochanová 1967), Bakony Forest and Gerecse Mts in Hungary (Frech 1904; E. Végh-Neubrandt 1960, 1964; S. Végh 1964), Apuseni Mts in Rumania (Patrulius & Bleahu 1967), Northern Limestone Alps (Schafhäutl 1863; Tausch 1892; Zapfe 1950, 1957, 1963, 1964; Fischer 1964; Czurda & Nicklas 1970) and Lombardian Alps (Stoppani 1865).

Conchodon goeteli sp. n.
(Pl. 27, Figs 1*a*—*c*, 2*a*—*c*)

Holotype: the specimen presented in Pl. 27, Figs 2*a*—*c*.
Type horizon: Lower Rhaetian.
Type locality: Mt. Mały Kopieniec (section *III*, layer *2*), Tatra Mts (Poland).
Derivation of the name: goeteli — in honour of the late Professor W. Goetel, an outstanding student of the Tatric Rhaetian.

Diagnosis. — Shell symmetric in front view, elongated, *V*-shaped; shell sides generally convex; beaks flattened, rounded in side view, strongly curved forwards. Lunule fairly high, triangular in outline, equalling over one-third of total shell height. Area short, moderately wide and deep. Posterior margin situated at the mid-height. Hinge plate elongated.

Material. — Four, fairly well-preserved specimens varying in age.

Dimensions /mm/:	height a	height b	width	thick-ness	lunule height	lunule width	area /total width/
Pl.27: Fig.1a-c	42	51	43	34	19	16	13
Fig.2a-c	60	76	58	52	27	27	26

a - up to the base of beaks b - total height

Description. — Valves equal, *V*-shaped, markedly longer than wide; shell thickness equalling *c.* 70% of total shell height. Valve sides somewhat convex; beaks markedly flattened, rounded in side view, strongly curved forwards. Lunule triangular in outline, fairly high, situated almost at the mid-height, with rib-like imprints of soft parts (German *Gefäßleisten*). Area short, moderately wide and deep, delineated from two sides by sharp angular edges continuing from the base of beak towards and converging close to the posterior margin. Posterior margin situated close to the mid-height, sharp, strongly bent; lower margin rounded. Pallial line distinctly marked on the right valve; fragments of hinge sometimes preserved.

Remarks. — *Conchodon goeteli* sp. n. differs from all the remaining *Conchodon* species in elongated, *V*-shaped shell, elongated hinge plate, and in markedly flattened and strongly incurved beaks.

Occurrence. — Known from the type locality only.

Genus *RHAETOMEGALODON* Végh-Neubrandt, 1969

Rhaetomegalodon incisus (Frech, 1904)

(Pl. 26, Fig. 4*a*—*c*)

1969. *Rhaetomegalodon incisus* (Frech); Végh-Neubrandt, pp. 4—5 [*cum syn.*].

Material. — Five, poorly preserved specimens.

Dimensions /mm/:	width	thick- -ness	area /total width/
Pl.26: Fig.4a-c	57	62	30

Remarks. — Although the author's specimens are poorly preserved and rather incomplete, they correspond to the species *Rhaetomegalodon incisus* (Frech) in all their features, *viz.*: elongated shape, convex sides, long, sharp beaks, rather shallow area, wide lower margin, and very high and markedly concave lunule (*cf.* Frech 1904, 1909; Végh-Neubrandt 1960, 1969; S. Végh 1964; Zapfe 1964).

Occurrence. — Mt. Mały Kopieniec (section *III*, layer *2*); Mt. Palenica Lendacka (*VI*, in the scree). The species is recorded here for the first time from the Tatra Mts, and from the Carpathians. It is hitherto known from the Rhaetian of Hungary (Bakony Forest, Gerecse Mts — Frech 1904, 1909; Kutassy 1934; E. Végh-Neubrandt 1960, 1964, 1969; S. Végh 1964), Northern Limestone Alps (Zapfe 1964, 1969), and Italian Dolomites (Cros 1965a).

Rhaetomegalodon tatricus sp. n.

(Pl. 26, Figs 1*a*—*c* — 3*a*—*c*)

Holotype: the specimen presented in Pl. 26, Figs 3*a*—*c*.
Type horizon: Lower Rhaetian.
Type locality: Mt. Mały Kopieniec (section *III*, layer *2*), Tatra Mts (Poland).
Derivation of the name: tatricus — after the Tatra Mts.

Diagnosis. — Shell almost equivalvate. Beaks sharp, elongated but short, with upper portion somewhat curved towards the anterior and inwards. Shell sides convex. Lunule relatively small, concave, slightly higher than wide. Area wide, shallow, elongated, of the bitruncate type, *i.e.* delineated from two sides by angular edges.

Material. — Three, well-preserved specimens varying in age.

Dimensions /mm/:	height	width	thick- -ness	lunule height	lunule width	area t.w.
Pl.26: Fig.1a-c	47	37	27	18	15	14
Fig.2a-c	66	51	37	23	20	18
Fig.3a-c	92	53	62	38	35	40

Description. — Valves almost equal; shell slender, higher than wide (thickness equalling *c.* 60% of shell height). Valve sides convex; beaks moderately high, sharp, somewhat curved towards the anterior and inwards. Lunule concave, The study comprises analyses of inorganic, biosedimentary, and organic components (*cf.* Figs 3—5, 7—9). Its results contributed to stratigraphic subdivision of the strata studied and to reconstruction of sedimentary environment. The characteristics of inorganic and biosedimentary constituents will be discussed in the present chapter, whereas organic components will be discussed in the chapter on micropaleontology.

Inorganic components

Quartz

Quartz is fairly common in the strata studied. It is represented by both detrital quartz grains (Pl. 7, Figs 3, 6; Pl. 14, Fig. 12) and rather scarce idiomorphic crystals of authigenic quartz (Pl. 16, Figs 1—6).

Detrital quartz. — Detrital quartz grains occur in the majority of layers (*cf.* Figs 3—5, 7—9) in subordinate amounts, becoming fairly common in upper parts of those sections, close to the Rhaetian/Liassic boundary (Text-figs 5, 8—9). Angular and unrounded grains predominate (Pl. 7, Figs 3, 6), whereas poorly-rounded ones are markedly subordinate. The grains show lack of sorting. Particular grains markedly differ in size; grains 0.3—0.8 mm in diameter predominate. Finer grains, 0.04—0.07 mm in diameter, are also common, particularly in pelitic limestones. There are also some markedly larger grains, over 1.5 mm in diameter.

Idiomorphic crystals. — Idiomorphic crystals were found to occur in biopelsparite from Lejowa Valley (Pl. 16, Fig. 6). The crystals are markedly elongate (Pl. 16, Figs 1—2, 5) and 0.2—0.5 mm long. Similar forms were reported from Mesozoic limestones of West Carpathians (Mišík 1963, Pl. 9) and from Rhaeto-Liassic strata of the Northern Limestone Alps of Bavaria and Tyrol (Fabricius 1966, Pl. 16). The origin of the idiomorphic crystals of authigenic quartz is related to late diagenetic processes and to migration of SiO_2 solutions (Mišík 1963, 1972). This is evidenced by destruction of primary constituents of the deposits (Pl. 16, Fig 2), in the present case by the destruction of foraminifer test.

Heavy (Accessory) minerals

Thin sections display some heavy minerals. They include tourmaline, zircon, and rutile, represented by single, fairly well-rounded grains up to 0.1 mm in diameter. They are most common in more sandy deposits from lower parts of the sections from Lejowa Valley (section *I*, layer *2*) and Szeroka Bielska Pass (*V*, layers *1* and *3*). Those minerals were previously reported from the Keuper and Rhaetian of the Bielskie Tatra Mts (Borza 1959) and from the high-tatric Rhaetian (Radwański 1968).

Limonite

Limonite spots, resulting in yellow-rusty colouring or rocks, may be noted in more sandy and oolitic layers of the section of Lejowa Valley (section *I*, layer *41*) and Mt. Mały Kopieniec (*III*, layer *8*).

Pyrite

Pyrite is represented by small black grains up to 0.1 mm in diameter. It was previously reported from the sub-tatric Rhaetian of the Bielskie Tatra Mts by Borza (1959) and Mišík, Kúšik & Borza (1960). Appearance of pyrite in a sedimentary basin is indicative of reduction conditions and low pH (*cf.* Chilingar, Bissel & Wolf 1968).

Muscovite

Muscovite is represented by small single gray-coloured flakes up to 0.2 mm in size. They were found only in Lejowa Valley (section *I*, layer *5*) and Mt. Mały Kopieniec (*III*, layers *19—20*). That mineral is fairly common in the Keuper and high-tatric Rhaetian of the Tatra Mts (*see* Turnau-Morawska 1953, and Radwański 1968, respectively).

Clay minerals

Admixtures of clay minerals found in some layers (*cf.* Lejowa Valley *I*, layer *39*; Mt. Palenica Lendacka *VI*, layer *20*) result in marly character of limestones forming those layers.

Bituminous matter

Bituminous matter is represented by streaks and some thin intercalations common in marly shales (Pl. 8, Fig. 1).

Intraclasts

The term intraclasts refers to fragments of deposit, which resulted from scouring of the deposit and were subsequently redeposited within the same sedimentary basin (*cf.* Folk 1959, 1962; Kutek 1969; Flügel 1972a). In the sections studied, intraclasts (*cf.* Figs 3—5, 7—9) occur in subordinate amounts, except for the sections of Lejowa Valley (*I*, layers *8* and *20*) and Javorina (*IV*, layers *2* and *3*) where they are fairly common. The intraclasts are of irregular shape (Pl. 10, Fig. 6), sometimes rounded (Pl. 8, Fig. 4), and usually built of micrite with occasional admixture of organodetrital material (Pl. 8, Fig. 2; Pl. 13, Fig. 3; Pl. 14, Fig. 4). The are loosely spaced in the deposit (Pl. 8, Fig. 4), and are up to 3 mm in size. Intraclasts are characteristic of increased water turbulence zones, and indicate scouring of layers (Folk 1959, 1962).

Pellets

In the present paper the term pellets refers to both pellets *sensu stricto* (Folk 1959, 1962; Kutek 1969) and aggregational grains (including mud aggregates, grapestones, and small fecal pellets). Those forms are usually represented by aggregational concentrations of micrite, ellipsoidal in shape and up to 0.3 mm in diameter. Although they are loosely spaced (Pl. 7, Fig. 1) they are fairly common in the deposits studied (Text-figs 3—5, 7—9; Pl. 8, Fig. 2; Pl. 10, Fig. 6; Pl. 13, Fig. 1; Pl. 14, Fig. 2). They are particularly numerous in deposits from Mt. Mały Kopieniec (*III*, layer *1*), Javorina (*IV*, layer *6*), and Mt. Palenica Lenadcka (*VI*, layer *39*). Those forms differ from intraclasts in markedly rounded shape, smaller dimensions, and lack of any internal structure. Similar Recent forms are known from the Bahama shoals (Illing 1954, Purdy 1963) and are characteristic of sheltered shallow-water zones of weak turbulence and increased salinity.

Ooids

Ooids originate by oolitization, *i.e.* a process of formation of oolite coatings around various grains. Ooids are characterized by spherical or sometimes by discoidal shape (Pl. 8, Fig. 6; Pl. 9, Fig. 5; Pl. 12, Fig. 2; Pl. 14, Fig. 6; and Text-

Fig. 10

Oosparite from Lejowa Valley (section *I*, layer *41*). Particular ooids are formed around elongated fragments of pelecypod valves; all the ooids are poorly sorted and loosely packed in sparry calcite cement, × 60

-fig. 10), and attain 0.4—0.6 mm in diameter. They are composed of a nucleus and several concentric layers. Ooid layers show more or less distinct radial texture (*cf.* Fig. 10). Ooid nuclei usually represent various organic fragments, such as foraminifers, trochites, brittle star vertebrae, echinoid prickles, pelecypod shell fragments, as well as quartz grains, and sometimes pellets (*cf.* Pl. 15, Fig. 8; Pl. 33, Fig. 6; Pl. 47, Figs 4, 9). Ooids are usually poorly sorted (Pl. 12, Fig. 2). Sometimes they are closely packed (Pl. 9, Fig. 5), which results in the formation of pressure-solution pits (*cf.* Radwański 1965). Ooids are fairly common (*cf.* Figs 3—5, 7—9) and sometimes they even predominate in the strata studied. In the latter case they form oolitic limestones (oosparites), known from Lejowa Valley (section *I*, layer *41*) and Javorina (section *IV*, layer *18*) (*see* also Pl. 9, Fig. 5, and Text-fig. 10). Recent ooids originate in result of chemical precipitation of calcium carbonate in warm and shallow, turbulent zones situated close to shores (Newell, Purdy & Imbrie 1960). The genesis of fossil ooids is interpreted to be similar (*cf.* Radwański 1968, Kutek 1969).

Biosedimentary components

Onkolitic structures, the origin of which is related to activity of algae, are discussed here. In accordance with the subdivision proposed by Radwański (1968), these structures are here divided into onkolitic crusts and coatings, and onkolites proper.

Onkolitic crusts (*vide* Radwański 1968) are represented by irregularly dark-gray concentrations of micrite on surfaces of some organic fragments, and, occasionally, on single ooids and quartz grains (*cf.* Pl. 7, Fig. 1; Pl. 8, Fig. 4). These micrite concentrations are highly variable in shape. Lichenoid encrustations with somewhat streaky structure are fairly common in the majority of layers of the sections studied.

Onkolitic coatings are similar to onkolitic crusts, except for the fact that they usually envelope whole organic fragments, or inorganic grains (Pl. 7, Fig. 4; Pl. 10, Fig. 6; Pl. 13, Fig. 3). Onkolitic coatings are common in organogenic limestones of the sections of Lejowa Valley (*I*, layer *11*), Mt. Mała Świnica (*II*, layer *19*), and Mt. Palenica Lendacka (*VI*, layer *41*).

Onkolites result from the process of onkolitization, *i.e.* formation of successive onkolitic coatings around various grains. The process represents the final stage in the development of onkolitic structure. Onkolites are built of dark-gray micrite arranged usually in markedly concentric coatings around a grain (commonly around organic fragment) which represents the nucleus. However, it should be noted that nucleus is lacking in the center of some onkolites (*cf.* Pl. 9, Fig. 3; Pl. 15, Fig. 7; Pl. 47, Figs 7—8). In the strata studied onkolites are fairly common but at the same time quantitatively subordinate rock-forming elements (*cf.* Text-figs 3—5, 7—9). They achieve rock-forming importance in the section of Lejowa Valley (*I*, layer *17*) only. Onkolites show highly variable shapes, from spherical or ellipsoidal (Pl. 9, Fig. 3) to markedly irregular (Pl. 15, Fig. 7), varying from 0.5 to 4.0 mm in size. On the basis of their size, they may be assigned to micro- and pizoonkolites, respectively (*cf.* Kutek & Radwański 1965, Radwański 1968). The forms reported here are very numerous in high-tatric Rhaetian (*cf.* Radwański 1968).

In analogy to recent forms, onkolitic crusts and coatings as well as onkolites are considered to be related to life activity of blue-green algae (Ginsburg 1960, Radwański 1968, Szulczewski 1968) trapping and binding calcareous ooze. Thus, formation environment of these structures may be regarded as indicative of a common occurrence of blue-green algae. At present, mass occurrence of algae is typical of tidal zones, and such algal structures were recorded from depth not greater than 20 m (Ginsburg 1960). Comparisons of Recent and fossil blue-green algal structures show that conditions of their formation were highly similar (*cf.* Radwański 1968); these algal structures may therefore be a highly useful bathymetric index, unless they are redeposited.

MICROPALEONTOLOGY

The chapter deals with minute plant and animal remains the studies of which were carried out on thin-sections or on material extracted from residuum after dissolving rock samples in acetic acid. Various organic groups are briefly characterized, except for foraminifers, which, on account of their stratigraphic importance, are characterized in detail and their systematic and taxonomy are given.

In the analysis of the plant and animal remains the author followed remarks and suggestions given by Majewske (1969), Horowitz & Potter (1971), Johnson (1971) and others.

ALGAE

Type **Chlorophyta** or **Schizophyta**
Section **Porostromata**
Genus *GIRVANELLA* Nicholson & Etheridge, 1878
Girvanella minuta Wethered, 1890
(Pl. 29, Figs 1—4)

The forms placed in that species were found in a few layers of the sections studied (*cf.* Figs 3—5, and 7—9) and at Jaworzyna Alp (*VIII*). They are usually represented by encrustations or coatings (Pl. 29, Figs 1—2), and occasionally by balls (Pl. 29, Figs 3—4), wrapped around different organic fragments. The largest *Girvanella* balls do not exceed 7 mm in diameter. *Girvanella* tubes are sometimes strongly sparitized (Pl. 29, Figs 3—4), which results in gradual obliteration of their structure, and primarily in obliteration of outline of walls which are commonly obscure. Particular tubes vary from 7 to 14 microns in diameter. This species was previously recorded from the high-tatric Rhaetian and Liassic (*see* Radwański 1968, and Schaleková 1959, respectively); it should be noted that this species is much more common in the latter strata than in the sub-tatric Rhaetian.

Type **Chlorophyta**
Family **Dasycladaceae**
Genus *ACICULARIA* d'Archiac, 1843
Acicularia sp.
(Pl. 30, Figs 1—4)

The forms discussed here represent reproductive branches of thallus. They are characterized by circular or ellipsoidal transversal section (*see* Pl. 30, Fig. 1 and Pl. 30, Figs 2—3, respectively), with spherically distributed spore chambers (Pl. 30, Figs 1—3) that sometimes are developed within reproductive branches of thallus (Pl. 30, Fig. 4). The specimens figured here attain 0.2—0.3 mm in diameter; the number of cavities observable in cross-section varies from 8 to 12, and the cavities range from 40 to 60 microns in diameter. Spore chambers are infilled with dark micrite, whereas the remaining parts of thallus are distinctly sparitized (Pl. 30, Figs 1—4).

The genus *Acicularia* is primarily known from Jurassic and younger deposits (*cf.* Andrusov 1938). Its oldest representatives were reported from the Permian (Güvenc 1966), and more recently from the Lower Carboniferous (Bilan & Golonka 1973). Forms closely resembling those figured here were reported from the Ladinian and Norian-Rhaetian of the West Carpathians (Byštrický 1964, and Mišík 1966;

respectively). Recently, Elliott (1971) suggested that a number of early Mesozoic forms referred to *Acicularia* s.l. may actually belong to the genus *Aciculella* Pia.

The forms figured here seem to make quite a common component of the sub-tatric Rhaetian deposits. They were recorded from all the sections studied (*see* Figs 3—5 and 7—9). They are common in organodetrital and pelitic limestones, as well as in limestones yielding remarkable admixture of detrital quartz (*e.g.* Szeroka Bielska Pass, section *V*, layers *13*, *15*, and *17*, and Mt. Palenica Lendacka, *VI*, layers *48—49*), which indicates their remarkable environmental tolerance.

Type **Rhodophyta**
Family **Solenoporaceae**
Genus *SOLENOPORA* Dybowski, 1879
Solenopora sp.
(Pl. 31, Figs 1—4)

Thallus of that genus commonly attains ovate shape (Pl. 31, Figs 1—4). Its particular individuals range from 2 to 5 mm in size, forming compact forms with distinct concentric lamination (Pl. 31, Fig. 2). Thallus microstructure is hardly visible in result od advanced process of sparitization of cells (Pl. 31, Fig. 1). Some better preserved cells appear to be ellipsoidal in oblique section, and they attain 50 microns in size. The forms discussed here are somewhat similar to *Solenopora liasica* Le Maître, 1937 (*vide* Johnson 1964; Pl. 6, Figs 1—6) from the Liassic of Morocco; however, their poor preservation precludes any reliable comparisons. *Solenopora* sp. is fairly common in the sections of Lejowa Valley, Mt. Mała Świnica, Mt. Mały Kopieniec, Javorina, Mt. Palenica Lendacka (*cf.* Figs 3—5 and 7—9), and Mt. Hradok (*XV*). It should be noted that *Solenopora* sp. is occasionally of rock--building importance, as *e.g.* at Javorina (*cf.* Pl. 31, Figs 3—4).

Genus *PYCNOPORIDIUM* Yabe & Toyama, 1928
Pycnoporidium? eomesozoicum Flügel, 1972

This species forms clusters composed of numerous, fairly densely spaced tubes. Individual tubes, more or less regular in cross-section, are as a rule parallel to one another; tube diameter ranges from 40 to 60 microns. Longitudinal sections sometimes show dichotomous branching of tubes, whereas transversal ones do circular outlines of tubes. Forms discussed here are almost identical with those reported by Zankl (1969, Abb. 39) and Flügel (1972b, Pl. 2, Fig. 2; Pl. 3) from the Norian-Rhaetian Dachstein Limestone of the Northern Alps.

This species was found in sandy, crinoidal biopelmicrite from Mt. Palenica Lendacka (section *VI*, layers *37* and *39*) exclusively.

SPORES

Plant spores are represented by *Globochaete alpina* Lombard, *G. tatrica* Radwański, and *Globochaete* sp., and are of secondary importance as a rock-forming element. Those spores are attributed to algae of the family Protococcaceae (*cf.* Lombard 1945). Their occurrence appears primarily to be confined to micrite and pelmicrite limestones with fine debris of ostracodes, branchiopods, and pelecypods.

Globochaete alpina Lombard, 1945
(Pl. 32, Figs 1—2)

Spores *Globochaete alpina* are characterized by ellipsoidal to circular outline and attain 80—100 microns in diameter (Lombard 1945). They occur in associations comprising a few individuals (Pl. 32, Figs 1—2).

Globochaete alpina was found in sections of Lejowa Valley, Javorina, Szeroka Bielska Pass, Palenica Lendacka (*cf.* Figs 3 and 7—9), and Mt. Przednia Kopa (*XIII*). It was previously reported from the high-tatric Rhaetian by Radwański (1968). This species is known to have occurred since Anisian (Borza 1970, Mišík 1970, Zawidzka 1972) to Eocene (Mišík 1959), being particularly common in pelagic microfacies of the Upper Jurassic of the Mediterranean province (Lombard 1937, 1945; Leischner 1959, 1961; Mišík 1959, 1966; Lefeld & Radwański 1960).

Globochaete tatrica Radwański, 1968
(Pl. 32, Figs 3—5)

Globochaete tatrica resemble *G. alpina* in shape, internal structure, and mode of subdivision (*cf.* Pl. 35, Figs 3—5), differing from them in markedly larger size (*cf.* Radwański 1968). *Globochaete tatrica* attain 300—500 microns in diameter and occurs in sets comprising two (Pl. 32, Figs 3—4) or three (Pl. 32, Fig. 5) spores.

Globochaete tatrica was found in sections of Lejowa Valley (*I*, layer *14*), Mt. Mały Kopieniec (*III*, layers *9—11*), and Javorina (*IV*, layer *4*). It was described for the first time from the high-tatric Rhaetian of the Tatra Mts (Radwański 1968), and was more recently reported from the Rhaetian of Choč nappe of Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973) and from Rhaetian reef limestones of Hohen Wand in Lower Austria (Flügel 1972b).

Globochaete sp.
(Pl. 33, Fig. 5)

Forms identified as *Globochaete* sp. are very close to *G. alpina* and *G. tatrica*, differing in mode of association. They occur in sets comprising a few tens of individuals (*cf.* Pl. 33, Fig. 5) and are characterized by rather specific, rosette-like mode of subdivision. Individual spores range from 80 to 180 microns in diameter. It should be noted that similar mode of spore association was reported from the Lower Muschelkalk of Lower Silesia by Zawidzka (1972; Pl. 1, Figs 1—2) and from the Upper Muschelkalk of NW Germany by Bachmann (1973, Abb. 57; in this case being interpreted as spherulites). The forms presented here were found at Mt. Mała Świnica (section *III*, layer 7).

FORAMINIFERS

Introductory remarks

Microscopic studies on benthic foraminifers from the sub-tatric Rhaetian of the Tatra Mts were carried out on the basis of thin-sections of rock samples taken bed-by-bed in particular sections (*see* Figs 3—5, 7—9). In the Rhaetian, foraminifers are generally abundant and well-preserved. Their different sections displayed in thin-sections make possible reliable identifications (Figs 3—5 and 7—9 show frequency of occurrence and stratigraphical ranges of particular taxa in the sections analysed). Paleontological descriptions given below follow the remarks and suggestions made by Loeblich & Tappan (1964), Kristan-Tollmann (1962, 1964a, b, 1970), Koehn-Zaninetti (1969), Salaj, Biely & Bystrický (1967), Neumann (1967), Salaj (1969b), and others.

Occurrence of foraminifers in the sub-tatric Rhaetian of the Križna nappe was reported by O. Saxl (*in* Goetel 1917), and recently by the present author (Gaździcki 1970). Characteristics of foraminifer assemblage from the Rhaetian of the Choč nappe is given in a separate paper (Gaździcki & Zawidzka 1973).

The studies on foraminifers from the Rhaetian of the Tatra Mts made possible more accurate stratigraphical subdivision of those strata which will be the subject of the chapter following the systematic descriptions. Stratigraphic ranges of foraminifers given in the descriptions below are summarized on the basis of the literature and, as it will be shown below, they often require revision.

Systematic descriptions

Family **Ammodiscidae** Reuss, 1862
Subfamily **Ammodiscinae** Reuss, 1862
Genus *AMMODISCUS* Reuss, 1862
Ammodiscus sp.
(Pl. 51, Figs 1—4)

Material. — Four poorly preserved specimens, represented by internal moulds.

Description. — Test discoidal; proloculus spheroidal; second chamber represented by planispirally coiled tube. Whorls spherical, 4—6 in number.

Dimensions of the test (in microns): diameter — 400—500.

Occurrence. — Juráňova Valley (*VII*).

Genus *GLOMOSPIRA* Rzehak, 1885
Glomospira tenuifistula Ho, 1959
(Pl. 38, Figs 5—7)

1959. *Glomospira tenuifistula* sp. nov.; Ho, p. 411, Pl. 4, Figs 3—7.
1970. *Glomospira tenuifistula* Ho; Kristan-Tollmann, p. 6, Abb. 4, 6, Figs 1—12, 19—20.
1970. *Glomospira tenuifistula* Ho; Pantić, Pl. 4, Fig. 5.

Material. — Five specimens.

Association. — Recorded exclusively in association with *Agathammina austroalpina*, *Tetrataxis inflata*, *T. nanus*, and *Glomospirella friedli*.

Description as given by Ho (1959).

Dimensions of the test (in microns): diameter — 170—200.

Remarks. — The specimens generally show features typical of *Glomospira tenuifistula*, i.e.: circular cross-section, small proloculus, thin walls, and number of whorls ranging from 5 to 7. However, they differ from typical representatives of this species in thicker tabular second chamber attaining up to 40 microns in thickness.

Occurrence. — In the Tatra Mts this species was recorded in the Lower Rhaetian of Lejowa Valley (section *I*, layer *5*), Mt. Palenica Lendacka (*VI*, layers *33* and *39*), Mt. Przednia Kopa (*XIII*). It is reported for the first time from the Carpathians.

Known from the Triassic of South Szechuan, China (Ho 1959), Anisian of Serbia (Pantić 1970), and Rhaetian of Lower Austria (Kristan-Tollmann 1970).

Genus *GLOMOSPIRELLA* Plummer, 1945
Glomospirella friedli Kristan-Tollmann, 1962 emend. Brönnimann & Zaninetti, 1970 (Pl. 36, Figs 1—2; Pl. 37, Figs 1—6)

1969a. *Angulodiscus friedli* (Kristan-Tollmann); Salaj, Pl. 4, Fig. 3.
1969b. *Angulodiscus friedli* (Kristan-Tollmann); Salaj, Pl. 4, Figs 1a, 2—4.
1970. *Glomospirella friedli* Kristan-Tollmann; Brönnimann, Poisson & Zaninetti, pp. 10—16, Pl. 1, Figs 4—8 and Text-fig. 4 [*cum syn.*].
1970. *Glomospirella friedli* Kristan-Tollmann; Urošević & Andelković, Pl. 4, Figs 1, 6.
1970a. *Angulodiscus friedli* (Kristan); Salaj & Stranik, Pl. 1, Figs 1—2; Pl. 2, Figs 1—2, 7c.
1971. *Glomospirella friedli* (Kristan-Tollmann); Hohenegger & Lobitzer, Pl. 1, Fig. 14.
1972b. *Glomospirella friedli* Kristan-Tollmann; Brönnimann & *al.*, Text-fig. 6 (1—2, 4).

Material. — Over 200 well-preserved specimens; sometimes rock-building element (*see* Pl. 36, Figs 1—2).

Association. — Commonly cooccurring with *Glomospira* sp., *Glomospirella? pokornyi*, *G. parallela*, *Glomospirella* sp., *Agathammina austroalpina*, *Tetrataxis inflata*, *T. nanus*, *Frondicularia woodwardi*, *Involutina communis*, *I. gaschei* and *Tolypammina?* sp., occasionally with *Triasina hantkeni*.

Description as given by Kristan-Tollmann (1962) and Brönnimann & Zaninetti (*in* Brönnimann & *al.* 1970).

Dimensions of the test (in microns): diameter — 500—600, height — 250—300.

Remarks. — The author's specimens (*see* Pl. 37, Figs 1—6) correspond to typical representatives of *Glomospirella friedli* in overall outline, arrangement of whorls, mode of coiling observable in particular cross-sections, and in thickness of walls (*cf.* Kristan-Tollmann, 1962, and Brönnimann & Zaninetti *in* Brönnimann & *al.* 1970).

It should be noted that the diagnosis given by Kristan-Tollmann (1962) was not sufficiently precise, which resulted in some difficulties with identification of this species (*see* Salaj 1969b). Detailed analysis, carried out more recently by Brönnimann & Zaninetti (*in* Brönniman & *al.* 1970) showed complex structure and ontogenetic development of this species. The emendation of the diagnosis made by the latter authors resulted in the increase of stratigraphic value of that species.

Occurrence. — In the Tatra Mts this species was recorded in Lower Rhaetian and sometimes in Upper Rhaetian strata from the sections studied — at Lejowa Valley (*I*, layers *20—21*, *27—29*, *31*, and *33*), Mt. Mała Świnica (*II*, layers *4—5* and *18*), Mt. Mały Kopieniec (*III*, layers *2—3*, *5*, *7*, and *11*), Javorina (*IV*, layers *1—2*, *10*, and *17—19*), Mt. Palenica Lendacka (*VI*, layers *8*, *18*, *33*, *39*, *42*, and *44—45*), Juráňova Valley (*VII*), Jaworzyna Alp (*VIII*), Mt. Gładkie Upłaziańskie (*IX*). This species was not hitherto known from the Tatra Mts.

Known from the Upper Norian of Austria (Koehn-Zaninetti 1969), Norian-Rhaetian of Austria (Kristan-Tollmann 1962, Czurda & Nicklas 1970, Hohenegger

& Lobitzer 1971), Lycian Taurus in Turkey (Brönnimann & *al.*, 1970), Naiband Formation of Iran (Brönnimann & *al.* 1972b), from the Lower Rhaetian of Slovakia (Salaj 1969a, b), Djebel Fkirine (the Eastern Atlas Mts) of Tunisia (Salaj & Stranik 1970a, b), from the Rhaetian of Lower Austria (Kristan-Tollmann & Tollmann 1964; Oberhauser & Plöchinger 1968), Switzerland (Brönnimann & Page 1966), Haute-Savoie in France (Brönnimann & *al.* 1969), Serbia (Urošević & Anđelković 1970), and from Late Triassic — Early Jurassic strata of Northern Apennines (Boccaletti & *al.* 1969).

Glomospirella parallela Kristan-Tollmann, 1964
(Pl. 38, Figs 1—2)

1964b. *Glomospirella parallela* n. sp.; Kristan-Tollmann, pp. 138—139, Pl. 2, Figs 8—10.
1969. *Glomospirella parallela* Kristan-Tollmann; Brönnimann & *al.*, pp. 94—96, Pl. 1, Figs 1—6, and Text-fig. 1 (*E*—*G*).
1970a. *Angulodiscus parallela* (Kristan-Tollmann); Salaj & Stranik, Pl. 2, Figs 5, 7*a*.
1970. *Glomospirella parallela* Kristan-Tollmann; Kristan-Tollmann, Abb. 6, Fig. 16.

Material. — Over 40 well-preserved specimens.

Association. — Most often cooccurring with *Glomospira* sp., *Glomospirella? pokornyi*, *G. friedli*, *Glomospirella* sp., *Agathammina austroalpina*, *Tetrataxis inflata*, *T. nanus* and *Tolypammina?* sp.

Description as given by Kristan-Tollmann (1964b).

Dimensions of the test (in microns): diameter — 450—500, thickness — 100—130.

Remarks. — Test elongated, discoidal, with small medial swelling, deuteroloculus initially irregularly (curled up) and later planispirally coiled into 4—6 whorls (*cf.* Pl. 38, Figs 1—2), and general size of test are typical of the species *Glomospirella parallela* (*cf.* Kristan-Tollmann 1964b). This species differs from *Glomospirella friedli* in markedly elongated shape and in the arrangement and higher compression of whorls in younger test part.

Occurrence. — In the Tatra Mts this species was often recorded in the Lower Rhaetian and occasionally in the Upper Rhaetian strata from the sections studied — Lejowa Valley (*I*, layers *27* and *29*), Mt. Mała Świnica (*II*, layers *4*—*5*, *11*, and *18*), Mt. Mały Kopieniec (*III*, layers *1*—*2*, *5*, *12*—*13*), Javorina (*IV*, layers *2*, *10*, and *18*), Szeroka Bielska Pass (*V*, layer *12*), and Mt. Palenica Lendacka (*VI*, layers *18* and *39*). This species was not hitherto known from the Carpathians.

Known from the Lower Rhaetian of Djebel Fkirine (the Eastern Atlas Mts) in Tunisia (Salaj & Stranik 1970a, b), and from the Rhaetian of Lower Austria (Kristan-Tollmann 1964b, 1970; Oberhauser & Plöchinger 1968) and Haute-Savoie in France (Brönnimann & *al.* 1969).

Glomospirella sp.
(Pl. 38, Figs 3—4)

Material. — Approximately 25 poorly preserved specimens.

Association. — *Agathammina austroalpina*, *Agathammina?* sp., *Tolypammina?* sp., *Frondicularia woodwardi*, *Glomospirella? pokornyi* and *G. friedli*.

Description. — Test discoidal, strongly elongated in the axial cross-section. Proloculus obscure. Deuteroloculus initially irregularly coiled (curled up), and later almost regularly (with some oscillations) planispirally coiled into *c.* 8 whorls.

Dimensions of the test (in microns): diameter — 500—600, thickness — 100—180.

Remarks. — It differs from *Glomospirella parallela* in larger ultimate size of test and in more numerous whorls. It appears somewhat similar to *Glomospirella* sp. reported by Kristan-Tollmann (1970, Abb. 6, Fig. 14) from the Rhaetian of Lower Austria.

Occurrence. — It was recorded from the Lower and Upper Rhaetian of all the sections studied (*cf.* Figs 3—5, and 7—9).

Glomospirella? pokornyi (Salaj, 1967) (Pl. 34, Figs 1—3; Pl. 35, Figs 1—9)

1967. *Angulodiscus pokornyi* Salaj nov. sp.; Salaj, Biely & Bystrický, p. 128, Pl. 6, Fig. 6*a*—*b*.
1969a. *Angulodiscus pokornyi* Salaj; Salaj, Pl. 4, Fig. 2.
1969b. *Angulodiscus pokornyi* Salaj; Salaj, Pl. 4, Fig. 1*c*, *d* (*non b*).
1970a. *Angulodiscus pokornyi* Salaj; Salaj & Stranik, Pl. 1, Fig. 4.

Material. — Over 120 well-preserved specimens.

Association. — Commonly cooccurring with *Agathammina austroalpina*, *Glomospirella parallela*, *G. friedli*, *Glomospirella* sp., *Frondicularia woodwardi*, *Nodosaria* sp., and *Tolypammina?* sp.

Description as given by Salaj (*in* Salaj, Biely & Bystrický 1967).

Dimensions of the test (in microns): diameter — 500—700, thickness — 100—200.

Remarks. — The species proposed by Salaj (*in* Salaj & *al.* 1967) was placed in the genus *Angulodiscus* Kristan, which is recently regarded as synonym of the genus *Involutina* Terquem emend. Koehn-Zaninetti (*cf.* Koehn-Zaninetti 1969). However, the structure of test, mode of coiling, and arrangement of chambers observable in different cross-sections (*cf.* Pl. 35, Figs 1—9) indicate that this species should be placed in the genus *Glomospirella* Plummer rather than in *Involutina* Terquem.

Occurrence. — In the Tatra Mts this species was recorded from the Lower Rhaetian of the sections of Lejowa Valley (*I*, layer *6*), Mt. Mała Świnica (*II*, layers *4—5*, and *7*), Mt. Mały Kopieniec (*III*, layers *1—2*), Javorina (*IV*, layer *2*), Szeroka Bielska Pass (*V*, layers *8—10*, and *12*), Mt. Palenica Lendacka (*VI*, layers *29*, *32*, *33*, and *35*). This species was not hitherto known from the Tatra Mts.

Known from the Lower Rhaetian of Choč nappe at Hybe in Slovakia (Salaj & *al.* 1967) and Djebel Fkirine (the Eastern Atlas Mts) in Tunisia (Salaj & Stranik 1970a, b).

Subfamily **Tolypammininae** Cushman, 1928

Genus *TOLYPAMMINA* Rhumbler, 1895

Tolypammina? aff. *gregaria* Wendt, 1969 (Pl. 42, Figs 2—5)

1972. *Tolypammina?* aff. *gregaria* Wendt; Brönnimann & Zaninetti, pp. 87—43, Pl. 6, Figs 1—10; Pl. 8, Figs 14—15; Pl. 9, Figs 1—4, 5 and Text-figs 6—7 [*cum syn.*].

Material. — About 50 specimens.

Association. — *Agathammina austroalpina*, *Glomospira* sp., *Glomospirella parallela*, *G. friedli*, *Planiinvoluta deflexa*, *Tolypammina?* sp., and *Ophthalmidium* sp.

Dimensions of the test (in microns): diameter of vertical section — 500—1,200, diameter of deuteroloculus — 50—100.

Remarks. — *Tolypammina?* aff. *gregaria* is a sessile foraminifer commonly encrusting organic debris. Individuals illustrated here are very similar to those identified as *Tolypammina?* aff. *gregaria* Wendt by Brönnimann and Zaninetti (1972; *see* especially Pl. 8, Figs 14—15, and Pl. 9, Figs 1—2, and 5), differing in somewhat larger diameter of deuteroloculus. It is not certain whether or not the test walls are agglutinated, hence this species was retained in the genus *Tolypammina* Rhumbler with reservation (*see* also Brönnimann & Zaninetti 1972).

Occurrence. — In the Tatra Mts this species was recorded from the Lower Rhaetian of Mt. Palenica Lendacka (section *VI*, layers *12* and *39*). This species was not hitherto known from the Carpathians.

Known from the Upper Muschelkalk of the western Basse-Provence in France (Brönnimann & Zaninetti 1972).

Tolypammina? sp.
(Pl. 42, Figs 1, 7)

Material. — Approximately 50 specimens.

Association. — Commonly cooccurring with *Agathammina austroalpina*, *Tetrataxis inflata*, *Glomospirella? pokornyi*, *G. parallela*, *G. friedli*, and occasionally with Involutinidae.

Description. — Test bilocular, consisting of spherical proloculus and tabular irregularly coiled deuteroloculus; proloculus sometimes obscure. Walls recrystallized and coated with gray micritic layer.

Dimensions of the test (in microns): diameter in vertical section — 600—1,300.

Remarks. — It is not certain whether or not this species belongs to the genus *Tolypammina* Rhumbler, as the structure of walls is obscure (compare Brönnimann & Zaninetti 1972 and remarks to *Tolypammina?* aff. *gregaria*).

Occurrence. — Lower and Upper Rhaetian in all the sections studied.

Family **Trochamminidae** Schwager, 1877
Subfamily **Trochammininae** Schwager, 1877
Genus *TROCHAMMINA* Parker & Jones, 1859
Trochammina alpina Kristan-Tollmann, 1964
(Pl. 41, Figs 1—2)

1964a. *Trochammina alpina* n. sp.; Kristan-Tollmann, pp. 43—44, Pl. 7, Figs 2—3.
1973. *Trochammina alpina* Kristan-Tollmann; Gaździcki & Zawidzka, Pl. 4, Fig. 3.

Material. — Over 30 well-preserved specimens.

Association. — *Agathammina austroalpina*, *Frondicularia woodwardi*, *Nodosaria* sp., *Tolypammina?* sp., *Glomospira* sp., *Involutina communis*, *I. gaschei*, *Diplotremina* sp. and *Planiinvoluta deflexa*.

Description as given by Kristan-Tollmann (1964a).

Dimensions of the test (in microns): diameter of the base — 200—400, height — 200—300.

Remarks. — Number of whorls and arrangement of chambers observable in the vertical cross-section (Pl. 41, Figs 1—2) are almost identical as in the specimen described by Kristan-Tollmann (1964a, Pl. 7, Fig. 2c) as *Trochammina alpina*; the Polish specimen differs from the latter one in slightly smaller general size and in the apical angle. The specimen from the Ladinian of Slovakia, figured by Salaj & *al.* (1967, Pl. 1, Fig. 12) as *Trochammina alpina* most probably represents the species *Trochammina almtalensis* Koehn-Zaninetti.

Occurrence. — In the Tatra Mts this species was recorded from the Lower Rhaetian and occasionally from the Upper Rhaetian in the sections of Lejowa Valley (*I*, layers *3—4*, *6* and *10*), Mt. Mały Kopieniec (*III*, layers *7* and *9*), and Mt. Hradok (*XV*). It was previously recorded from the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

Known from the Rhaetian (Zlambach-marls) of Austria (Kristan-Tollmann 1964a).

Family **Caligellidae** Reitlinger, 1959
Genus *ALPINOPHRAGMIUM* Flügel, 1967
Alpinophragmium perforatum Flügel, 1967
(Pl. 43, Figs 1—3)

1967. *Alpinophragmium perforatum* n. sp.; Flügel, pp. 383—388, Pl. 1—2, Abb. 2—6 [*cum syn.*].
1968. *Alpinophragmium perforatum* Flügel; Oberhauser & Plöchinger, Pl. 1, Fig. 4.
1969. *Alpinophragmium perforatum* Flügel; Zankl, p. 46, Abb. 56.
1971. *Alpinophragmium perforatum* Flügel; Hohenegger & Lobitzer, Pl. 2, Fig. 10.

Material. — Six poorly preserved specimens.

Association. — *Involutina communis*, *I. gaschei*, *Glomospirella friedli*, *Glomospirella* sp. and *Tetrataxis inflata*.

Description as given by Flügel (1967).

Dimensions of the test (in microns): length — 2,000—3,300, width — 1,000—1,700.

Remarks. — This is a sessile foraminifer usually encrusting organic debris. Structure and general size of its test matches the diagnosis of the species *Alpinophragmium perforatum* as given by Flügel (1967). This form was assigned by Flügel (1967) to the family Caligellidae on the basis of wall structure; however, the results of studies by Hohenegger & Lobitzer (1971) showed that this species would be better accomodated in the Miliolina, as its test appears to be porcelaneous.

Occurrence. — In the Tatra Mts this species was recorded in the Upper Rhaetian of the sections of Lejowa Valley (*I*, layers *20* and *24*), Javorina (*IV*, layers *3* and *19*), Mt. Palenica Lendacka (*VI*, layer *49*) and Mt. Gładkie Upłaziańskie (*IX*). It was not hitherto known from the Carpathians.

It was known from the Norian and Rhaetian reef limestones (Dachstein-Kalke, Oberrät-Riffkalke) of the Northern Alps (*cf.* Fabricius 1966, Flügel 1967, Oberhauser & Plöchinger 1968, Zankl 1969, Hohenegger & Lobitzer 1971).

Family **Moravamminidae** Pokorný, 1951
Subfamily **Earlandiinae** Cummings, 1955
Genus *EARLANDIA* Plummer, 1930
Earlandia sp.
(Pl. 33, Figs 1—4)

Material. — Approximately 20 well-preserved specimens.

Association. — Commonly cooccurring with *Frondicularia woodwardi*, *Glomospira* sp., *Glomospirella? pokornyi*, *G. friedli*, *Agathammina austroalpina*, *Tetrataxis inflata*, *Planiinvoluta deflexa*, *Involutina communis* and *I. gaschei*.

Description. — Test small, markedly elongate, with initial chamber subglobular, conical in longitudinal cross-section and circular in transversal cross-section, with microgranular, thin walls.

Dimensions of the test (in microns): length — 260—300, width — 88—132, thickness of wall — 11—15.

Remarks. — A number of problematic microfossils of uncertain taxonomic status and previously described under the generic name *Aeolisaccus* Elliott (*cf.* Elliott 1958; Mišik 1971, 1972; Flügel 1972b) known from the Permian to Cretaceous were recently placed in the foraminifer genus *Earlandia* Plummer (*see* Zaninetti & *al.* 1972, Brönnimann & *al.* 1972a).

Forms figured here (Pl. 38, Figs 1—4) are markedly shorter than *Earlandia dunningtoni*. They differ from *Earlandia tintinniformis* described by Mišik (1971, 1972) from the Central West Carpathians in markedly larger size, diameter of transversal section, length and in thickness of lateral sides.

Occurrence. — In the Tatra Mts this species was recorded from the Lower and Upper Rhaetian of the section of Lejowa Valley (*I*, layers *6*, *10* and *22*), Javorina (*IV*, layer *6*), Szeroka Bielska Pass (*V*, layer *5*), Mt. Palenica Lendacka (*VI*, layer *33*).

Family **Tetrataxidae** Galloway, 1933
Genus *TETRATAXIS* Ehrenberg, 1854
Tetrataxis inflata Kristan, 1957
(Pl. 41, Figs 4—10)

1957. *Tetrataxis inflata* nov. sp.; Kristan, pp. 280—284, Pl. 27, Fig. 4.
1964a. *Tetrataxis inflata* Kristan; Kristan-Tollmann, pp. 44—45, Pl. 7, Figs 4—7.
1971. *Tetrataxis inflata* Kristan; Hohenegger & Lobitzer, Pl. 1, Fig. 11.
1971. *Tetrataxis inflata* Kristan; Premoli Silva, p. 336, Pl. 26, Fig. 9.

Material. — Over 150 well-preserved specimens.

Association. — *Frondicularia woodwardi*, *Glomospira tenuifistula*, *Agathammina austroalpina*, *Glomospirella? pokornyi*, *G. parallela*, *G. friedli*, *Tolypammina?* sp., *Nodosaria* sp., *Alpinophragmium perforatum*, *Involutina gaschei*, *I. communis* and *I. sinuosa sinuosa*.

Description as given by Kristan (1957).

Dimensions of the test (in microns): diameter of the base — 450—500, height — 300—360.

Remarks. — The specimens have the shape of axial test section (with long diameter of the base and moderate height) and 70° apical angle with are typical of the species *Tetrataxis inflata* Kristan (*cf.* Kristan 1957, Kristan-Tollmann 1964a).

Occurrence. — The species is fairly common in the Tatra Mts, generally more common in the Lower than in the Upper Rhaetian. It is reported from the sections of Lejowa Valley (*I*), Mt. Mała Świnica (*II*), Mt. Mały Kopieniec (*III*), Javorina (*IV*), Mt. Palenica Lendacka (*VI*), and Mt. Hradok (*XV*). This species was not hitherto known from the Tatra Mts.

Known from the Rhaetian of Northern Alps (Kristan 1957, Kristan-Tollmann 1964a, Hohenegger & Lobitzer 1971), and from the Anisian of Northern Italy (Premoli Silva 1971).

Tetrataxis nanus Kristan-Tollmann, 1964
(Pl. 41, Figs 11—12)

1964a. *Tetrataxis nanus* n. sp.; Kristan-Tollmann, p. 45, Pl. 7, Figs 8—9.
1964. *Tetrataxis nanus* Kristan-Tollmann; Kristan-Tollmann & Tollmann, pp. 549—550, Pl. 3, Figs 3—6; Pl. 5, Figs 4—6.

Material. — Five specimens.

Association. — *Frondicularia woodwardi*, *Agathammina austroalpina*, *Tetrataxis inflata* and *Glomospirella friedli*.

Description as given by Kristan-Tollmann (1964a).

Dimensions of the test (in microns): diameter of the base — 350, height — 400.

Remarks. — This form differs from *Tetrataxis inflata* in smaller diameter of the base, usually not exceeding 350 microns, in sharper apical angle, and in test height markedly exceeding length of its base (*cf.* Pl. 41, Figs 11—12).

Occurrence. — This species, hitherto unknown from the Tatra Mts, was found in the Lower Rhaetian of Lejowa Valley (section *I*, layer *6*) and in Upper Rhaetian of Mt. Palenica Lendacka (*VI*, layer *44*).

Known from the Rhaetian of Northern Alps (Kristan-Tollmann 1964a, Kristan-Tollmann & Tollmann 1964).

Family **Fischerinidae** Millett, 1898

Subfamily **Cyclogyrinae** Loeblich & Tappan, 1961

Genus *AGATHAMMINA* Neumayr, 1887

Agathammina austroalpina Kristan-Tollmann & Tollmann, 1964
(Pl. 40, Figs 1—7)

1969. *Agathammina austroalpina* Kristan-Tollmann & Tollmann; Koehn-Zaninetti, pp. 57—58, Pl. 8, Figs *A—D*, and Text-fig. 11 [*cum syn.*].
1970. *Agathammina austroalpina* Kristan-Tollmann; Jendrejáková, Pl. 1, Fig. 3.

Material. — Over 100 well-preserved specimens.

Association. — *Frondicularia woodwardi*, *Nodosaria* cf. *ordinata*, *Nodosaria* sp., *Glomospira* sp., *Glomospirella? pokornyi*, *G. friedli*, *G. parallela*, *Glomospirella* sp., *Tetrataxis inflata*, *Trochammina alpina*, *Involutina communis* and *I. gaschei*.

Description as given by Kristan-Tollmann & Tollmann (1964).

Dimensions of the test (in microns): diameter — 250—280, thickness — 120—150.

Remarks. — Ellipsoidal outline of test in axial section (Pl. 40, Figs 1—3) ovate in transversal section (Pl. 40, Figs 4—6), and tabular second chamber coiled in quinqueloculine manner are typical of the species *Agathammina austroalpina* (*cf.* Kristan-Tollmann & Tollmann 1964).

Occurrence. — This species, hitherto unknown from the Tatra Mts, is very common in the Lower and Upper Rhaetian of all the sections studied (*cf.* Figs 3—5, 7—9).

Known from the Anisian-Ladinian of Austria (Koehn-Zaninetti 1969), Bulgaria (Trifonova 1972), from the Carnian of Slovakia (Salaj & *al.* 1967, Jendrejáková 1970), and Austria (Koehn-Zaninetti 1969), from the Norian of Austria (Koehn-Zaninetti 1969), and Slovakia (Jendrejáková 1972), and from the Rhaetian of Austria (Kristan-Tollmann 1964b, c; Kristan-Tollmann & Tollmann 1964; Koehn-Zaninetti 1969) and Switzerland (Brönnimann & Page 1966).

Agathammina? sp.
(Pl. 40, Figs 8—9)

Material. — Approximately 20 well-preserved specimens.

Association. — *Frondicularia woodwardi*, *Triasina hantkeni*, *Glomospira* sp., *Glomospirella* sp., *Tetrataxis inflata* and *Tolypammina?* sp.

Description. — Test ellipsoidal, elongated. Proloculus globular; deuteroloculus tabular, initially irregularly coiled and finally with markedly oscillating whorls (*see* Pl. 40, Figs 8—9).

Dimensions of the test (in microns): diameter — 260—270, thickness — 120—130.

Remarks. — The forms figured here do not display quinqueloculine type of coiling, hence it is not certain whether or not they belong to the genus *Agathammina* Neumayr. It should be noted that the arrangement of whorls in the last phase of coiling appears somewhat similar to that of the genus *Glomospirella* Plummer. Similar forms were reported under the name *Agathammina austroalpina* by Boccaletti & *al.* (1969, Figs 43*a, g, i, n*) from the Rhaetian and Lower Liassic of Northern Apennines.

Occurrence. — In the Tatra Mts — Upper Rhaetian of Javorina (section *IV*, layers *2, 8, 16* and *18*), Mt. Palenica Lendacka (*VI*, layer *48*) and Mt. Gładkie Upłaziańskie (*IX*). Compare also the above remarks.

Genus *VIDALINA* Schlumberger, 1900

"*Vidalina*" *leischneri* (Kristan-Tollmann, 1962)
(Pl. 50, Figs 1—8)

1962. *Neoangulodiscus leischneri* n. gen., n. sp.; Kristan-Tollmann, p. 230, Pl. 2, Figs 25—34.
1965. *Cornuspira?*; Cita, Pl. 9, Figs 1—2.
1970. "*Vidalina*" *leischneri* (Kristan-Tollmann); Brönnimann, Poisson & Zaninetti, pp. 18—19, Text-figs 6 (4—5, 9).
1970. *Neoangulodiscus leischneri* Kristan; Papp & Turnovsky, Pl. 34, Figs 2—3.

Material. — Approximately 50 well-preserved specimens.

Association. — Cooccurring exclusively with *Involutina farinacciae*, *I.* cf. *liassica*, and *I.* cf. *turgida*.

Description as given by Kristan-Tollmann (1962).

Dimensions of the test (in microns): diameter — 210—270, thickness — 40—60.

Remarks. — The forms figured here (Pl. 50, Figs 1—8) have all the features characteristic of the species "*Vidalina*" *leischneri* (Kristan-Tollmann) (*cf.* figures and descriptions given by the authors enlisted in the synonymy).

Records of the genus *Vidalina* from the Triassic and Jurassic are questionable. Recent studies by Wernli (1972) showed that transverse sections of foraminifers of the species of the genus *Ophthalmidium* Kübler & Zwingli from the Jurassic of the Jura Mts are very similar to those illustrated under the names of biloculine genera, such as *Vidalina* Schlumberger, *Neoangulodiscus* Kristan-Tollmann, and *Cyclogyra* Wood.

Occurrence. — In the Tatra Mts this species was found in the Lower Liassic of Lejowa Valley (section *I*, limestone intercalations occurring a few meters above layer *42*) and Strążyska Valley (*XI*). This form was hitherto unknown from the Carpathians.

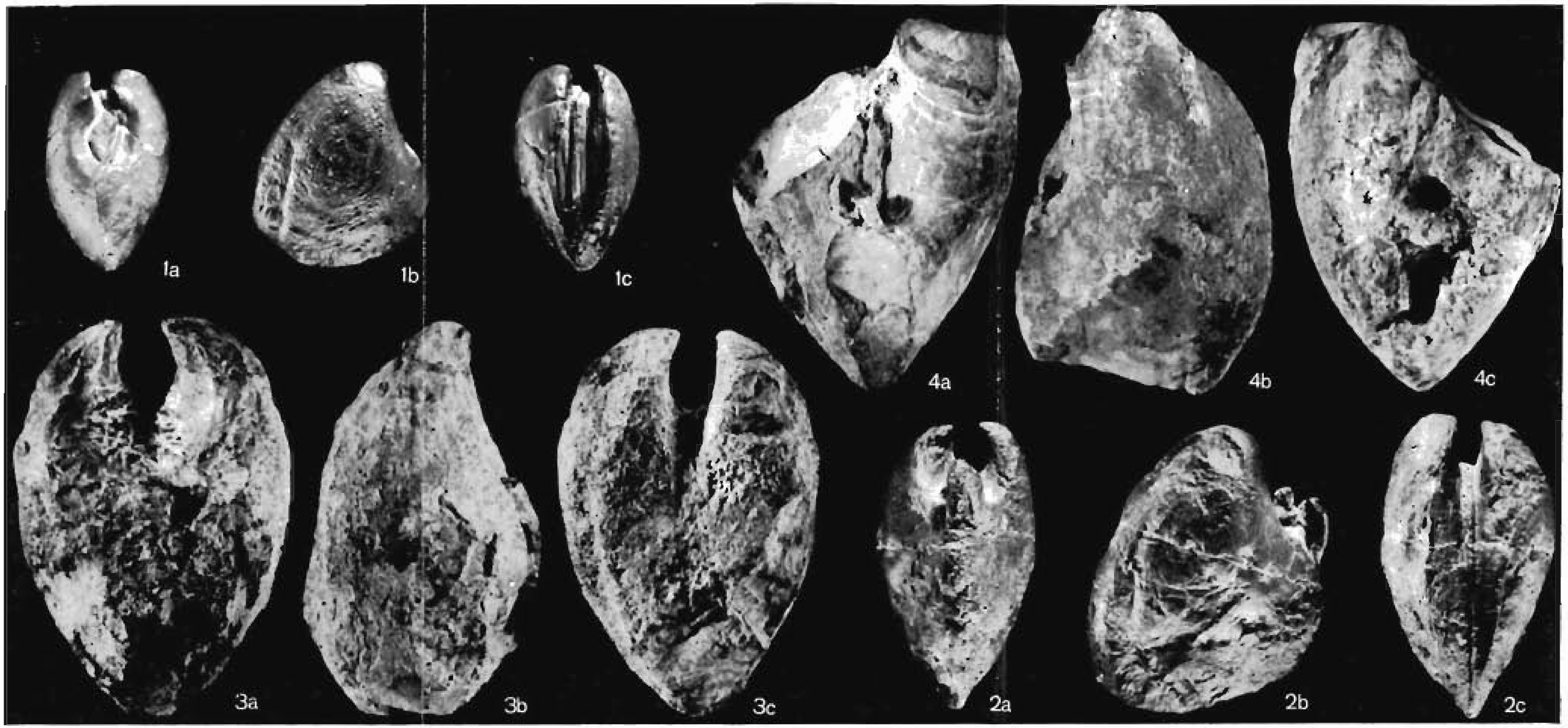
This species, misinterpeted as *Angulodiscus* sp., was reported for the first time from the Lower Liassic of Northern Limestone Alps by Leischner (1961; Pl. 2, Figs 5—7), and thereafter it was reported from Lower Liassic limestones with *Arietites* sp. pierced by the borehole in the Vienna area (Kristan-Tollmann 1962). It is also know from the Liassic of Southern Alps (Cita 1965), Austria (Papp & Turnovsky 1970), and from Lycian Taurus in Turkey (Brönnimann & *al.* 1970).

Conchodon infraliasicus Stoppani; Lower Rhaetian, Mt. Mały Kopieniec (section *III*, layer *2*)

1-7 — specimens varying in age: *a* anterior view, *b* posterior view, *c* side view; *8* — specimen with preserved fragment of the hinge (cardinal tooth is visible): *a* anterior view, *b* side view

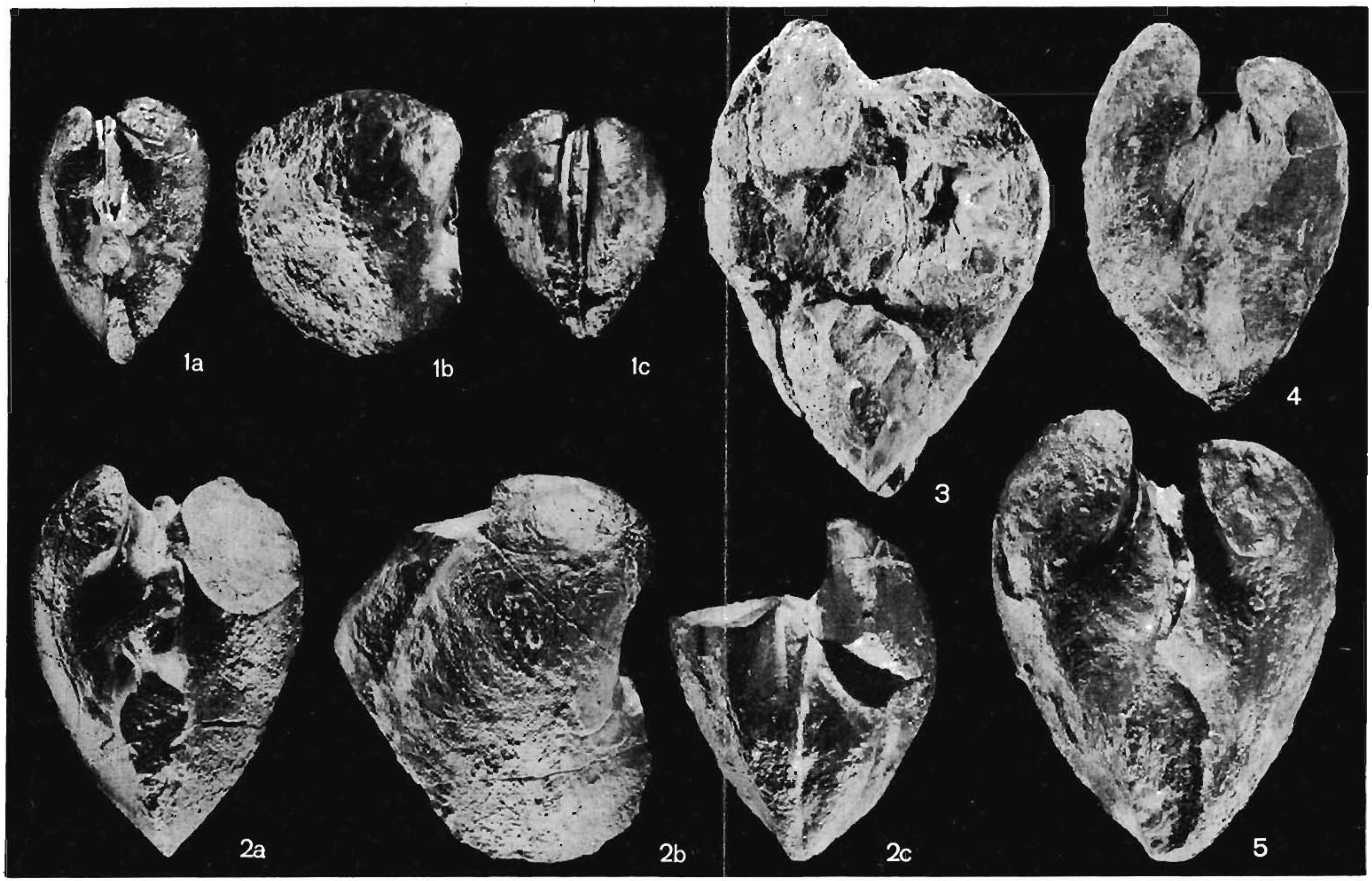
All photos in nat. size

1-3 — *Rhaetomegalodon tatricus* sp. n.: Lower Rhaetian, Mt. Mały Kopieniec (section *III*, layer *2*)



1a-c and *2a-c* — paratypes (juvenile specimens), *3a-c* — holotype: *a* anterior view, *b* side view, *c* posterior view
4 — *Rhaetomegalodon incisus* (Frech): Rhaetian at Mt. Palenica Lendacka (scree)
All photos in nat. size

Conchodon goeteli sp. n.; Lower Rhaetian, Mt. Mały Kopieniec (section *III*, layer *2*)



1a-c — paralype (juvenile specimen), *2a-c* — holotype: *a* anterior view, *b* side view, *c* posterior-top view toward area: *3-5* — badly preserved adult specimens (anterior views)

All photos in nat. size

Vertical sections of a block of *Megalodon* limestone from Polana pod Wołoszynem (section *XIV*); visilbe are erosion surfaces at the middle and top part of the bed (*cf.* Gaździcki 1971, Text-fig. 4 and Pl. 1)

Subfamily Calcivertellinae Loeblich & Tappan, 1964
Genus *PLANIINVOLUTA* Leischner, 1961
Planiinvoluta carinata Leischner, 1961
(Pl. 42, Fig. 6)

1961. *Planiinvoluta carinata* n. g. n. sp.; Leischner, pp. 11—12, Pl. 10, Figs 1—14; Pl. 12, Figs 6, 7a—8a.
1964c. *Planiinvoluta carinata* Leischner; Kristan-Tollmann, Pl. 7, Fig. 4.

Material. — Five specimens.

Association. — *Frondicularia woodwardi, Nodosaria* sp., *Glomospirella? pokornyi, G. friedli, G. parallela* and *Agathammina austroalpina.*

Description as given by Leischner (1961).

Dimensions of the test (in microns): diameter — 300—400, thickness — 50—90.

Remarks. — The sessile foraminifer figured here (Pl. 42, Fig. 6), shows all the features typical of the species *Planiinvoluta carinata* Leischner (*cf.* illustrations and descriptions given by the authors enlisted in the synonymy). This species differs from *Planiinvoluta deflexa* in smaller size and markedly flattened attachment area.

Occurrence. — In the Tatra Mts this species was found in the Lower and Upper Rhaetian of Javorina (section *IV*, layers *3, 12,* and *18*), Mt. Palenica Lendacka (*VI*, layers *29* and *35*). It was hitherto unknown from the Carpathians.

It is known from the Norian (Kristan-Tollmann 1964c) and mostly from the Rhaetian (Leischner 1961) of Northern Limestone Alps.

Planiinvoluta deflexa Leischner, 1961
(Pl. 43, Figs 4—7)

1961. *Planiinvoluta deflexa* n.g.n.sp.; Leischner, p. 12, Pl. 10, Figs 15—22; Pl. 12, Figs 7b—8b.
1969. *Planiinvoluta deflexa* Leischner; Koehn-Zaninetti, pp. 60—62, Text-fig. 12 (A—C).
1973. *Planiinvoluta deflexa* Leischner; Gaździcki & Zawidzka, Pl. 6, Figs 5—6.

Material. — Approximately 20 specimens.

Association. — *Glomospira tenuifistula, Glomospirella? pokornyi, G. friedli, G. parallela, Agathammina austroalpina, Trochammina alpina, Frondicularia woodwardi, Diplotremina* sp., *Tolypammina?* sp., *Involutina communis, I. gaschei* and *Tetrataxis inflata.*

Description as given by Leischner (1961).

Dimensions of the test (in microns): diameter — 500—600, thickness — 100—200.

Remarks. — It is sessile form with markedly flattened test, consisting of globular proloculus and planispirally enrolled second chamber, and with concave attachment area (*cf.* Pl. 43, Figs 5 and 7), typical of the species *Planiinvoluta deflexa* (*cf.* Leischner 1961, Wendt 1969; Koehn-Zaninetti 1969).

Occurence. — In the Tatra Mts this species was found in Lower and (more often) in Upper Rhaetian of Lejowa Valley (section *I*, layers *6, 10,* and *27*), Javorina (*IV*, layers *2* and *3*), Szeroka Bielska Pass (*V*, layers *1* and *5*), Mt. Palenica Lendacka (*VI*, layers *39, 41,* and *43*), Jaworzyna Alp (*VIII*), and Stólnia (*XII*). It is also known from the Upper Rhaetian of Choč nappe from Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973). Outside Poland, it is known from the Rhaetian of Northern Limestone Alps (Leischner 1961, Koehn-Zaninetti 1969).

Family **Miliolidae** Ehrenberg, 1839
Genus *OPHTHALMIDIUM* Kübler & Zwingli, 1870
Ophthalmidium sp.
(Pl. 38, Figs 8—9)

Material. — Three poorly preserved specimens.

Association. — *Frondicularia woodwardi*, *Nodosaria* sp., *Agathammina austroalpina*, *Trochammina alpina* and *Tolypammina?* sp.

Description. — Test ovate, elongate, rounded on both ends. Proloculus spherical; subsequent chambers tubular, planispirally coiled; diameter of chambers of outer whorls markedly larger than that of inner whorls.

Dimensions of the test (in microns): height — 220, thickness — 80.

Remarks. — One of the specimens figured (Pl. 38, Fig. 8) seems to be similar to *Agathamminoides* Zaninetti (*cf.* Zaninetti 1969); however, scarce material and innumerous cross-sections preclude any more detailed identifications. It should be noted that *Ophthalmidium* was hitherto placed in the family Nubeculariidae; however, recent studies on wall microstructure, character of coiling and chamber to whorl length ratio (Pazdro 1972) indicate that this genus should be placed in the family Miliolidae.

Occurrence. — Lower Rhaetian of Lejowa Valley (section *I*, layer *3*) and Mt. Palenica Lendacka (*VI*, layer *12*).

Family **Miliolíporidae** Brönnimann & Zaninetti, 1972
Genus *MILIOLIPORA* Brönnimann & Zaninetti, 1972
Miliolipora sp.
(Pl. 38, Fig. 11)

Material. — Two poorly preserved specimens.

Association. — Exclusively with *Involutina communis*, *I. tumida*, *I. impressa*, *I. muranica*, *I. sinuosa sinuosa*, *I. gaschei*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Diplotremina* sp. and *Tolypammina?* sp.

Description. — Test consisting of proloculus and tubular chambers, wall calcareous, thick, with large subcircular perforations.

Dimensions of the test (in microns): length — 350, width — 200.

Remarks. — Prior to the establishment of the genus *Miliolipora*, this form was usually assigned to "*Guttulina*" d'Orbigny (*cf.* Kristan-Tollmann 1964b, Koehn-Zaninetti 1969).

Occurrence. — This form, hitherto unknown from the Carpathians, was found in the Upper Rhaetian of Lejowa Valley (section *I*, layer *15*). Outside Poland, it is known from the Upper Norian — Rhaetian of Austria (Kristan-Tollmann 1964b, Koehn-Zaninetti & Brönnimann 1968c, Koehn-Zaninetti 1969) and from contemporaneous Naiband Formation in Iran (Brönnimann & *al.* 1972b).

Family **Nodosariidae** Ehrenberg, 1838
Subfamily **Nodosariinae** Ehrenberg, 1838
Genus *NODOSARIA* Lamarck, 1812
Nodosaria cf. *ordinata* Trifonova, 1965
(Pl. 39, Figs 8—9)

Material. — Six poorly preserved specimens.

Association. — *Tetrataxis inflata* and *Frondicularia woodwardi*.

Description. — Test straight, elongate, with rounded anterior part, consisting of 5—10 trapezoidal chambers gradually increasing in size as added. Septum separating chambers markedly bent forwards in the axial test part. Proloculus rounded. Wall calcareous, smooth, usually strongly recrystallized.

Dimensions of the test (in microns): length — c. 200, width — c. 80.

Occurrence. — This form, hitherto unknown from the Tatra Mts, was found in the Lower Rhaetian of Lejowa Valley (section *I*, layer *6*).

Nodosaria sp.
(Pl. 39, Figs 10—11)

Remarks. — Single, incomplete forms identified as *Nodosaria* sp. are characterized by straight, elongate test consisting of a few chambers, subrectangular or subcircular in axial cross-section (Pl. 39, Fig. 10 and Pl. 39, Fig. 11, respectively).

One of the forms figured (Pl. 39, Fig. 10) was found in association with *Glomospirella parallela* and *G. friedli* in Mt. Palenica Lendacka (section *VI*, layer *18*), and the another one (Pl. 39, Fig. 11) in the Lower Liassic of Strążyska Valley (*XI*).

Genus *AUSTROCOLOMIA* Oberhauser, 1960
Austrocolomia sp.
(Pl. 39, Figs 12—13)

Material. — Three poorly preserved specimens.

Association. — *Glomospirella friedli, Frondicularia woodwardi*, and *Glomospira* sp.

Description. — Test straight in axial cross-section, markedly elongate, triangular in outline, chambers semicircular, up to three in number; septum separating chambers rounded and bent forwards; wall calcareous.

Dimensions of the test (in microns): length — c. 300, width — c. 200.

Remarks. — The forms resemble in all their features preserved the genus *Austrocolomia* Oberhauser, common in the Upper Triassic.

Occurrence. — Juráňova Valley (*VII*), Jaworzyna Alp (*VIII*), Stólnia (*XII*), and Mt. Hradok (*XV*). This genus was hitherto unknown from the Tatra Mts.

Genus *FRONDICULARIA* Defrance, 1824
Frondicularia woodwardi Howchin
(Pl. 39, Figs 1—6)

1961. *Frondicularia woodwardi* Howchin; Leischner, p. 26, Pl. 4, Figs 26—30 [*cum syn.*].
1966. *Frondicularia woodwardi* Howchin; Radwański, Pl. 6, Fig. 2; Pl. 34, Fig. 1.
1969. *Frondicularia* cf. *woodwardi* Howchin; Boccaletti & *al.*, Fig. 42e—m.
1970. *Frondicularia woodwardi* Howchin; Salaj & Stranik, Pl. 2, Fig. 8.
1973. *Frondicularia woodwardi* Howchin; Gaździcki & Zawidzka, Pl. 1, Figs 8—9; Pl. 4, Fig. 2.

Material. — Over 150 specimens.

Association. — Most often with *Agathammina austroalpina, Tetrataxis inflata, Nodosaria* sp., *Glomospira* sp., *Glomospirella? pokornyi, G. friedli, G. parallela, Glomospirella* sp. and *Tolypammina?* sp.

Description as given by Leischner (1961).

Dimensions of the test (in microns): length — 200—450, width — 50—100.

Remarks. — General structural plan of the test (test elongate, slightly curved in axial cross-section, consisting of a series 9—11 ellipsoidal chambers) and its size well match the diagnosis of the species *Frondicularia woodwardi* Howchin (*cf.* Leischner 1961).

Occurrence. — In the Tatra Mts this species is fairly common in the Lower and Upper Rhaetian of the sections of Lejowa Valley (*I*), Mt. Mały Kopieniec (*III*), Javorina (*IV*), Mt. Palenica Lendacka (*VI*) — *see* Figs 3, 5, 7, and 9. It is also known from the Upper Rhaetian of Choč nappe from Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973) and from the high-tatric Rhaetian of Mt. Kopieniec Starorobociański and Dolinka za Kiczerem (Radwański 1968).

This species was often reported from Norian — Lower Liassic strata of Northern Limestone Alps (Leischner 1959, 1961; Czurda & Nicklas 1970), Dolomites (Bosellini & Broglio Loriga 1965), Northern Apennines (Boccaletti & *al.* 1969), and from Eastern Atlas in Tunisia (Salaj & Stranik 1970a, b). It was also reported from the Muschelkalk of Western Aquitaine (Cuvillier 1961), from the Anisian of Bavarian Alps (Hagn 1955), and recently from the Upper Anisian of Choč nappe of Mt. Wielkie Koryciska in the Tatra Mts (Gaździcki & Zawidzka 1973).

Family **Duostominidae** Brotzen, 1963
Genus *DIPLOTREMINA* Kristan-Tollmann, 1960
Diplotremina sp.
(Pl. 38, Fig. 10)

Material. — Three poorly preserved specimens.

Association. — Commonly with *Involutina communis*, *I. tumida*, *I. muranica*, *I. impressa*, *I. gaschei*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Miliolipora* sp., and *Tolypammina?* sp., and sometimes with *Agathammina austroalpina*, *Trochammina alpina* and *Planiinvoluta deflexa*.

Description. — Test trochospirally coiled, with circular outline in equatorial section (Pl. 38, Fig. 10). Chambers spirally arranged and increasing in size as added. Large umbilicus observable in axial part.

Dimensions of the test (in microns): diameter — *c.* 300.

Remarks. — The mode of coiling and arrangement of chambers are typical of the genus *Diplotremina* Kristan-Tollmann (*cf.* Kristan-Tollmann 1960). However, scarce and poorly preserved material is not sufficient for specific identification.

Occurrence. — Upper Rhaetian of Lejowa Valley (section *I*, layers *10* and *15*). This genus was previously found in the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

Family **Involutinidae** Bütschli, 1880
Genus *INVOLUTINA* Terquem, 1862, emend. Koehn-Zaninetti, 1968
Involutina communis (Kristan, 1957)
(Pl. 44, Figs 1—5, 7—8)

1969. *Involutina communis* (Kristan); Koehn-Zaninetti, pp. 113—115, Text-figs 28 (excl. *D*, *F*, *J*, *M*), 36 (1—3) [*cum syn.*].
1970. *Involutina communis* (Kristan); Brönnimann, Poisson & Zaninetti, p. 23, Pl. 2, Figs 1—8.
1971. *Involutina communis* (Kristan); Hohenegger & Lobitzer, Pl. 1, Fig. 20; Pl. 3, Fig. 1.
1972b. *Involutina communis* (Kristan); Brönnimann & *al.*, Text-fig. 5 (18—20).
1972. *Involutina communis* (Kristan); Samuel, Borza & Köhler, Pl. 27, Fig. 4.

Material. — Approximately 80 well-preserved specimens.

Association. — Most often with *Involutina gaschei, I. impressa, I. sinuosa sinuosa, I. muranica, I. tumida, Trocholina permodiscoides, T. crassa, Triasina hantkeni*, and sometimes with *Agathammina austroalpina, Trochammina alpina, Frondicularia woodwardi, Glomospirella friedli* and *Tetrataxis inflata*.

Description as given by Kristan (1957) and Koehn-Zaninetti (1969).

Dimensions of the test (in microns): diameter — 700—800, thickness — 350—400.

Remarks. — The forms occurring in sub-tatric Rhaetian are characterized by lenticular test, elliptical axial section with medial swelling, and 6—8 flat, involutely coiled whorls. Such features are typical of the species *Involutina communis* (see diagnoses given by Kristan, 1957, and Koehn-Zaninetti, 1969).

Occurrence. — In the Tatra Mts this species was found in the Lower and Upper Rhaetian of the sections of Lejowa Valley (*I*, layers *4, 6, 10—11, 13, 15, 20—21*, and *24*), Javorina (*IV*, layers *2—3*), and Mt. Palenica Lendacka (*VI*, layers *3, 33*, and *39*). It is also known from the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

The form common in the Upper Norian-Rhaetian of Alpine-Carpathian geosyncline and south-western Asia (*cf.* Kristan 1957; Leischner 1959; Kristan-Tollmann 1964b; Kristan-Tollmann & Tollmann 1964; Cros & Neumann 1964; Oberhauser 1964; Bosellini & Broglio Loriga 1965; Fabricius 1966; Koehn-Zaninetti 1969; Jendrejáková 1970, 1972; Brönnimann & *al.* 1970, 1972b; Hohenegger & Lobitzer 1971; Samuel & *al.* 1972).

Involutina tenuis (Kristan, 1957)
(Pl. 46, Figs 1*a*, 2)

1969. *Involutina tenuis* (Kristan); Koehn-Zaninetti, p. 116, Text-fig. 33 [*cum syn.*].
1970. *Involutina tenuis* (Kristan); Brönnimann, Poisson & Zaninetti, p. 25, Text-fig. 7 (10).
1970a. *Arenovidalina tumida* (Kristan-Tollmann); Salaj & Stranik, Pl. 1, Fig. 5.
1970. *Involutina* aff. *tenuis* (Kristan); Jendrejáková, Pl. 3, Fig. 6.
1972b. *Involutina* cf. *tenuis* (Kristan); Brönnimann & *al.*, Text-fig. 5 (22).
1973. *Involutina tenuis* (Kristan); Gaździcki & Zawidzka, Pl. 5, Figs 4—5.
1973. *Involutina* cf. *tenuis* (Kristan); Gaździcki & Zawidzka, Pl. 5, Figs 6—7.

Material. — Seven specimens.

Association. — Usually with *Involutina communis, I. tenuis, I. tumida, Trocholina permodiscoides*, and occasionally with *Agathammina austroalpina* and *Glomospirella friedli*.

Description as given by Kristan (1957) and Koehn-Zaninetti (1969).

Dimensions of the test (in microns): diameter — 600—800, thickness — 150—200.

Remarks. — The forms are characterized by markedly flattened, discoidal test and strongly elongate axial section (Pl. 46, Fig. 1*a*), typical of the species *Involutina tenuis* (*cf.* Kristan 1957, Koehn-Zaninetti 1969).

Occurrence. — In the Tatra Mts this species was found in the Upper Rhaetian of Lejowa Valley (section *I*, layer *13*) and Lower Rhaetian of Javorina (*IV*, layer *1*). It is also known from the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

This species is known from the Norian-Rhaetian of Slovakia (Salaj & *al.* 1967, Salaj 1969a, Jendrejáková 1970), Austria (Koehn-Zaninetti 1969, Czurda & Nicklas 1970), from the Lower Rhaetian of Djebel Fkirine (Eastern Atlas) in Tunisia (Salaj & Stranik 1970a, b), from the Rhaetian of Austria (Kristan 1957, 1964b), and from the Norian-Rhaetian of Lycian Taurus in Turkey (Brönnimann & *al.* 1970) and Naiband Formation in Iran (Brönnimann & *al.* 1972b).

Involutina impressa (Kristan-Tollmann, 1964)

1969. *Involutina impressa* (Kristan-Tollmann); Koehn-Zaninetti, pp. 118—119, Text-figs 34, 36 (8—11) [*cum syn.*].
1969a. *Semiinvoluta clari* Kristan; Salaj, Pl. 3, Fig. 4.
1969b. *Semiinvoluta clari* Kristan; Salaj, Pl. 2, Fig. 4; Pl. 3, Fig. 1.
1970. *Involutina impressa* (Kristan-Tollmann); Brönnimann, Poisson & Zaninetti, p. 25, Text-fig. 7 (11).
1970a. *Semiinvoluta clari* Kristan; Salaj & Stranik, Pl. 1, Fig. 3; Pl. 2, Figs 4a, 6.
1970a. *Angulodiscus* cf. *impressus* (Kristan-Tollmann); Salaj & Stranik, Pl. 2, Fig. 7b.
1972b. *Involutina* cf. *impressa* (Kristan-Tollmann); Brönnimann & *al.*, Text-fig. 5 (24).
1973. *Involutina impressa* (Kristan-Tollmann); Gaździcki & Zawidzka, Pl. 4, Fig. 7.
1973. *Involutina* cf. *impressa* (Kristan-Tollmann); Gaździcki & Zawidzka, Pl. 4, Fig. 6a.

Material. — Two specimens.

Association. — Occurring exclusively with *Involutina communis*, *I. tumida*, *I. sinuosa sinuosa*, *I. gaschei*, *I. muranica*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina*? sp.

Description as given by Kristan-Tollmann (1964b) and Koehn-Zaninetti (1969).

Dimensions of the test (in microns): diameter — 600—650, thickness — 170—200.

Remarks. — This species was previously reported from sub-tatric (Choč) Rhaetian of the Tatra Mts (*cf.* Gaździcki & Zawidzka 1973; Pl. 4, Fig. 7). The Tatric forms are characterized by axial section elliptical, with distinct medial depression, and by flattened spire, often oscillating and consisting of *c.* 8 involutely coiled whorls. Such features are typical of the species *Involutina impressa* (*cf.* diagnoses given by Kristan-Tollmann, 1964b, and Koehn-Zaninetti, 1969).

Occurrence. — In the Tatra Mts this species was recorded in the Upper Rhaetian of Lejowa Valley (section *I*, layer *15*), and previously in the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

This species in known from the Norian-Rhaetian of Slovakia (Salaj & *al.* 1967; Salaj 1969a, b; Jendrejáková 1970, 1972), Austria (Koehn-Zaninetti 1969), Lycian Taurus in Turkey (Brönnimann & *al.* 1970), and Nalband Formation in Iran (Brönnimann & *al.* 1972b), from the Lower Rhaetian of Djebel Fkirine (Eastern Atlas) in Tunisia (Salaj & Stranik 1970a, b), and from the Rhaetian of Austria (Kristan-Tollmann 1962, 1964b).

Involutina tumida (Kristan-Tollmann, 1964)
(Pl. 44, Fig. 6; Pl. 45, Figs 1—3)

1969. *Involutina tumida* (Kristan-Tollmann); Koehn-Zaninetti, pp. 120—121, Text-fig. 35 (5—9) [*cum syn.*].
1970. *Involutina tumida* (Kristan-Tollmann); Brönnimann, Poisson & Zaninetti, pp. 25—26, Text-fig. 7 (7, 12).
1970. *Angulodiscus tumidus* Kristan-Tollmann; Kristan-Tollmann, Abb. 6, Figs 16—17.
1971. *Involutina tumida* (Kristan-Tollmann); Hohenegger & Lobitzer, Pl. 8, Fig. 4.

Material. — Five specimens.

Association. — *Involutina communis*, *I. tenuis*, *I. tumida*, *I. impressa*, *I. muranica*, *I. gaschei*, *I. sinuosa sinuosa*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Diplotremina* sp. and *Tolypammina*? sp., and sometimes with *Agathammina austroalpina*.

Description as given by Kristan-Tollmann (1964b) and Koehn-Zaninetti (1969).

Dimensions of the test (in microns): diameter — 600—700, thickness — 150—200.

Remarks. — *Involutina tumida* is characterized by lenticular, discoidal shape and margins rounded in axial section (*cf.* Pl. 45, Figs 1—3); it is planispirally coiled into *c.* 8 whorls; some oscillations may be noted in the first phase of coiling;

the youngest whorls are always flat. This form appears somewhat similar to *I. communis* from which it differs in more elongate axial section and in flattened ultimate whorl.

Occurrence.— In the Tatra Mts this species was recorded from the Lejowa Valley (section *I*, layers *13* and *15*). This form was hitherto unknown from the Tatra Mts.

This species is known from the Norian-Rhaetian of Slovakia (Jendrejáková 1972), Austria (Koehn-Zaninetti 1969, Hohenegger & Lobitzer 1971), Lycian Taurus in Turkey (Brönnimann & *al.* 1970), from the Rhaetian of Austria (Kristan-Tollmann 1964b, 1970). Moreover, it was recorded together with *Triasina hantkeni* under the name of *Involutina* cf. *liassica* (Jones)? from the Norian-Rhaetian of Western Dolomites (Bosselini & Broglio Loriga 1965) and was described as *Involutina* sp. *1* from the Rhaetian-Hettangian of Central Dolomites (Cros & Neumann 1964).

Involutina sinuosa sinuosa (Weynschenk, 1956)
(Pl. 47, Figs 1—3)

1969. *Involutina sinuosa sinuosa* (Weynschenk); Koehn-Zaninetti, pp. 121—123, Text-figs 36 (1—3), 37 (3) [*cum syn.*].
1969a. *Aulotortus sinuosus* Weynschenk; Salaj, Pl. 6, Fig. 3.
1970. *Involutina sinuosa sinuosa* (Weynschenk); Brönnimann, Poisson & Zaninetti, p. 23, Pl. 2, Fig. 9 and Text-fig. 7 (1, 4—5).
1970. *Involutina sinuosa sinuosa* (Weynschenk); Jendrejáková, Pl. 3, Fig. 3.
1970. *Aulotortus sinuosus* Weynschenk; Kristan-Tollmann, Abb. 2.
1971. *Involutina sinuosa sinuosa* (Weynschenk); Hohenegger & Lobitzer, Pl. 3, Fig. 2.
1972b. *Involutina sinuosa sinuosa* (Weynschenk); Brönnimann & *al.*, Text-fig. 5 (14—15).
1972. *Involutina ("Aulotortus") sinuosa* (Weynschenk); Gušić & Babić, Pl. 1, Fig. 2 (*pro parte*).
1973. *Involutina ("Aulotortus") sinuosa* (Weynschenk); Babić & *al.*, Pl. 1, Fig. 2 (*pro parte*).

Material. — Ten fairly well-preserved specimens.

Association. — *Involutina communis, I. gaschei, I. tumida, I. impressa, I. muranica, Trocholina permodiscoides, T. crassa, Triasina hantkeni, Diplotremina* sp., *Miliolipora* sp., *Tolypammina?* sp.

Description as given by Weynschenk (1956) and Koehn-Zaninetti (1969).

Dimensions of the test (in microns): diameter — 1,200—1,700, thickness — 700—800.

Remarks. — Large, distinctly subspherical shape of axial section with markedly rounded margins and whorls distinctly oscillating in terminal part of the spire (*cf.* Pl. 47, Figs 1—3) are typical of the subspecies *I. sinuosa sinuosa* (Weynschenk) and separate it from the remaining species and subspecies of the genus *Involutina* Terquem (*cf.* Koehn-Zaninetti 1969). Prior to detailed analysis of that group by Koehn-Zaninetti (1969), this form used to be described under the name *Aulotortus sinuosus*.

Occurrence. — This subspecies, hitherto unknown from the Tatra Mts, was found in the Upper Rhaetian of Lejowa Valley (section *I*, layers *15*, *24* and *34*), Javorina (*IV*, layer *2*), Mt. Palenica Lendacka (*VI*, layer *46*).

It is known from the Upper Carnian of Western Dolomites (Bosellini & Broglio Loriga 1966), from the Norian-Rhaetian of Slovakia (Salaj & *al.* 1967; Salaj 1969a; Jendrejáková 1970, 1972), Austria (Koehn-Zaninetti 1969, Hohenegger & Lobitzer 1971), Lycian Taurus in Turkey (Brönnimann & *al.* 1970), and Naiband Formation in Iran (Brönnimann & *al.* 1972b). This form was also recorded together with *Triasina hantkeni* in the Norian-Rhaetian of Croatia (Gušić & Babić 1972, Babić & *al.* 1973), from the Rhaetian of Austria (Kristan-Tollmann 1964b, 1970;

Papp & Turnovsky 1970), Serbia (Urošević & Anđelković 1970), from the Rhaetian--Hettangian of Dolomites (Cros & Neumann 1964), and Lower Liassic of Dinaric Alps (Radoičić 1966).

Involutina muranica Jendrejáková, 1972

1972. *Involutina muranica* n. sp.; Jendrejáková, pp. 197—200, Text-figs 1—6.
1973. *Involutina muranica* Jendrejáková; Gaździcki & Zawidzka, Pl. 4, Fig. 8.

Material. — Two poorly preserved specimens.

Association. — Cooccurring exclusively with *Involutina communis*, *I. tumida*, *I. sinuosa sinuosa*, *I. gaschei*, *I. impressa*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina?* sp.

Description as given by Jendrejáková (1972).

Dimensions of the test (in microns): diameter — 1,200, thickness — 700.

Remarks. — This form was previously recorded in the sub-tatric (Choč) Rhaetian of the Tatra Mts (*cf.* Gaździcki & Zawidzka 1973; Pl. 4, Fig. 8). It is characterized by deuteroloculus reduced to 2—3 whorls, which markedly differs it from the remaining representatives of the genus *Involutina* Terquem (*cf.* Jendrejáková 1972).

Occurrence. — In the Tatra Mts this species was found in the Upper Rhaetian of Lejowa Valley (section *I*, layer *15*). It was previously found in the Upper Rhaetian of the Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973) and in the Norian-Rhaetian of Slovakia (Jendrejáková 1972).

Involutina gaschei (Koehn-Zaninetti & Brönnimann, 1968) (Pl. 45, Figs 4—9)

1969. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Koehn-Zaninetti, pp. 127—130, Pl. 11, Figs E, F and Text-fig. 38 [*cum syn.*].
1969b. Nov. gen. nov. sp.; Salaj, Pl. 3, Fig. 2.
1970. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Brönnimann, Poisson & Zaninetti, p. 26, Pl. 2, Figs 3—4.
1970. *Involutina* aff. *gaschei* (Koehn-Zaninetti & Brönnimann); Jendrejáková, Pl. 2, Figs 4—5.
1970. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Jedrejáková, Pl. 2, Fig. 6.
1970. *Involutina*; Urošević & Anđelković, Pl. 2, Figs 1—4.
1971. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Hohenegger & Lobitzer, Pl. 3, Fig. 3.
1972. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Gušić & Babić, Pl. 1, Fig. 3.
1972. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Samuel, Borza & Köhler, Pl. 28, Figs 1—6.
1973. *Involutina ("Angulodiscus") gaschei* (Koehn-Zaninetti & Brönnimann); Babić & *al.*, Pl. 1, Fig. 3.
1973. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann); Gaździcki & Zawidzka, Pl. 5, Figs 8—9.
1973. *Involutina* cf. *gaschei* (Koehn-Zaninetti & Brönnimann); Gaździcki & Zawidzka, Pl. 4, Fig. 6b; Pl. 5, Fig. 10.

Material. — About 30 well-preserved specimens.

Association. — Commonly with *Involutina communis*, *I. tumida*, *I. sinuosa sinuosa*, *I. impressa*. *I. muranica*, *Trocholina permodiscoides*, *T. crassa*, *Triasina hantkeni*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina?* sp. and occasionally with *Agathammina austroalpina*, *Trochammina alpina*, *Glomospira* sp., *Glomospirella friedli*, *Frondicularia woodwardi* and *Tetrataxis inflata*.

Description as given by Koehn-Zaninetti & Brönnimann (1968) and Koehn--Zaninetti (1969).

Dimensions of the test (in microns): diameter — 700—800, thickness — 300—400.

Remarks. — *Involutina gaschei* is characterized by lenticular axial section (*cf.* Pl. 45, Figs 4—6), coiling involute, initially irregular (curled-up spire), later planispiral. Because of its similarity in arrangement of whorls, this form may be easily mistaken with *Glomospirella friedli*, from which it differs in size and in thick, finely-perforated wall, typical of involutinids. It differs from the Ladinian-Carnian subspecies *I. gaschei praegaschei* in planispiral ultimate whorl.

Occurrence. — In the Tatra Mts this form was found in the Lower and Upper Rhaetian of Lejowa Valley (section *I*, layers *6*, *11*, *15*, *20*, and *34*), Mt. Palenica Lendacka (*VI*, layers *3*, *33*, and *39*). It is also known from the Upper Rhaetian of the Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973), and from Carnian-Norian of Slovakia (Jendrejáková 1970, 1972). This species was recorded from the Norian-Rhaetian of Alpine-Carpathian geosyncline and south-western Asia (*cf.* Koehn-Zaninetti & Brönnimann 1968a, Koehn-Zaninetti 1969, Salaj 1969b, Brönnimann & *al.* 1970, Urošević & Andelković 1970, Hohenegger & Lobitzer 1971, Samuel & *al.* 1972, Gušić & Babić 1972, Babić & *al.* 1973).

Involutina farinacciae Brönnimann & Koehn-Zaninetti, 1969
(Pl. 47, Fig. 5)

1969. *Involutina farinacciae*, n.sp.; Brönnimann & Koehn-Zaninetti, pp. 76—77, Text-figs 1*C*, 2 (*A*—*G*).
1969. *Aulotortus regularis*, n.sp.; Zuccari, pp. 420—421, Text-figs 1*a*, 2*A*—*D*, *G*.

Material. — Five well-preserved specimens.

Association. — Cooccurring exclusively with "*Vidalina*" *leischneri*, *Involutina* cf. *liassica* and *I.* cf. *turgida*.

Description as given by Brönnimann & Zaninetti (1969), and Zuccari (1969).

Dimensions of the test (in microns): diameter — 350—450, thickness — 200—250.

Remarks. — *Involutina farinacciae* is characterized by umbilical masses composed of numerous pillars, which is typical of post-Triassic involutinids. This form was illustrated by Farinacci (1967; Pl. 3, Figs 5—8) under the name *Semiinvoluta clari* Kristan.

Occurrence. — In the Tatra Mts these forms were found in the Lower Liassic of Strążyska Valley (*XI*). It was hitherto unknown in the Carpathians.

This species was reported from the Lower Liassic of Northern Apennines (Farinacci 1967, Brönnimann & Koehn-Zaninetti 1969), and from the Middle Liassic of Perugia in Italy (Zuccari 1969).

Involutina cf. *turgida* Kristan, 1957
(Pl. 47, Fig. 8)

Material. — Three poorly preserved specimens.

Association. — Cooccurring exclusively with "*Vidalina*" *leischneri*, *Involutina farinacciae*, and *I.* cf. *liassica*.

Dimensions of the test (in microns): diameter — 550—700, thickness — 350—400.

Remarks. — The form figured here shows some features typical of the species *Involutina turgida* Kristan, but scarcity of material and its poor preservation preclude reliable identification.

Occurence. — In the Tatra Mts these forms were found in the Lower Liassic of Strążyska Valley (*XI*).

In the Alpine-Carpathian geosyncline, *Involutina turgida* Kristan is known from the Rhaetian (Kristan 1957; Kristan-Tollmann 1964a, 1970; Kristan-Tollmann & Tollmann 1964; Samuel & *al.* 1972) and from the Liassic (Kristan-Tollmann 1962, Manganelli & Zuccari 1969, Papp & Turnovsky 1970, Gušić & Babić 1972, Babić & *al.* 1973).

Involutina cf. *liassica* (Jones, 1853)
(Pl. 47, Fig. 4)

Material. — Four badly preserved specimens.

Association. — Cooccurring exclusively with *"Vidalina" leischneri*, *Involutina farinacciae* and *I.* cf. *turgida*.

Dimensions of the test (in microns): diameter — 500—600, thickness — 260—300.

Remarks. — Scarce and poorly preserved material make difficult any reliable identification. However, it may be noted that subaxial section figured herein (Pl. 47, Fig. 4) is characterized by lenticulinar shape, tubular deuteroloculus planispirally involutely coiled, and by umbilical masses composed of discrete pillars. Those features make it possible to assign those forms to *Involutina* cf. *liassica*.

Occurrence. — In the Tatra Mts this species is found in the Rhaetian of Juráňova Valley (*VII*) and in the Liassic of Strążyska Valley (*XI*).

In the Alpine-Carpathian geosyncline *Involutina liassica* was occasionally reported from the Rhaetian (Kristan 1957) and fairly often from the Liassic (Hagn 1955; Leischner 1961; Mišík 1961, 1964, 1966; Kristan-Tollmann 1962; Farinacci & Radoičić 1964; Cita 1965; Radoičić 1966; Fabricius 1966; Salaj & *al.* 1967; Brönnimann & *al.* 1970; Gušić & Babić 1972; Babić & *al.* 1973), and also from the Hettangian of Baden-Wuerttembergia (Schloz 1972).

Genus *TROCHOLINA* Paalzow, 1922
Trocholina permodiscoides Oberhauser, 1964
(Pl. 46, Figs 4—5, 7—8)

1964. *Trocholina permodiscoides* nov. sp.; Oberhauser, pp. 207—208, Pl. 2, Figs 13—15, 18, 20, 22; Pl. 3, Fig. 1.
1969. *Trocholina permodiscoides* Oberhauser; Koehn-Zaninetti, pp. 137—139, Pl. 12, Fig. *A* and Text-fig. 27 (1—3, 5).
1969b. *Trocholina (Trochonella) permodiscoides* Oberhauser; Salaj, Pl. 4, Fig. 1e.
1970. *Trocholina permodiscoides* Oberhauser; Brönnimann, Poisson & Zaninetti, p. 30, Text-fig. 7 (2—3).
1972b. *Trocholina permodiscoides* Oberhauser; Brönnimann & *al.*, Text-fig. 5 (25—49).
1973. *Trocholina permodiscoides* Oberhauser; Gaździcki & Zawidzka, Pl. 6, Fig. 2.

Material. — Thirty well-preserved specimens.

Association. — Commonly with *Involutina communis*, *I. tumida*, *I. sinousa sinousa*, *I. gaschei*, *I. impressa*, *I. muranica*, *Trocholina crassa*, *Triasina hantkeni*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina?* sp., and occasionally with *Agathammina austroalpina*, *Glomospirella friedli*, *G. parallela* and *Glomospirella? pokornyi*.

Description as given by Oberhauser (1964).

Dimensions of the test (in microns): diameter of the base — 1,000—1,200, height — 500—600.

Remarks. — This species differs from the remaining species of the genus *Trocholina* in test conical in vertical section, obtuse (over 130°) apical angle, and long diameter of base. The test is trochospirally coiled in to 5—8 whorls.

Occurrence. — In the Tatra Mts this species was recorded in the Upper Rhaetian of Lejowa Valley (section *I*, layers *11*, *13*, and *28*), Javorina (*IV*, layer *2*), Mt. Palenica Lendacka (*VI*, layer *46*), and also in the Upper Rhaetian of the Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973). It was also reported from the Upper Norian — Rhaetian of Slovakia (Salaj & *al.* 1967; Salaj 1969a, b; Jendrejáková 1970, 1972).

This species cooccurs with *Triasina hantkeni* in the Upper Norian of Northern Alps (Oberhauser 1964), the Norian-Rhaetian of Dolomites (Bosellini & Broglio Loriga 1965), in the Rhaetian of Lower Austria (Oberhauser & Plöchinger 1968), the Norian-Rhaetian of Lycian Taurus in Turkey (Brönnimann & *al.* 1970) and in the Upper Norian — Lower Rhaetian of Naiband Formation in Iran (Brönnimann & *al.* 1972b).

Trocholina crassa Kristan, 1957

1957. *Trocholina (Trochonella) crassa* n.sp.; Kristan, pp. 285—286, Pl. 24, Figs 5—11.
1964. *Trocholina (Trochonella) crassa* Kristan; Kristan-Tollmann & Tollmann, p. 552, Pl. 4, Figs 3—6; Pl. 5, Fig. 10.
1964b. *Trocholina (Trochonella) crassa Kristan*; Kristan-Tollmann, pp. 142—143, Pl. 4, Figs 5—10.
1971. *Trocholina crassa* Kristan; Hohenegger & Lobitzer, Pl. 1, Fig. 19.
1973. *Trocholina crassa* Kristan; Gaździcki & Zawidzka, Pl. 6, Fig. 1.

Material. — Seven well-preserved specimens.

Association. — Commonly with *Involutina communis*, *I. tumida*, *I. sinuosa sinuosa*, *I. gaschei*, *I. muranica*, *I. impressa*, *Trocholina permodiscoides*, *Triasina hantkeni*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina?* sp., and sometimes with *Glomospira tenuifistula*, *Glomospirella friedli*, *Agathammina austroalpina*, *Tetrataxis inflata* and *Frondicularia woodwardi*.

Description as given by Kristan (1957).

Dimensions of the test (in microns): diameter of the base — 800—850, height — 500—550.

Remarks. — This form was recently reported from sub-tatric (Choč) Rhaetian of the Tatra Mts (*cf.* Gaździcki & Zawidzka 1973; Pl. 6, Fig. 1). *Trocholina crassa* is characterized by conical test with markedly rounded apex, and trochospiral coiling into *c.* 6 whorls. It differs from *Trocholina permodiscoides* in more slender shape of vertical section and lower apical angle (not greater than 100°).

Occurrence. — In the Tatra Mts this species was recorded in the Lower and Upper Rhaetian of Lejowa Valley (section *I*, layer *15*), Mt. Palenica Lendacka (*VI*, layer *33*). It was previously found in the Upper Rhaetian of the Choč nappe at Mt. Siwiańskie Turnie (Gaździcki & Zawidzka 1973).

This species is known from the Norian of Slovakia (Jendrejáková 1970, 1972) and Rhaetian of Austria (Kristan 1957, Kristan-Tollmann 1964b, Kristan-Tollmann & Tollmann 1964, Oberhauser & Plöchinger 1968).

Genus *TRIASINA* Majzon, 1954
Triasina hantkeni Majzon, 1954
(Pl. 48, Figs 1—2; Pl. 49, Figs 1—6)

1954. *Triasina hantkeni* nov. sp.; Majzon, p. 245, Pl. 1, Figs 1—2; Pl. 2, Figs 3—5; Pl. 3, Fig. 6.
1954. *Triasina hantkeni* nov. sp. var. *elliptica*; Majzon, p. 245, Pl. 3, Fig. 7.
1955. *Involutina liasina* (Jones); Hagn, Pl. 14, Fig. 1 (*pro parte*).
1959. *Pseudolacazina?*; Agip Min., Microfacies italiane, Pls 30—31, 39.

1963. ?*Triasina* sp.; Widenmayer, p. 579, Text-fig. 19b.
1964. *Triasina hantkeni* Majzon; Cros & Neumann, pp. 129—130, Pl. 2, Figs 1—5.
1964. *Trasina hantkeni* Majzon; Loeblich & Tappan, p. C 484, Text-figs. 372 (1—3).
1964. *Triasina* cf. *hantkeni*; Oberhauser, p. 209, Pl. 3, Figs 2—7.
1964. *Triasina* (?*hantkeni* Majzon); S. Végh, Pl. 1, Figs 3—4.
1964. *Triassina hantkeni* Majzon; Farinacci & Radoičić, Pl. 2, Fig. 1.
1965. *Triasina hantkeni* Majzon; Bosellini & Broglio Loriga, p. 173, Pl. 2, Figs 3—7.
1966. *Triassina hantkeni* Majzon; Radoičić, Pl. 57, Figs 1—2.
1966. *Triasina hantkeni* Majzon; Fuganti & Mosna, pp. 88—90, Pl. 4, Figs 12, 14; Pl. 5, Figs 15—16.
1966. *Triasina hantkeni* Majzon; Fabricius, Pl. 4, Fig. 1.
1966. *Triasina hantkeni* Majzon; Koehn-Zaninetti & Brönnimann, pp. 83—87, Text-figs 1—7.
1967. *Triasina hantkeni* Majzon; Pantić, Pl. 8, Figs 7—8.
1967. *Triasina hantkeni* Majzon; Neumann, p. 170, Pl. 31, Figs 1—6.
1967. *Triasina hantkeni* Majzon; Salaj, Biely & Bystrický, Pl. 6, Fig. 2.
1968. *Triasina hantkeni* Majzon; Oberhauser & Plöchinger, Pl. 1, Fig. 3.
1969. *Triasina hantkeni* Majzon; Salaj, p. 126, Pl. 4, Fig. 4.
1970. *Triasina hantkeni* Majzon; Gaździcki, pp. 105—110, Pls 1—4.
1970. *Triasina hantkeni* Majzon; Kristan-Tollmann, Abb. 3.
1970. *Triasina hantkeni* Majzon; Papp & Turnovsky, Pl. 28, Fig. 1; Pl. 29, Figs 1—2; Pl. 30, Figs 1—4; Pl. 32, Fig. 3.
1971. *Triasina hantkeni* Majzon; Zaninetti & Brönnimann, Pl. 10, Figs 3, 6, 9, 12.
1972. *Triasina hantkeni* Majzon; Gušić & Babić, Pl. 1, Figs 1—2.
1972. *Triasina hantkeni* Majzon; Samuel, Borza & Köhler, Pl. 27, Figs 1—2.
1973. *Triasina hantkeni* Majzon; Gaździcki & Zawidzka, Pl. 3, Figs 1—4; Pl. 6, Figs 3—4.
1973. *Triasina hantkeni* Majzon; Babić & *al.*, Pl. 1, Figs 2, 4.

Material. — Over 300 well preserved specimens; sometimes of rock-building importance (*cf.* Pl. 48, Figs 1—2).

Association. — Commonly with *Involutina communis*, *I. tumida*, *I. sinuosa sinuosa*, *I. gaschei*, *I. impressa*, *I. muranica*, *Trocholina permodiscoides*, *T. crassa*, *Diplotremina* sp., *Miliolipora* sp. and *Tolypammina?* sp., and occasionally with *Agathammina austroalpina*, *Frondicularia woodwardi*, *Tetrataxis inflata*, *Glomospira* sp. and *Glomospirella friedli*.

Description as given by Majzon (1954; *cf.* Gaździcki 1970).

Dimensions of the test (in microns): diameter — 1,000—1,200, thickness — 600—800.

Remarks. — Majzon (1954) placed the species *Triasina hantkeni* in the family Peneroplidae, Cros & Neumann (1964) — in Lituolidae, Oberhauser (1964) — in Archaediscidae, and Koehn-Zaninetti (1969) — in Involutinidae. Recent studies by Koehn-Zaninetti & Brönnimann (1966, 1968b) and Koehn-Zaninetti (1969) give evidence in favour of allocation of the genus *Triasina* in the family Involutinidae Bütschli, 1880. This was confirmed by the finding of *Triasina oberhauseri* Koehn-Zaninetti & Brönnimann, a transitional form between involutinids and *Triasina hantkeni*. It should be noted that the existence of those forms was inferred previously by Oberhauser (1964, Abb. 1) on theoretical grounds.

Occurrence. — In the Tatra Mts this species was found in the Upper Rhaetian of Križna nappe of Lejowa Valley (section *I*, layers *10—11*, *15*, *17*, and *34*), Javorina (*IV*, layer *2*), Mt. Palenica Lendacka (*VI*, layers *42*, *44*, *46*, and *48*) and also in the Upper Rhaetian of Choč nappe at Mt. Siwiańskie Turnie and Mt. Małe Koryciska (Gaździcki & Zawidzka 1973). This form was also reported from numerous localities in Europe and North Africa.

This species is known from the Upper Norian of Austria (Oberhauser 1964), from the Norian-Rhaetian of Hungary (Majzon 1954), Croatia (Gušić & Babić 1972, Babić & *al.* 1973), Dolomites (Bosellini & Broglio Loriga 1965), from the Rhaetian of Rif Mts in Marocco (Raoult 1962), Northern Italy (Agip Mineraria 1959, Fuganti & Mosna 1966), Lombardian Alps (Wiedenmayer 1963), Serbia (Pantić 1967, Pantić & Rampnoux 1972), Austria (Oberhauser & Plöchinger 1968, Kristan-Tollmann 1970, Papp & Turnovsky 1970), Slovakia (Salaj & *al.* 1967, Salaj 1969a, b, Samuel & *al.*

1972), from the Rhaetian-Hettangian of Dolomites (Cros & Neumann 1964) and Northern Limestone Alps (Fabricius 1966), and from the Lower Liassic of Northern Limestone Alps (Hagn 1955) and Vojnik Mts in Jugoslavia (Farinacci & Radoičić 1964, Radoičić 1966).

Conclusions on foraminifers

Among the presented foraminifers the representatives of the families Ammodiscidae and Involutinidae markedly predominate. These families are characterized by remarkable differentiation and are widely distributed in Upper Triassic strata of the Tethys geosyncline (Kristan--Tollmann 1963; Salaj, Biely & Bystrický 1967; Koehn-Zaninetti 1969;

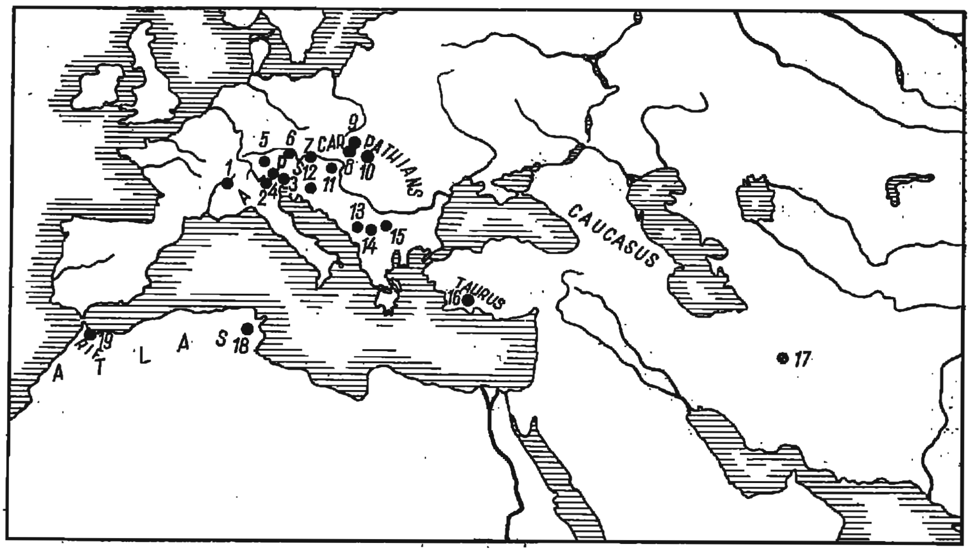


Fig. 11

Geographical distribution of the foraminifer family Involutinidae Bütschli in the Rhaetian deposits of the Tethys Ocean

1 Haute Savoie, France (Brönnimann & *al.* 1969); *2* Tovel-Amblar, Italy (Fuganti & Mosna 1966); *3* Lovinzola (Udine), Italy (Agip Mineraria 1959); *4* Dolomites (Cros & Neumann 1964, Bosellini & Broglio Loriga 1965); *5* Bavarian Alps (Hagn 1955, Oberhauser 1964, Fabricius 1966); *6* Upper Austria (Oberhauser 1964, Koehn-Zaninetti & Brönnimann 1968a, b; Koehn-Zaninetti 1969); *7* Lower Austria (Kristan 1957, Kristan-Tollmann 1962, 1964b, 1970; Oberhauser & Plöchinger 1968); *8* Hybe, Slovakia (Salaj & *al.* 1967, Salaj & Jendrejáková 1967, Salaj 1969a, b); *9* Tatra Mts, Poland (Gaździcki 1970, Gaździcki & Zawidzka 1973); *10* Slovakian Karst and Muráň-Plateau; Slovakia (Salaj & *al.* 1967, Salaj 1969a, Jendrejáková 1970, 1972); *11* Bakony Forest, Gerecse and Vértes Mts; Hungary (Majzon 1954, Vadász 1960, E. Végh-Neubrandt 1960, E. Végh-Neubrandt & Oravecz 1960, Oravecz & E. Végh-Neubrandt 1962, S. Végh 1964); *12* Mt. Medvednica, Croatia (Gušić & Babić 1972, Babić & *al.* 1973); *13* Tara Mts, Serbia (Pantić 1967); *14* Golija, Mihajlovići and Durmitor; Serbia (Pantić & Rampnoux 1972); *15* Senokos and Rosomač, Serbia (Urošević & Andelković 1970); *16* Lycian Taurus, Turkey (Brönnimann & *al.* 1970); *17* Kuh-e-Naiband, Iran (Brönnimann & *al.* 1972b); *18* Djebel Fkirine, Tunisia (Salaj & Straník 1970a, b); 19 Rif Mts, Marocco (Raoult 1962)

Salaj & Stranik 1970a, b; Brönniman & *al.* 1970, 1972b; Pantić & Rampnoux 1972). Special stratigraphic and paleogeographic importance is attributed to the family Involutinidae Bütschli (*cf.* Fig. 11; and Scheibnerová 1971, Gaździcki & Zawidzka 1973). It was found that evolution of the representatives of that family underwent acceleration in the Late Triassic times (*cf.* Koehn-Zaninetti 1969, Text-fig. 21), which resulted in an increase of their value as index fossils (*see* Salaj 1969a, b; Jendrejáková 1973; *see* also chapter on stratigraphy). It should also be noted that the majority of Involutinidae recede at the Rhaetian/Liassic boundary and only single forms are reported from the Liassic and younger strata.

SPONGE SPICULES

In the strata studied, calcareous sponge spicules are occasionally found, which results from the scarcity of sponges in that sedimentary environment. The spicules were found in sections of Lejowa Valley (*I*, layers *10* and *17*) and Mt. Palenica Lendacka (*VI*, layer *33*). The sponge material primarily comprises monaxons and triactines, up to 1 mm long. Identical forms were recorded from the Norian-Rhaetian Dachstein Limestone (Zankl 1965) and from other series of the Alpine Triassic (Mostler 1971, 1972).

SMALL GASTROPODS

Small gastropods found here are represented by internal moulds, markedly elongate, trochospirally coiled, and consisting of 3—4 whorls (*see* Pl. 51, Figs 5—8). The moulds are 0.5—1.4 mm long (high), 0.3—0.7 mm wide; apical angle does not exceed 50°. These forms are particularly numerous in section of Juráňova Valley (*VII*) and Mt. Hradok (*XV*).

OSTRACODES

Ostracodes are fairly common, particularly in various biomicrites and biosparites, as well as in exclusively micrite and sandy limestones (*cf.* Figs 3—5, 7—9). However, their shells are usually heavily sparitized (Pl. 33, Figs 7—8), which precludes identification. Attempts to free the shells from carbonate matrix by means of acetic acid were not successful. It should be noted that ostracodes have recently been recognized as of remarkable importance for stratigraphy of the Rhaetian (*cf.* Urlichs 1972).

HOLOTHUROIDS

Holothurian sclerites were occasionally found in brachiopod and pelecypod (*Megalodon*) biomicrites from Javorina (section *IV*, layer *2*), Mt Palenica Lendacka (*VI*, layers *33* and *37*), Juráňova Valley (*VII*), Mt. Gładkie Upłaziańskie (*IX*), Mt. Hradok (*XV*). Thin sections display only single sections of sclerites (*see* Pl. 15, Figs 1—3). These forms belong to the genus *Theelia* Schlumberger, 1890, common in the Triassic (*cf.* Zankl 1965, 1966; Czurda & Nicklas 1970; Zawidzka 1971; Oravecz-Scheffer 1972). The are of 0.15—0.20 mm in diameter, and their spokes are 0.010 mm wide. Better preserved forms appear to be somewhat similar to *Theelia variabilis* Zankl, described from the Rhaetian of the Northern Limestone Alps (Zankl 1966).

FISHES

Fish remains, reported already by Goetel (1917), are represented by small teeth (Pl. 51, Figs 9—10) and elasmobranch shagreen (Pl. 51, Figs 11—13). They are fairly common in various deposits of the sections studied (*cf.* Figs 3—5, 7—9), and are particularly abundant in Mt. Hradok section (*XV*).

Teeth, usually poorly preserved, represent apical parts of crowns, up to 1.0 mm in size.

Elasmobranch shagreen ("*Nurrella*" sp.) are characterized by relatively wide, usually ornamented petaloidal base (Pl. 51, Figs 12—13), 0.4—0.6 mm in diameter, and by tripartite lamina separated from the base by a constricted neck; lamina is 0.3—0.5 mm wide, and the whole shagreen is 0.6—0.8 mm high. The terminology is accepted here after Pomesano Cherchi (1967, Fig. 3); however, it should be noted that forms from the Muschelkalk of NW Sardinia, described under the generic name *Nurrella* were misinterpreted by that author as conodonts.

The forms analysed here (Pl. 51, Figs 11—13) are fairly common in the Triassic and were often reported as placoidal scales (*cf.* Wilczewski 1967, Pl. 13, Figs 1—7).

COPROLITES

Coprolites are found in some of the strata studied (*cf.* Gaździcki 1974b). The forms figured here (Pl. 7, Fig. 2; Pl. 52, Figs 1—7) were found in *Megalodon* limestones from Mt. Mały Kopieniec (section *III*, layer *2*), where they occur in masses and can be seen on rock surface with naked eye. Coprolites were freed from carbonate matrix also with acetic acid.

The forms are assigned to the genus *Bactryllium* Heer (*cf.* Allasinaz 1968) despite partial reduction of ornamentation of their external surface. It should be noted that *Bactryllium elongatum* sp. n. (Pl. 52, Fig. 7), with completely smooth external surface has some features in common with the forms described in the literature under the name *Coprolus* (*cf.* Mayer 1952, 1956; Gramann 1966).

The coprolites described here closely resemble some pelecypod fecal pellets (*cf.* Moore 1931, Cox 1969), and it may be assumed that they were produced by pelecypods. Mass occurrence of the coprolites was found in *Megalodon* limestones in which the *Megalodon* associations were interpreted as buried in life position (*cf.* Gaździcki 1971). Thus, it may be assumed that the discussed coprolites were produced by those very pelecypods. The recognized coprolites are assigned to new species, viz. *Bactryllium ornatum* sp. n. and *B. elongatum* sp. n.

Genus *BACTRYLLIUM* Heer, 1853
Bactryllium ornatum sp. n.
(Pl. 52, Figs 1*a*, 2—6)

Holotype: the specimen presented in Pl. 52, Fig. 5.
Type horizon: Lower Rhaetian.
Type locality: Mt. Mały Kopieniec (section *III*, layer *2*), Tatra Mts.

Derivation of the name: Latin *ornatum* — ornamented, on account of ornamented external surface.

Diagnosis. — Form commonly straight, cylindrical, somewhat flattened, with 8—10 transversal furrows.

Material. — Approximately 50 well-preserved specimens.

Dimensions (in *mm*): length — 1.54—2.20; thickness — 0.22—0.45.

Description. — Form relatively short, cylindrical, commonly straight, somewhat flattened "ventro-dorsally", rounded at both ends. Transversal furrows, somewhat oblique, 8—10 in number, clearly visible (Pl. 52, Fig. 5). Longitudinal furrows obscure.

Remarks. — The forms differ from all the remaining species of the genus *Bactryllium* Heer in reduced number of transversal furrows and in the lack of evident longitudinal furrows. It should be noted that these forms appear to be somewhat similar to *Bactryllium* sp. described by Allasinaz (1968, Pl. 76, Fig. 16a, b; Text-fig. 20) from the Rhaetian of northern Italy. The latter are also characterized by reduction in ornamentation of external surface.

Occurrence. — Known from the type locality only.

Bactryllium elongatum sp. n.
(Pl. 52, Figs 1b, 7)

Holotype: the specimen presented in Pl. 52, Fig. 7.
Type horizon: Lower Rhaetian.
Type locality: Mt. Mały Kopieniec (section *III*, layer 2), Tatra Mts.
Derivation of the name: Latin *elongatum* — elongate, on account of relatively elongate shape.

Diagnosis. — Form cylindrical, markedly elongate, somewhat flattened, arcuate or bent in *S*-like manner; external surface smooth.

Material. — About 10 well-preserved specimens.

Dimensions (in *mm*): length — 2.85—3.52; thickness — 0.44—0.53.

Description. — Form relatively large, cylindrical, markedly elongate (Pl. 52, Fig. 7) and commonly arcuate or bent in *S*-like manner; it is rounded on both ends, but some "ventro-dorsal" flatness may be noted. External surface smooth [*except for the traces of corrosion on the specimens figured*].

Remarks. — *Bactryllium elongatum* sp. n. differs from *B. ornatum* sp. n. in a larger, markedly elongate shape, and in lack of any ornamentation of external surface. Those features together with lack of longitudinal furrows separate that species from all the remaining species of the genus *Bactryllium* Heer.

Occurrence. — Known from the type locality only.

STRATIGRAPHY

The stratigraphy of the Rhaetian stage has been the subject of numerous discussions since the time when Gümbel (1861) distinguished "*Rhaetische Gruppe*" in the Alps. Stratigraphy of this stage is usually based on various ammonite zonations (*cf.* Slavin 1961; Tozer 1967; Silberling & Tozer 1968; Pearson 1970; Kozur 1972; Wiedmann 1972, 1973). However, no ammonites were found in the sub-tatric (Križna) Rhaetian, the stratigraphy of which was based on foraminifers, whose importance for the Triassic stratigraphy is constantly increasing (*cf.* Salaj 1969a, b, Koehn-Zaninetti 1969).

Foraminifer zonation

Detailed analysis of foraminifer succession in the strata studied (*cf.* Figs 3—5, 7—9) made it possible to distinguish herein the foraminifer zones on the basis of appearance or disappearance of characteristic forms or their associations (Fig. 12). This zonation follows suggestions made by Salaj (1969a). More complete analytic and comparative sections than those studied by Salaj (1969a) and a detailed analysis of more recent literature made it possible to define zone boundaries and to distinguish the *leischneri* Zone, the lowermost zone of the Liassic (*cf.* Gaździcki 1974a).

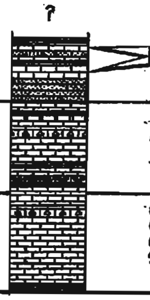
Stage	Substage	Zone	Sub-tatric sequence: Profiles:	Foraminifer assemblages:
Hettangian		- - - - ? - - - - - leischneri	? 	"Vidalina" leischneri Involutina farinacciae Involutina liassica Involutina turgida
Rhaetian	Upper	hantkeni		Triasina hantkeni Trocholina permodiscoides Alpinophragmium perforatum Planiinvoluta deflexa
	Lower	pokornyi & friedli		Glomospirella friedli Glomospirella parallela Glomospirella? pokornyi Trochammina alpina

Fig. 12

Foraminifer zonation in the sub-tatric Rhaetian and lowermost Hettangian of the Tatra Mts

1. *Glomospirella? pokornyi* & *Glomospirella friedli* Zone

Assemblage zone; Lower Rhaetian

Definition: *Glomospirella? pokornyi* occurring together with *G. friedli* or alone; or *G. friedli* occurring alone in the absence of *Triasina hantkeni*.
Lower boundary: Defined by the first appearance of *Glomospirella? pokornyi* or *Glomospirella friedli*.
Upper boundary: First appearance of *Triasina hantkeni*.

The *pokornyi* & *friedli* Zone, defined as above, comprises Angulodiscus pokornyi and "Glomospirella" friedli zones *sensu* Salaj (1969a).

However, the *pokornyi* Zone *sensu* Salaj (*cf.* Salaj 1969a, Table 1) comprised both the lowermost Rhaetian and the whole Upper Norian (Sevatian). So wide downward range of this zone seems to be incorrect, as *Glomospirella? pokornyi* (Salaj) is known from the Lower Rhaetian only (*cf.* subchapter on foraminifers). It should be noted that Salaj defined the lower boundary of this zone by the first appearance of this taxon. Thus, it may be accepted that the A. pokornyi Zone *sensu* Salaj (1969a) comprises only the Lower Rhaetian rather than both the Lower Rhaetian and Upper Norian. In some sections (*cf.* Figs 7 and 9) *Glomospirella friedli* appears before *G.? pokornyi*, so it is not certain whether or not *G.? pokornyi* actually precedes *G. friedli*, as commonly stated in literature (Salaj 1969a). Recently, *G. friedli* was reported from the supposed Upper Norian of Almtal region in Austria (Koehn-Zaninetti 1969) and from Naiband Formation in Iran (Brönnimann & *al.* 1972b), whereas *G.? pokornyi* is known not to appear before the Lower Rhaetian (*see* above). It should be noted that the latter is known from the West Carpathians and Eastern Atlas Mts, whereas the former is characterized by much wider geographic range. Here, the A. pokornyi and G. friedli zones proposed by this author are joined into one, the *pokornyi & friedli* Zone.

Geographic distribution. — West Carpathians (Salaj & *al.* 1967, Salaj 1969a, b), Austria (Kristan-Tollmann 1962, Koehn-Zaninetti 1969), Serbia (Urošević & Anđelković 1970), Taurus (Brönnimann & *al.* 1970), Eastern Atlas Mts (Salaj & Stranik 1970a, b).

2. *Triasina hantkeni* Zone

Range Zone; Upper Rhaetian

Definition: The range of this zone is defined by stratigraphic range of the species *Triasina hantkeni.*

The lower boundary of the *hantkeni* Zone is delineated in accordance with the definition given by Salaj (1969a), *i.e.* it is defined by the first appearance of *Triasina hantkeni.* Salaj (1969a) defined the upper boundary of this zone by the first appearance of *Involutina liassica* (Jones). However, the latter species is also known from the Rhaetian (Kristan 1957, Koehn-Zaninetti 1969), whereas the former does not enter the Liassic. The species *Triasina hantkeni* was occasionally reported from the Lower Liassic (*cf.* subchapter on foraminifers). However, those records are disputable, as cooccurring foraminifers from these localities (e.g. *Glomospirella friedli*) are also indicative of Rhaetian age (*cf.* Salaj 1969b). Thus, it may be accepted that *Triasina hantkeni* persists up to the end of the Rhaetian. If it is the case, then it seems unnecessary to draw the upper boundary of the *hantkeni* Zone in the way Salaj (1969a) proposed. That would be another boundary within the Rhaetian section.

However, when we accept the point of disappearance of *Triasina hantkeni* as defining upper boundary of this zone, such boundary would roughly correspond to the Rhaetian/Hettangian boundary. Accurate relations between the upper boundary of the *hantkeni* Zone and the Rhaetian/Hettangian boundary will be known when the foraminifer and orthostratigraphic ammonoid zonations will be reliably correlated. It should be noted that *Triasina hantkeni* disappears in upper parts of the sections studied before the end of sedimentation of the Rhaetian facies (*cf.* Figs 3, 7, 9). It is difficult to state whether this phenomenon is related to actual disappearance of this species or to a change in environmental, and therefore ecological conditions.

Geographic distribution. — Tatra Mts (Gaździcki 1970, Gaździcki & Zawidzka 1973), Slovakia (Salaj & *al.* 1967, Salaj 1969a, b), Hungary (Majzon 1954), Austria (Oberhauser 1964, Kristan-Tollmann 1970, Papp & Turnovsky 1970), Dolomites (Bosellini & Broglio Loriga 1965), Croatia (Gušić & Babić 1972), Serbia (Pantić & Rampnoux 1972).

3. "*Vidalina*" *leischneri* Zone

Range zone; Lower Liassic

Definition: The range of this zone is defined by stratigraphic range of the species "*Vidalina*" *leischneri*. This zone is also characterized by the association of index species with *Involutina farinacciae*, *I. liassica*, and *I. turgida*.

In the Tatra Mts, the index species of the zone was found in sections of Lejowa (*I*) and Strążyska (*XI*) valleys, about 10 m above the uppermost bed with *Triasina hantkeni*. Review of literature also shows that "*Vidalina*" *leischneri* seems to be confined to the Lower Liassic (Cita 1965, Papp & Turnovsky 1970, Brönnimann & *al.* 1970, Gušić & Babić 1972, Babić & *al.* 1973). In a borehole drilled in the Vienna area this species was found in core sample yielding *Arietites* sp., an ammonite typical of the Lower Liassic (*cf.* Kristan-Tollmann 1962).

Geographic distribution. — Austria (Kristan-Tollmann 1962, Papp & Turnovsky 1970), Southern Alps (Cita 1965), Croatia (Gušić & Babić 1972, Babić & *al.* 1973), Taurus (Brönnimann & *al.* 1970).

Some problems of chronostratigraphic boundaries

The above foraminifer zonation made it possible to distinguish the Lower and Upper Rhaetian: the *pokornyi & friedli* Zone corresponds to the Lower Rhaetian, whereas the *hantkeni* Zone — to the Upper Rhaetian. Moreover, an attempt was mode to delineate the Norian /Rhaetian and Rhaetian/Hettangian boundaries.

Norian/Rhaetian boundary

In sections studied (*cf.* Figs 3—5, 7—9) the base of the Rhaetian is defined by the first appearance of the species indicative of the *pokornyi & friedli* Zone. The underlying strata are tentatively regarded as being of Norian age. It should be noted that these underlying Norian strata are developed in the Rhaetian facies. Thus the lowermost part of "lithological" Rhaetian is placed in the Norian.

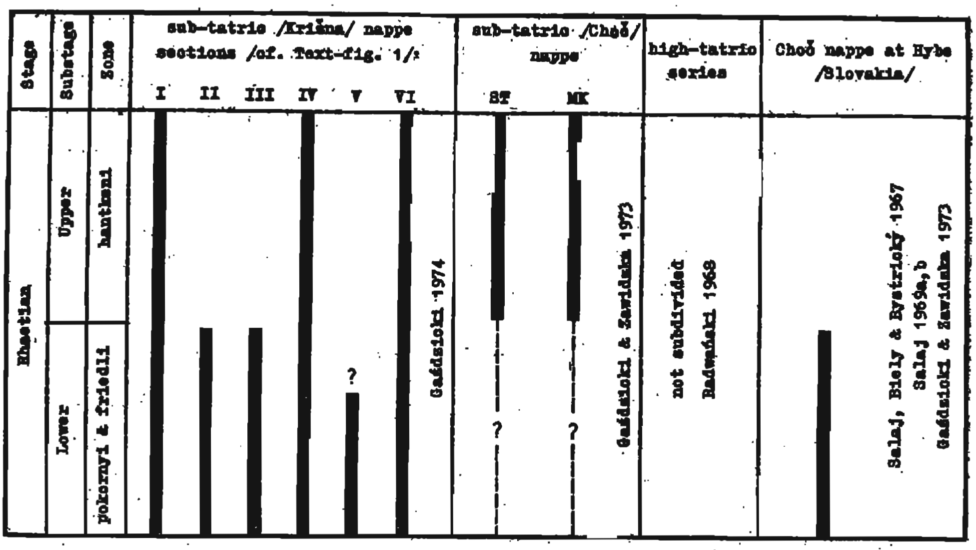
Rhaetian/Hettangian boundary

The uppermost bed yielding *Triasina hantkeni*, the species typical of the Upper Rhaetian, and the lowermost bed with *"Vidalina" leischneri*, typical of the Lower Liassic, are separated by about 10 m series without any foraminifers (*cf.* Fig. 12). This precludes any more accurate delineation of that boundary, and the discussed 10 m series is tentatively regarded as interval of correlation error.

All the presented boundaries are of chronostratigraphic character, and therefore they are to be tentative until they are correlated with orthostratigraphic ammonoid zonation.

Correlation of the sub-tatric Rhaetian

The foraminifer zones distinguished (*cf.* Fig. 12) made it possible to correlate the Rhaetian sections from various tectonic units in the Tatra Mts and neighboring areas (Fig. 13). The analysis showed that in the sub-tatric (Križna) nappe the complete Rhaetian (whole Lower and Upper Rhaetian) is displayed by sections from Lejowa Valley (*I*), Javo-



ST – Mt. Siwiańskie Turnie MK – Mt. Małe Koryciska

Fig. 13

Correlation of particular Rhaetian sections from various tectonic units in the Tatra Mts and neighboring regions rina (*IV*), and Mt. Palenica Lendacka (*VI*), whereas sections of Mt. Mała Świnica (*II*), Mt. Mały Kopieniec (*III*), and Szeroka Bielska Pass (*V*) display only the Lower Rhaetian. In the sub-tatric (Choč) nappe, sections of Mt. Siwiańskie Turnie and Mt. Małe Koryciska display the Upper Rhaetian and presumably Lower Rhaetian (*cf.* Gaździcki & Zawidzka 1973), whereas Hybe section (Kössen facies) in Slovakia represents the Lower Rhaetian only (*cf.* Salaj 1969a, b, Gaździcki & Zawidzka 1973). The lack of foraminifers in high-tatric Rhaetian (Radwański 1968) precludes its subdivision.

FACIAL DEVELOPMENT

The sub-tatric (Križna) Rhaetian sequence comprises carbonate sediments with clay-marly intercalations (*cf.* Figs 3—5, 7—9). The carbonate sediments are represented by various organodetrital limestones, lumachelles (brachiopod-pelecypod), coral and some pelitic (micrite) limestones, as well as and occasionally by dolomitic limestones and dolomites. These sediments are usually distinctly bedded (*cf.* Pl. 5, Fig. 1). Such carbonate series corresponds to the "Carpathian facies" of the Rhaetian (*cf.* Goetel 1917, Kochanová 1967, Čepek 1970). Clastic sediments are represented by claystones, siltstones, and sometimes by sandstones. The Rhaetian sediments are separated into a few main facies, which will be briefly characterized below.

Coral facies

The coral facies is represented by a series of commonly thick--bedded coral ("*Lithodendron*") limestones (*cf.* Uhlig 1897), represented in almost all sections studied (*cf.* Figs 3—5, 8—9). Corals occurring in these limestones are represented by the genera *Retiophyllia*, *Pamiroseris*, and *Astraeomorpha*, and they form numerous separate branched or groundling clusters of the biohermal type (*cf.* Pl. 1, Fig. 2). Coral clusters did not undergo destruction by mechanical factors (*e.g.*, by wave action) and the corals occur in their life position. The mode of development of coral colonies, the *Megalodon* assemblages occurring nearby, and the lack of calcareous sponges seem to indicate that sediments of this facies were presumably deposited in the back reef zone (*cf.* Zankl 1969, 1971).

Brachiopod facies

The brachiopod facies is represented by dark-gray brachiopod limestones and lumachelles. These strata are characterized by mass occurrence of *Rhaetina gregaria* which sometimes form the lumachelles (Pl. 23, Figs 1—4). Single spiriferins and rhynchonellids are also found. Brachiopod facies is fairly common in the sections studied (*cf.* Figs 3—5, 7—9), and brachiopod shells are sometimes crushed, which indicates increase of wave action or longer transport. Almost all brachiopod shells underwent post-mortal transportation towards and were deposited in zones of low agitated waters, situated at similar or somewhat greater depths than the areas inhibitated by the brachiopod communities. This shallow-water facies is characteristic of lower part of the subtidal zone (cf. Heckel 1972).

Megalodon facies

The *Megalodon* facies is represented by series of thick-bedded *Megalodon* limestones (*cf.* Gaździcki 1971), found in all the sections studied (*cf.* Figs 3—5, 7—9). These limestones are primarily built of shells of megalodontids of the genera *Conchodon* and *Rhaetomegalodon* (*cf.* Pls 25—28), and the megalodontids often occur in masses (*cf.* Pl. 3, Fig. 2; and Pl. 28). Megalodontid communities, in which individuals representing different stages of ontogenic development occur side-by-side, may be interpreted as buried in life position (*cf.* Zapfe 1957, Ager 1963, Gaździcki 1971). Megalodontids were the pelecypods inhabitating in groups shallow, moderately turbulent zones often situated nearby coral reefs (*cf.* Zapfe 1957), and particularly back-reef zones (*cf.* Zankl 1968, 1969, 1971). It may be assumed that the *Megalodon* and coral facies, often occurring one next to the other (*cf.* Figs 3—5, 7—9), represent sediments deposited in the back-reef zone.

Organodetrital facies

This facies comprises distinctly bedded dark-gray organodetrital limestones predominating in the sections studied (*cf.* Figs 3—5, 7—9). The limestones are characterized by remarkable contribution of different grain components, represented by crushed organic fragments (bioclasts), intraclasts, pellets, ooids, onkolites, and fine grains of detrital quartz. Microscopically, the limestones are represented by biosparrudite and biomicrudite, and sometimes by intrasparite, oosparite, and pelmicrite (*cf.* Pls 7—14). These sediments were deposited in higs agitated waters and are typical of shallow-water subtidal zone (*cf.* Czurda & Nicklas 1970, Shinn 1973).

Clay-marly facies

Clay-marly facies is represented by black and non-calcareous dark-gray shales with occasional intercalations of dark marly deposits (*cf.* Figs 3—5, 7—9). Organic fragments occur here in subordinate amounts, and are represented by innumerous crushed thin shells of pelecypods. Sediments of this facies are sometimes intercalated by limestone layers, which indicates both temporary changes of sedimentary conditions and interfinging of clay-marly and carbonate facies. Sediments of the clay-marly facies correspond to the "Swabian facies" of the Rhaetian (*cf.* Goetel 1917, Kochanová 1967, Michalik 1973). These sediments were presumably deposited in zones of similar bathymetry as carbonate sediments, but in times of break of carbonate precipitation.

Sandy facies

Predominance of sandy facies resulted in deposition of sandy and/or carbonate-sandy layers. These deposits are limited to the uppermost parts of the sections studied, close to the Rhaetian/Liassic boundary (*cf.* Figs 3—5, 7—9). They indicate a marked decrease in depth of the basin and proximity of shores.

General remarks on the facies

It should be noted that the Rhaetian strata exposed in the Tatra Mts area are characterized by high vertical and horizontal variability. The field studies indicate that particular layers may markedly change laterally in composition at the distance of a few meters.

The short review of the most characteristic lithologic members shows that the sub-tatric (Križna) Rhaetian is developed both in the "Carpathian" and "Swabian" facies, and none sediments developed in the "Kössen facies" typical of the Choč Rhaetian from Hybe in Slovakia (*cf.* Goetel 1917, Koutek 1927, Mahel & Kochanová 1962) were found here.

Rhythmics of sedimentation

Variability and succession of carbonate ("Carpathian") and clay--marly ("Swabian") facies were initially regarded by Goetel (1917) as resulting from repeating oscillations of the bottom of the shallow marine basin. However, this is in contradiction with new data, as Goetel's (1917) interpretation related every clay-marly layer with an event of decrease in sea depth or in distance from sea shores. Oscillatory short-term Earth crust movements that would be required for such repeated changes in sea depth and distance from shores seems to be hardly probable.

The interfinging of carbonate and clay-marly deposits, which is characteristics of the Križna Rhaetian, may be rather interpreted as resulting from a rhytmics of sedimentation independant on changes in basin bathymetry or in distance from shores. Such is the case of clastic Cambrian sediments of shallow marine basin from the Holy Cross Mts (*cf.* Dżułyński & Żak 1960).

Deposition of interfinging carbonate and clay-marly sediments in a shallow marine basin is determined by a number of factors, including pH, temperature, supply of fresh waters, as well as general climatic changes. If *e.g.* marine water is almost fully saturated with calcium carbonate (with pH equal 8.3), than a slight rise of temperature or decrease in amount of carbon dioxide will lead to precipitation of calcium carbonate. Whereas, during cooler period, when there is a drop of temperature, an increase in concentration of carbon dioxide ions takes place, the precipitation of calcium carbonate is stopped, and clay-marly sedimentation happens to prevail (*cf.* Fabricius & *al.* 1970a, b). Such a very set of factors might have been responsible for the above rhythmic changes in sedimentation, without any contribution of changes in bathymetry.

Sedimentary conditions

Fauna and flora appears to be fairly rich in the sub-tatric (Križna) Rhaetian, and all the organic communities are dominated by benthic sessile forms (algae, corals, brachiopods, pelecypods, and crinoids). Vagile benthos is also numerous, and it is represented by foraminifers, gastropods, echinoids, starfishes and ophiuroids. Plankton is presumably represented only by plant spores.

This wealth of organic remains in the majority of layers of the sections studied (*cf.* Figs 3—5, 7—9) indicates optimal biological conditions and repeated decrease in supply of terrigenic material. Cooccurrence of branched coral colonies, numerous crinoids, brachiopods, pelecypods, and gastropods evidence shallow-water conditions typical of zones situated somewhat further off the shores (*cf.* Heckel 1972), and more precisely, conditions typical of back reef zone (*sensu* Zankl 1967, 1968, 1969, 1971). In the Dachstein Reef Complex, this zone is characterized by cooccurrence of megalodontids, coral layers, algae Dasycladaceae and Solenoporaceae, foraminifers Involutinidae, and by predominance of calcarenites (*cf.* Zankl 1969, 1971; Hohenegger & Lobitzer 1971; Schöllnberger 1972a, b). Such set of sediments is common in the sub-tatric (Križna) Rhaetian (*cf.* Figs 3—5, 7—9), and it therefore may be assumed that at least a part of the sediments studied was deposited in that zone. At the same time it should be noted that no sediments typical of Central Reef Area in Dachstein were found here. Core zones of a central reef similar to the Dachstein reef are known from the Rhaetian of Gemerides (Muráň Plateau) of the southern part of the Carpathian geosyncline (*cf.* Bystrický 1972). The occurrence of reef formation of the Dachstein type in the Rhaetian of the Gemerides implicate that in this basin also back reef deposits of the Križna type were deposited. The problem whether or not these central reef and back reef areas correspond to one another remains open.

Effects of littoral currents in the sediments studied are occasionally recorded by occurrence of innumerous intraclasts and local scouring of the *Megalodon* layers (*cf.* Pl. 28). However, these sediments are characterized by distinct and regular bedding, and sets of layers are rather uniform in thickness, which seems to indicate constant hydrodynamic conditions and constant and uniform subsidence in this basin. It therefore is concluded that these sediments were deposited below the zone effected by littoral currents, *i.e.* at the depth of c. 30—50 m. Thus, they represent a zone somewhat deeper than that suggested by Zankl (1969, 1971) for the back reef zone of the Dachstein formation.

COMPARATIVE REMARKS

The sediments of the sub-tatric (Križna) Rhaetian are characterized by fairly uniform development over the whole area of the Tatra Mts (*cf.* Figs 1, 3—5, 7—9). The Rhaetian sections from various localities are more or less complete (*cf.* Fig. 12), but it may be estimated that the thickness of the Rhaetian markedly varies, ranging from 10 to 80 m.

The sediments studied form a markedly individualized series of the Mesozoic sequence of the sub-tatric (Križna) nappe. They distinctly differ from both the underlying Carpathian "Keuper" and overlying Liassic. The Rhaetian, developed in the Carpathian and Swabian facies, comprises typical marine sediments. Although no ammonites were found, these sediments were assigned to the Rhaetian as foraminifer assemblage appears to be indicative of this stage. Such age assignation is supported by the Triassic habitus of the remaining faunal and floral elements. These typical Rhaetian groups, such as the majority of involutinids, megalodontids, and some corals, recede at the Rhaetian/Liassic boundary.

Detailed facial and stratigraphic analyses made it possible to compare sub-tatric (Križna) Rhaetian with contemporaneous sediments from other tectonic units of the Tatra Mts, and primarily with the Choč and the high-tatric Rhaetian, as well as with those from other parts of the Tethys Ocean.

The Choč Rhaetian sediments from Mt. Siwiańskie Turnie and Mt. Małe Koryciska are developed in a mixed, Carpathian-Swabian facies and are lithologically very close to these of the sub-tatric (Križna) nappe (*cf.* Guzik 1959b, Zawidzka 1972a, Gaździcki & Zawidzka 1973). The former were assigned to the *hantkeni* Zone (Upper Rhaetian) on the basis of rich foraminifer fauna (Gaździcki & Zawidzka 1973).

The Choč Rhaetian from Hybe in Slovakia is developed in the "Kössen facies" (Goetel 1917, Zázvorka & Prantl 1936, Bystrický & Biely 1966), which is not known from the sub-tatric (Križna) Rhaetian.

The Hybe series may be interpreted as deposited in somewhat deeper part of basin than that of the sub-tatric Rhaetian, and it was assigned to the *pokornyi* & *friedli* Zone (Lower Rhaetian) on the basis of foraminifer fauna (*cf.* Gaździcki & Zawidzka 1973). It should be noted that Hybe is the only ammonite-bearing locality of Rhaetian age in this region, and the species *Arcestes (Rhaetites) rhaeticus* (Clark) was found herein (*cf.* Andrusov 1934, Kollárová-Andrusovová 1967).

The high-tatric Rhaetian was analysed in detail by Radwański (1968). It is developed in clastic-carbonate facies, roughly resembling the sub-tatric (Križna) facies. It differs from the latter in the lack of megalodontids and foraminifers (Ammodiscidae and Involutinidae). The high-tatric Rhaetian sediments were deposited in markedly shallower waters, which is evidenced by the wealth of algal structures (*cf.* Radwański 1968). However, it should be noted that the Rhaetian sediments from Mt. Kopieniec Starorobociański appears to represent a transitional type between the remaining high-tatric and the sub-tatric Rhaetian sediments.

The sub-tatric (Križna) Rhaetian appears to be very close to the Rhaetian strata of other tectonic units of the Central Carpathians (*cf.* Mahel, Buday & *al.* 1968; Bystrický 1967, 1972; Čepek 1970; Michalik 1973), which is evidenced by almost identical composition of organic assemblages, as well as facial development and succession.

Almost identical litho- and biofacies were reported from the Rhaetian of the Bakony Forest and Gerecse and Vértes Mts in Hungary (*cf.* Vadász 1960, E. Végh-Neubrandt 1960, 1972; E. Végh-Neubrandt & Oravecz 1960, Oravecz & E. Végh-Neubrandt 1962, S. Végh 1964).

The sub-tatric (Križna) Rhaetian appears particularly close to contemporaneous strata from the Northern Limestone Alps, one of the reference Rhaetian sections (*cf.* Fischer 1964; Zapfe 1964, 1969; Kristan-Tollmann & Tollmann 1964; Fabricius 1966, 1967, 1968; Zankl 1969, 1971; Koehn-Zaninetti 1969; Kristan-Tollmann 1970; Tollmann 1972; Pistotnik 1972). Foraminifer, coral, and megalodontid assemblages from these two regions appear to be almost identical.

Attention should be also paid to the Rhaetian of the Lombardian Alps (*cf.* Wiedenmayer 1963, Gnaccolini 1964, 1965a, b, c; Allasinaz 1962, 1965, 1968) and the Dolomites (*cf.* Cros 1964, 1965a, b; Cros & Neumann 1964; Bosellini 1965; Bosellini & Broglio Loriga 1965). The Rhaetian strata from these regions yield rich foraminifer fauna (including *Triasina hantkeni* association) and megalodontids (including *Conchodon* and *Rhaetomegalodon*). On the whole, these fauna assemblages and microfacies appear very close to these typical of the sub-tatric Rhaetian.

Some similarity also exists with the Rhaetian of the Pamirs in Central Asia (*cf.* Kushlin 1973, Kiparisova & Spasskaya 1973), which is also developed in coral-megalodontid facies, yielding faunal assemblages presumably identical with these from Europe.

To summarize, the Rhaetian facies and organic assemblages discussed here have been occupying vast areas of the Tethys Ocean (*cf.* Fig. 11). Further investigations should be carried on foraminifer faunas, which appear to have also vast geographic ranges, seem to be poorly dependant on facies, and relatively short-lasting, *i.e.* they seem to be good guide fossils. It may be assumed that further studies will make possible to correlate ammonite and foraminifer zonations of the Rhaetian stage and to precise the latter, which may be of great use in the absence of ammonites in any part of Rhaetian seas of the Tethys Ocean.

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A. GAŹDZICKI

MIKROFACJE, STRATYGRAFIA I ROZWÓJ FACJALNY RETYKU REGLOWEGO TATR

(Streszczenie)

Przedmiotem pracy jest wykształcenie mikrofacjalne, stratygrafia oraz sedymentacja retyku reglowego (kriżniańskiego) Tatr (*por.* fig. 1). Na podstawie analizy najbardziej reprezentatywnych profilów (*por.* fig. 2—9 oraz pl. 1—6) przedstawiono następstwo oraz ogólną charakterystykę osadów (pl. 7—14), a także ich składników nieorganicznych (fig. 10 oraz pl. 16) i biosedymentacyjnych, jak również poszczególnych zespołów florystycznych i faunistycznych (pl. 15, 17—33). W oparciu o licznie występujące otwornice (fig. 11 oraz pl. 34—51) opracowano stratygrafię tych utworów, wyróżniając retyk dolny — zonę *pokornyi* & *friedli* oraz górny — zonę *hantkeni* (fig. 12). Rozważono zagadnienie granic stratygraficznych retyku z „kajprem" i liasem przedstawiając także korelację ważniejszych profilów retyku Tatr oraz obszarów sąsiednich (fig. 13).

W obrębie różnych zespołów faunistycznych zwrócono uwagę na licznie tu występujące megalodonty (*por.* pl. 25—28), wśród których wyróżniono dwa nowe gatunki *Conchodon goeteli* sp. n. oraz *Rhaetomegalodon tatricus* sp. n. Opisano również dwa nowe gatunki koprolitów, *Bactryllium ornatum* sp. n. oraz *B. elongatum* sp. n. (*por.* pl. 52), sugerując, że reprezentują one najprawdopodobniej odchody megalodontów.

W oparciu o zmienność i następstwo facji przedstawiono rekonstrukcję środowiska sedymentacji retyku reglowego Tatr wykazując, że płytkomorskie te osady tworzyły się na obszarach odpowiadających przynajmniej częściowo strefie zarafowej (*zarafie—back reef*). W zakończeniu pracy przeprowadzono paralelizację utworów retyku reglowego z innymi osadami tego wieku znanymi w obrębie oceanu Tetydy.

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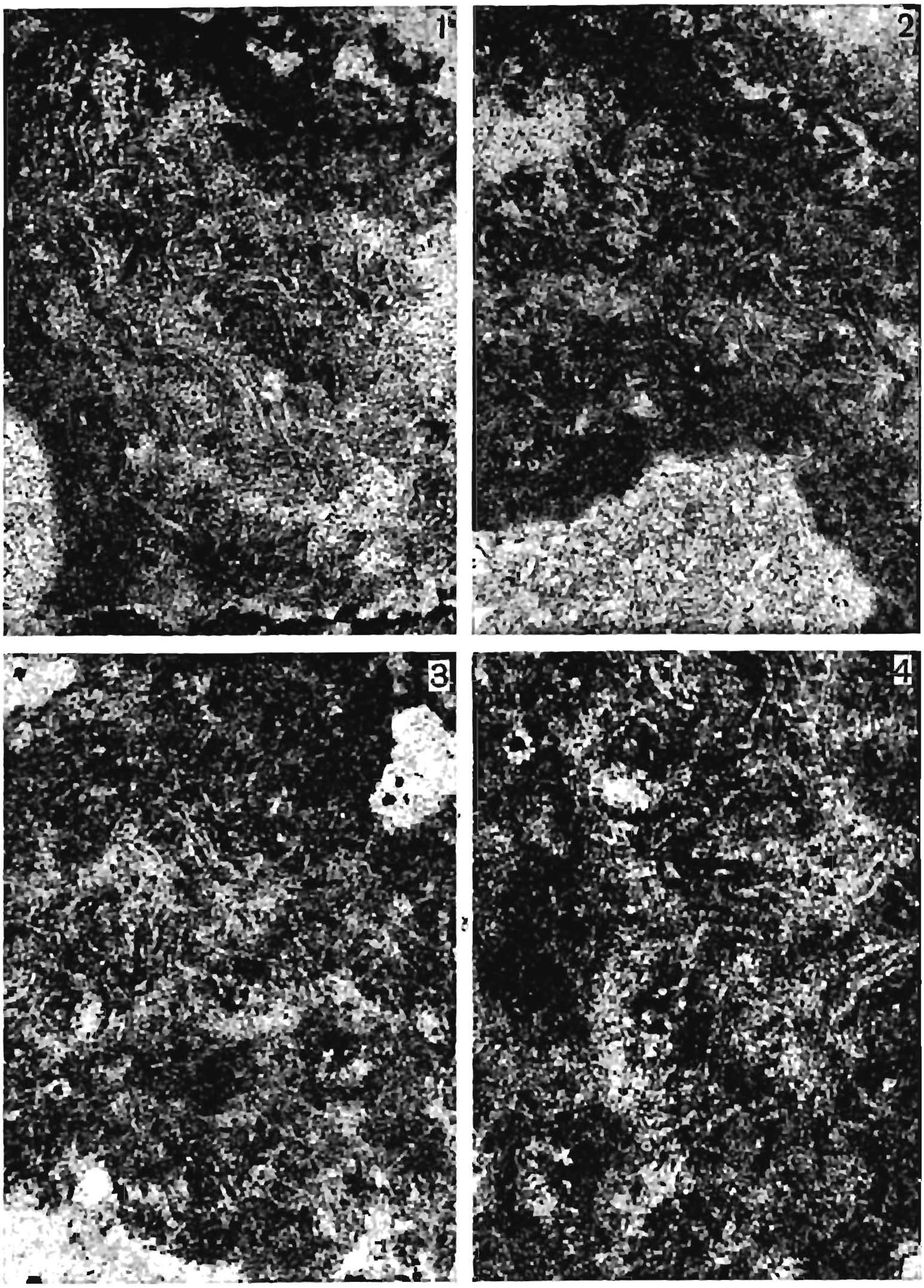
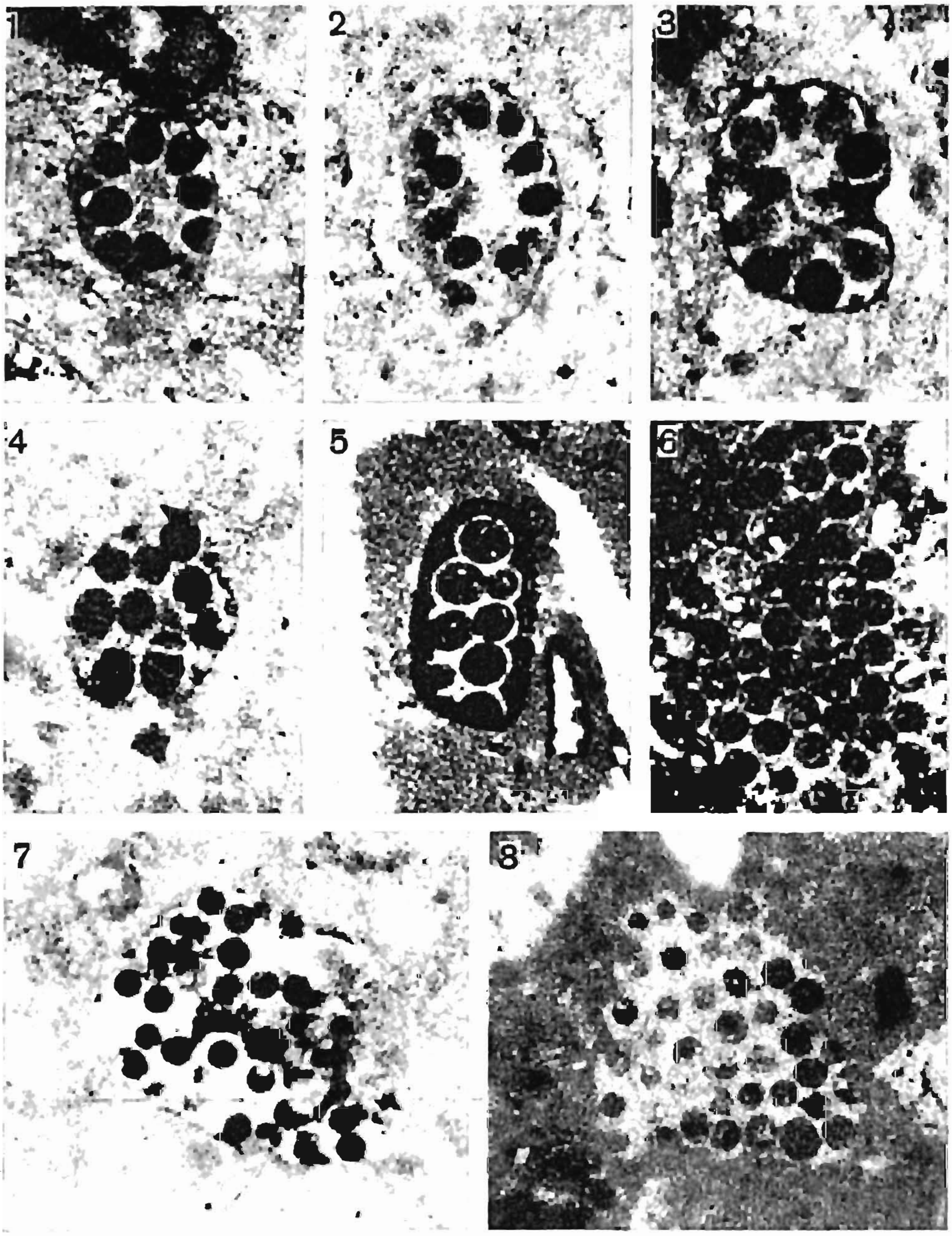


Girvanella minuta Wethered

1-2 — Felt of tubes within a girvanella crust, × 120. *1* from Mt. Mały Kopieniec (*III*, layer *2*); *2* from Szeroka Bielska Pass (*V*, layer *8*).

3-4 — Felt of tubes (strongly sparitized) within a girvanella ball; Lejowa Valley (*3* is × 120, *4* is × 200).

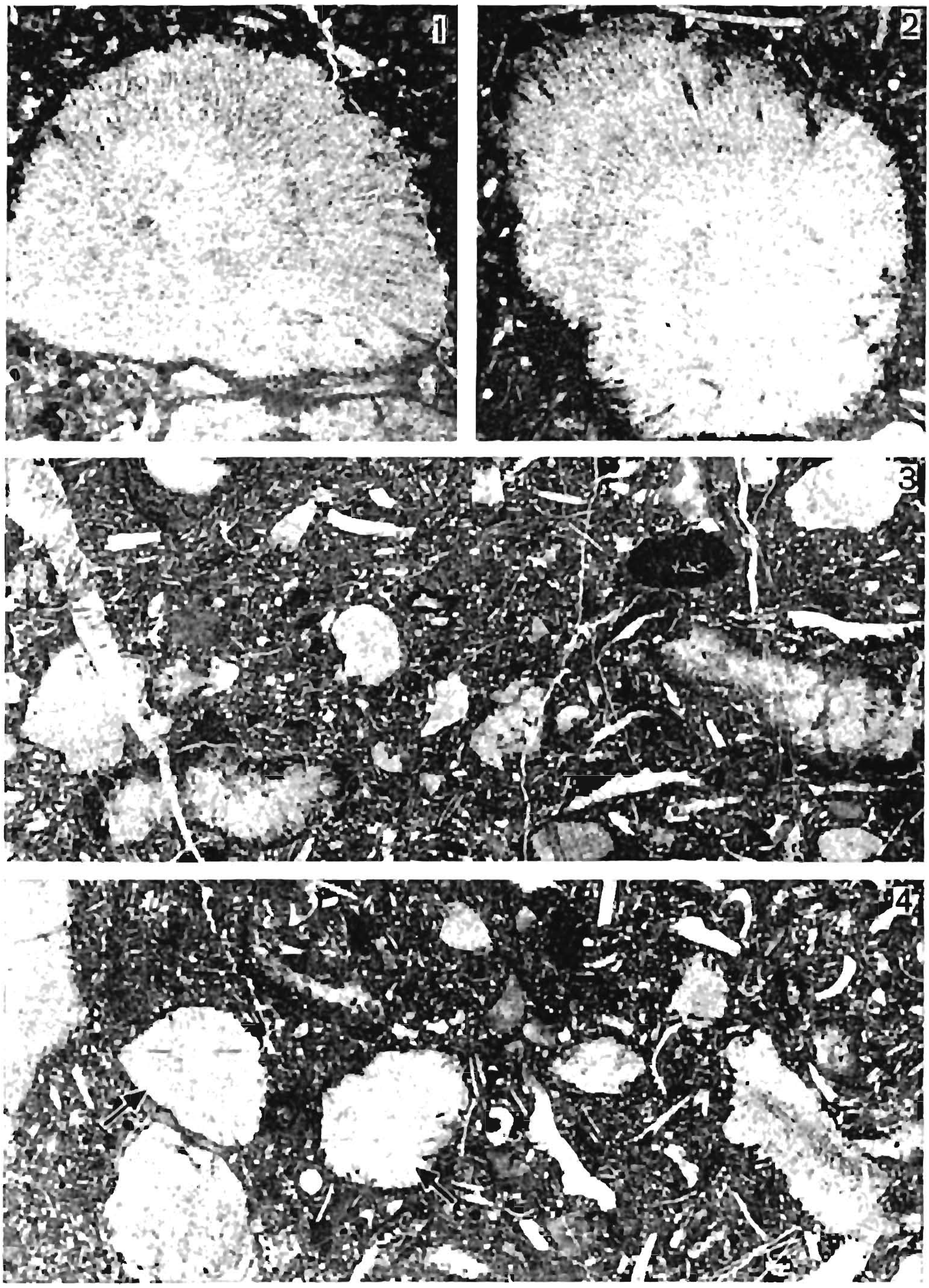


1-4 — *Acicularia* sp.

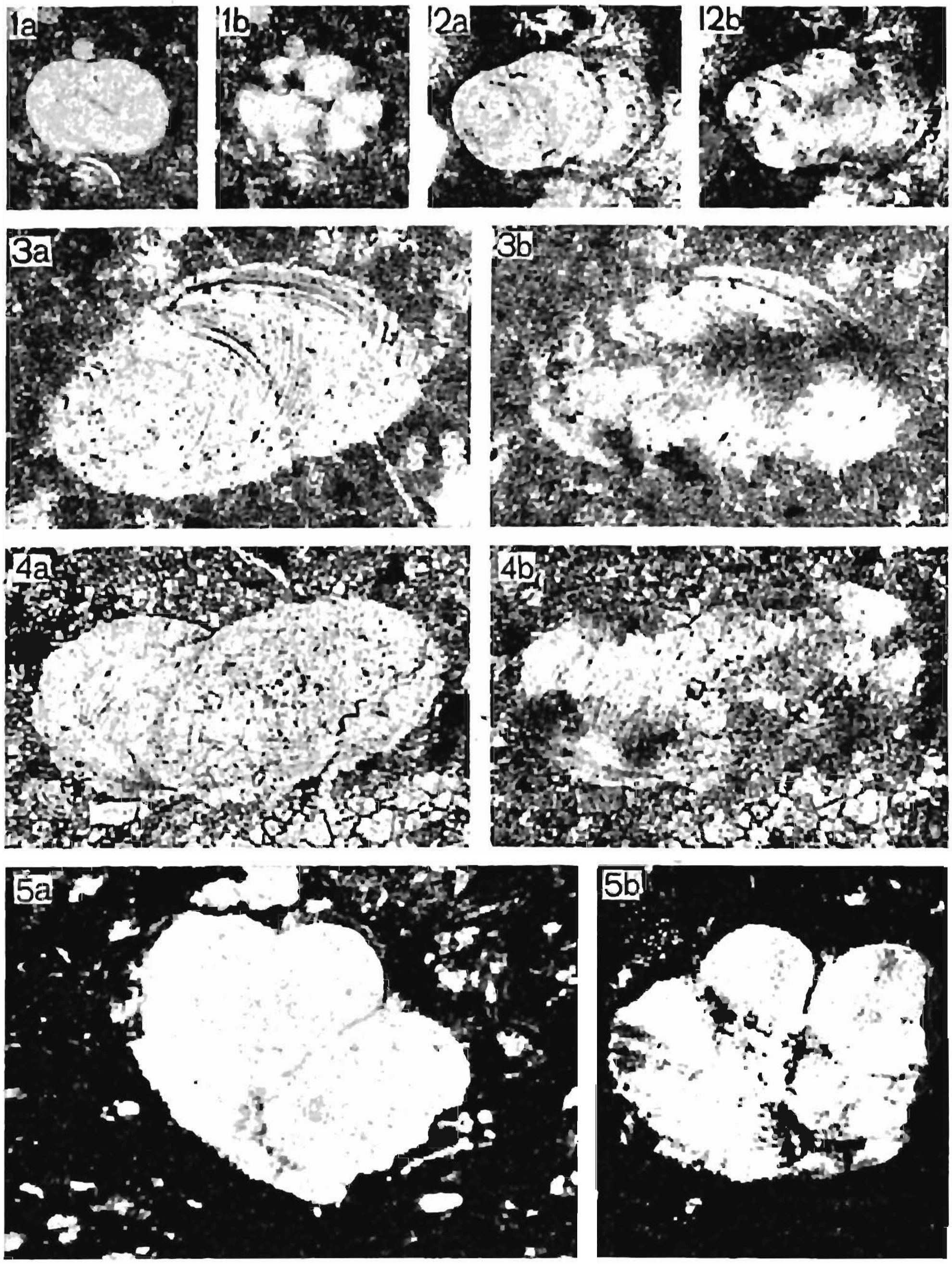
1—3 transverse sections, *4* oblique section; Lejowa Valley, × 140

5-8 — Problematic fragments of dasycladacean algae

5—6 from Lejowa Valley (*I*, layer 24), × 60; *7—8* from Lejowa Valley (*I*, layer 34), × 140

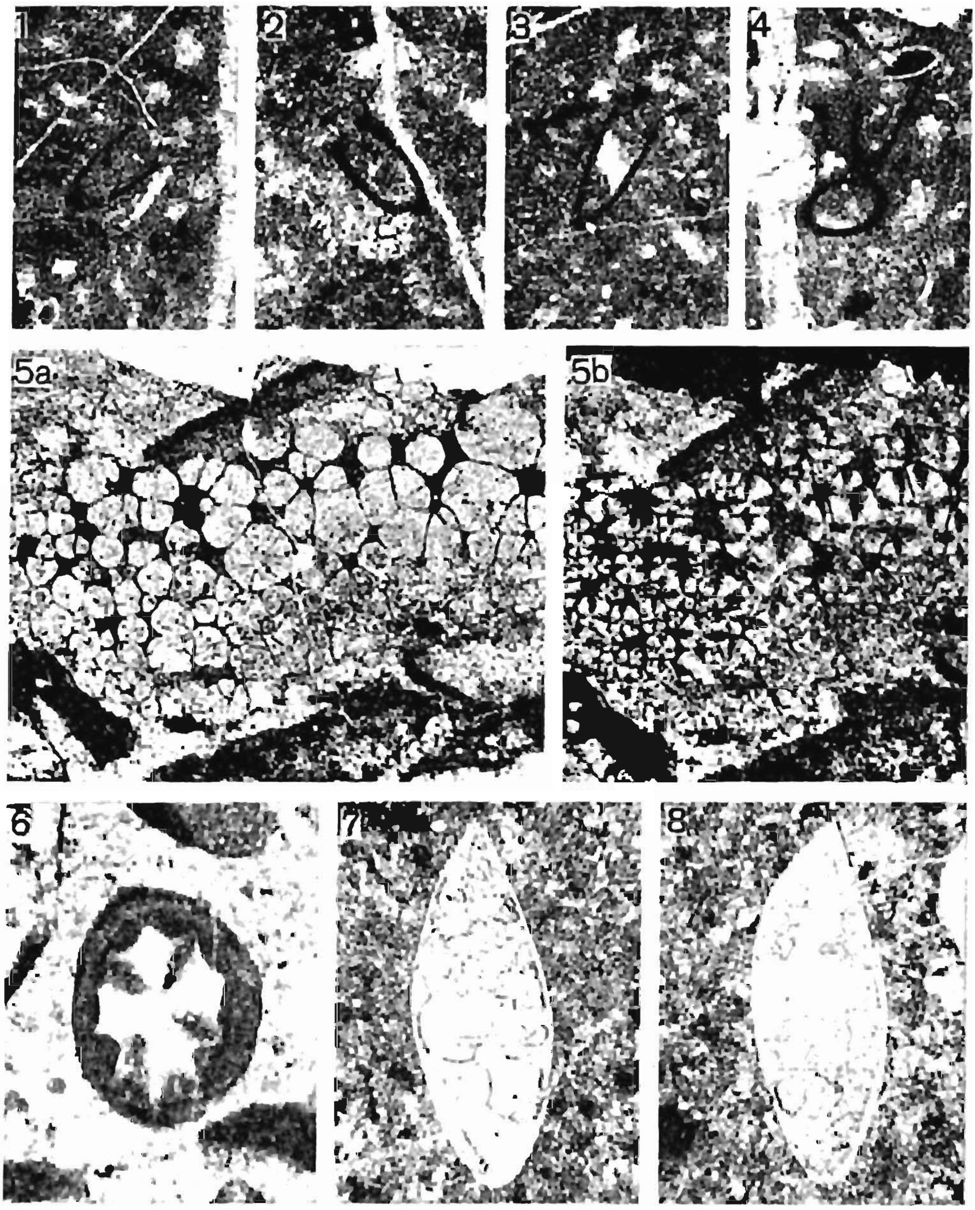


1-2 — *Solenopora* sp., oblique sections; Javorina (*IV*, layer *4*), × 40.
3-4 — Biomicrite with numerous *Solenopora* sp. (arrowed are colonies presented in Figs 1—2 of this plate); Javorina (*IV*, layer *4*), × 8.



1-2 — Spores *Globochaete alpina* Lombard in the initial stage of partition; Lejowa Valley (*I*, layer *34*).
3 — Spore *Globochaete tatrica* Radwański in the initial stage of partition; Javorina (*IV*, layer *4*).
4 — Spores *Globochaete tatrica* Radwański in the final stage of partition; Mt. Mały Kopieniec (*III*, layer *10*).
5 — Association of spores *Globochaete tatrica* Radwański; Lejowa Valley (*I*, layer *14*).

a — parallel nicols, *b* — crossed nicols; all figures × 100



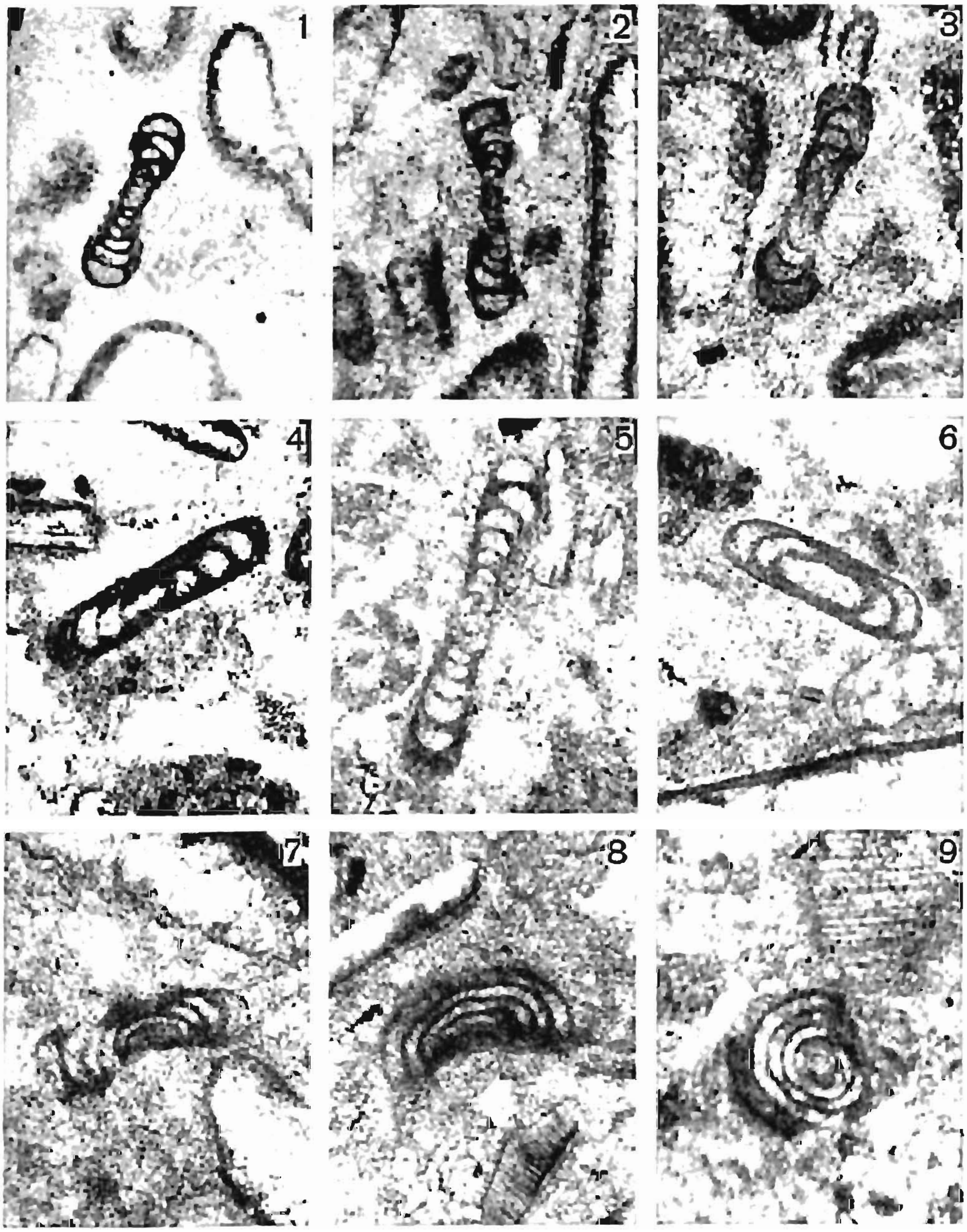
1-4 — *Earlandia* sp.: longitudinal sections (*1* and *3* from Lejowa Valley, *I*, layer *22*; *2* from Mt. Palenica Lendacka, *VI*, layer *33*) and variable sections (*4* from Lejowa Valley, *I*, layer *6*), × 50.

5 — Association of spores *Globochaete* sp. (*a* parallel nicols, *b* crossed nicols); Mt. Mała Świnica (*II*, layer *7*).

6 — Problematical microfossil as an ooid core; Strążyska Valley (*XI*), × 100 (nicols crossed).

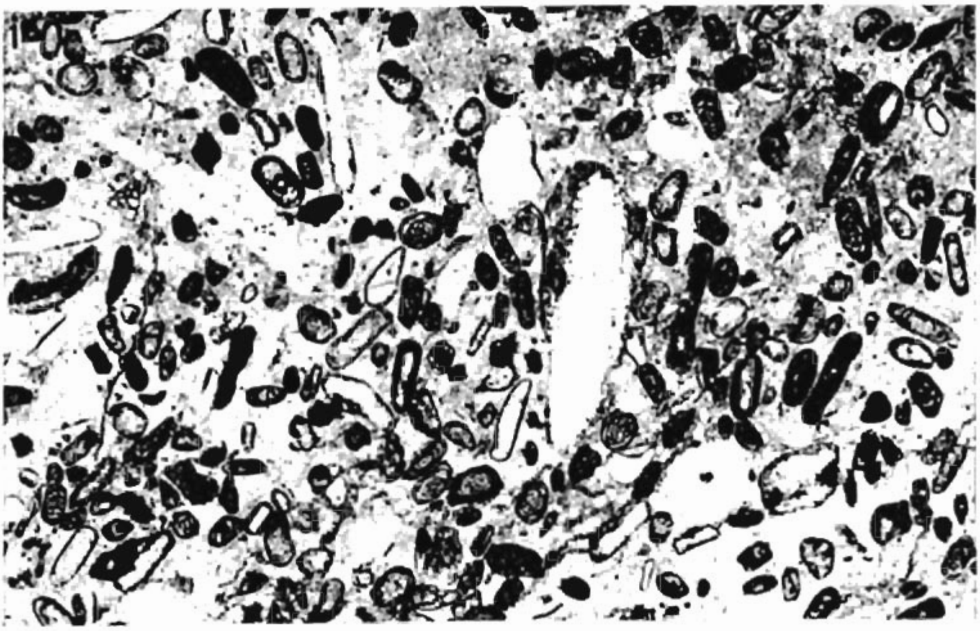
7-8 — Strongly sparitized ostracod shells; Mt. Mały Kopieniec (*III*, layer *11*), × 75.

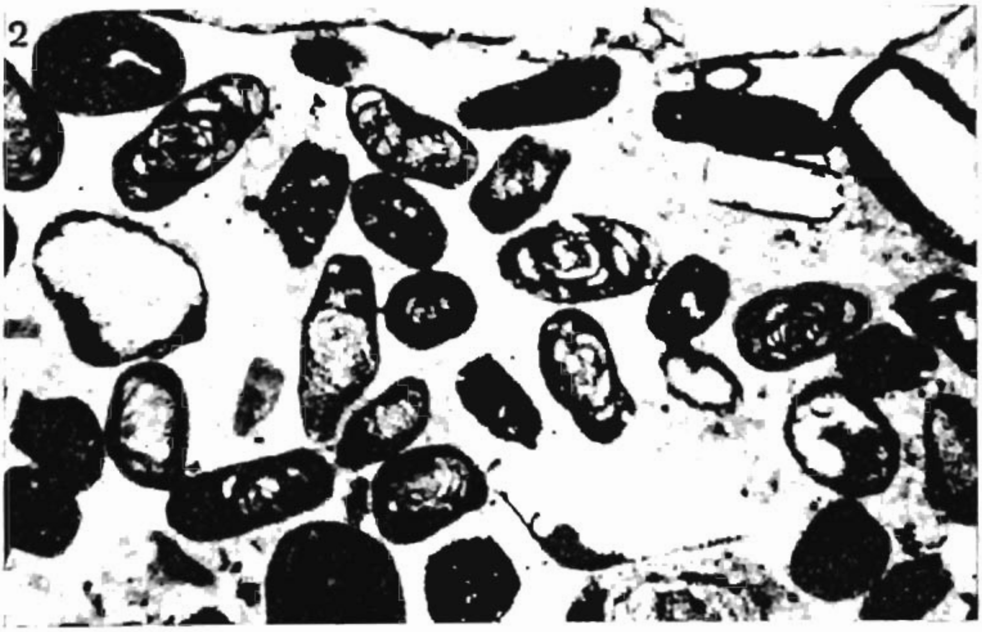
Frequent *Glomospirella? pokornyi* (Salaj) in brachiopod-crinoid biosparite; Szeroka Bielska Pass (section *V*, *1* and *3* from layer *12*, *2* from layer *9*), × 50



Glomospirella? pokornyi (Salaj)

1, 2, 3, 5 — axial sections; 4, 6, 7 — oblique sections; 8, 9 — equatorial sections
Szeroka Bielska Pass (section V, layers 9 and 12), × 70

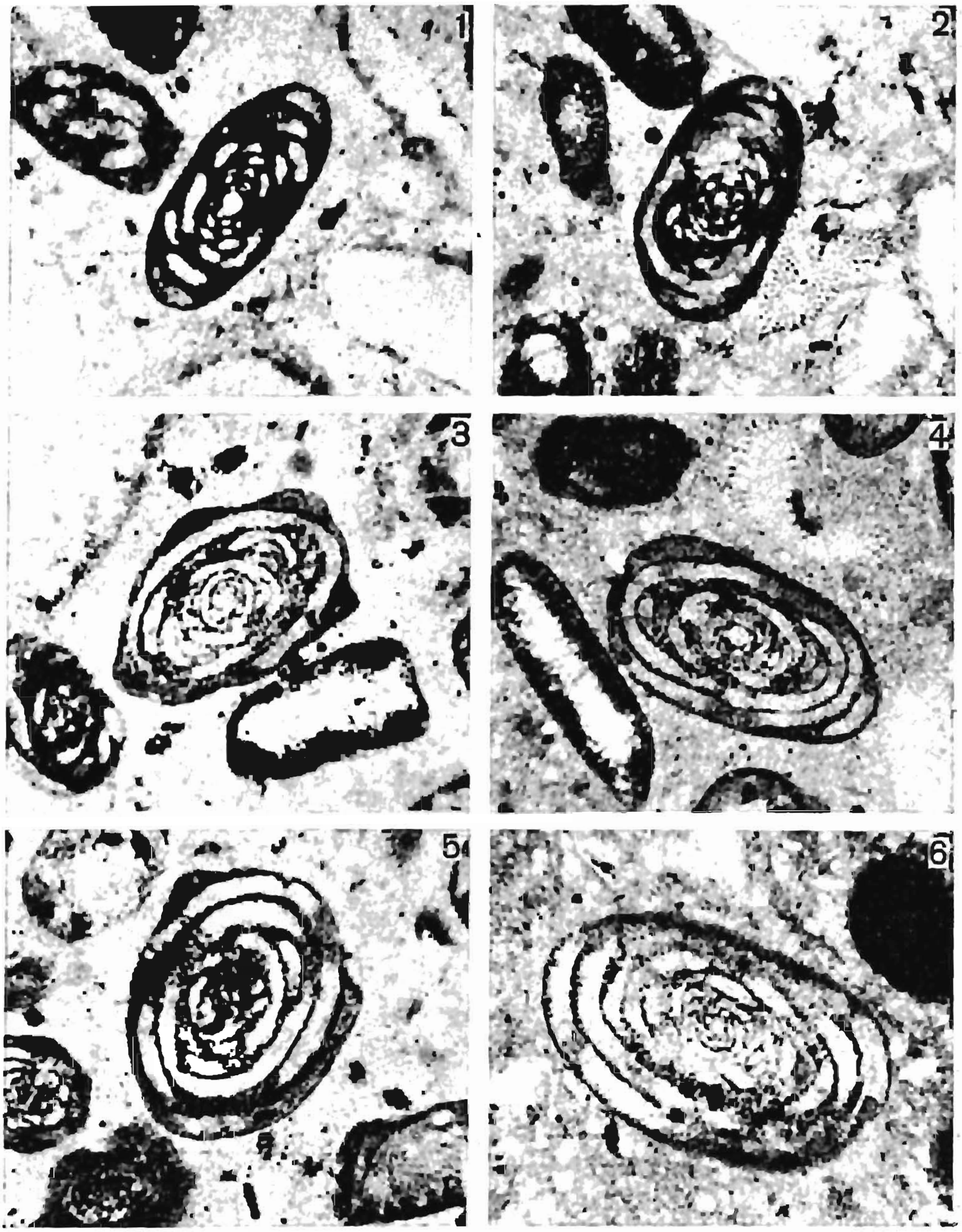




1 — Microfacies with *Glomospirella friedli* Kristan-Tollmann in organodetrital limestone, × 15.

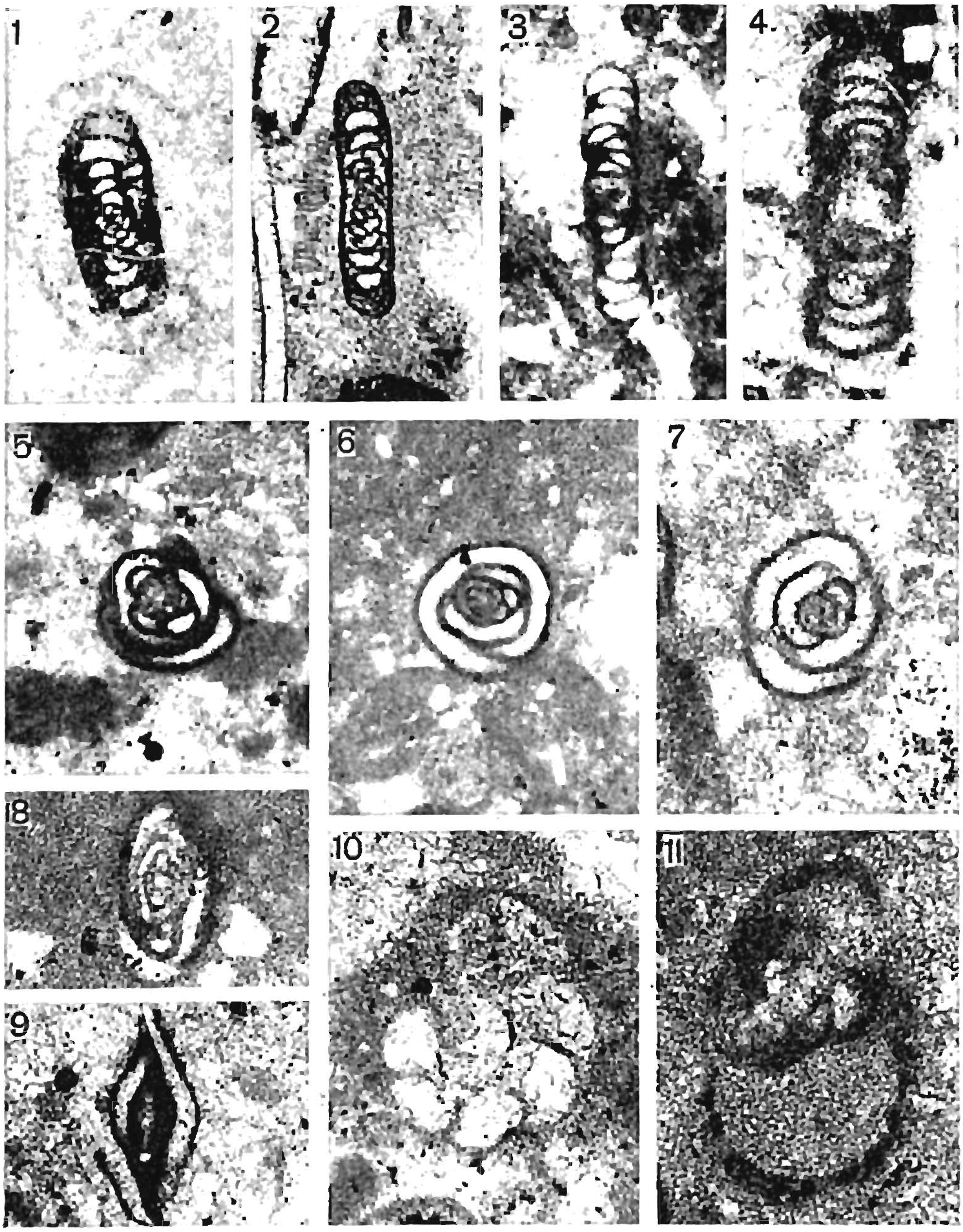
2 — Detailed view of microfacies with *Glomospirella friedli* Kristan-Tollmann; visible are variously oriented sections of the tests, more of less abraded and covered by blue-green-algal coatings; × 50.

Lejowa Valley (section *1*, layer 27)



Glomospirella friedli Kristan-Tollmann

1 — subaxial section, 2-5 — oblique sections, 6 — equatorial section
Lejowa Valley (section *I*, layer 27), × 70



1—2 *Glomospirella parallela* Kristan-Tollmann: *1* axial section, Javorina (section *IV*, layer *2*), *2* axial section, Mt. Palenica Lendacka (*VI*, layer *18*); × 70.

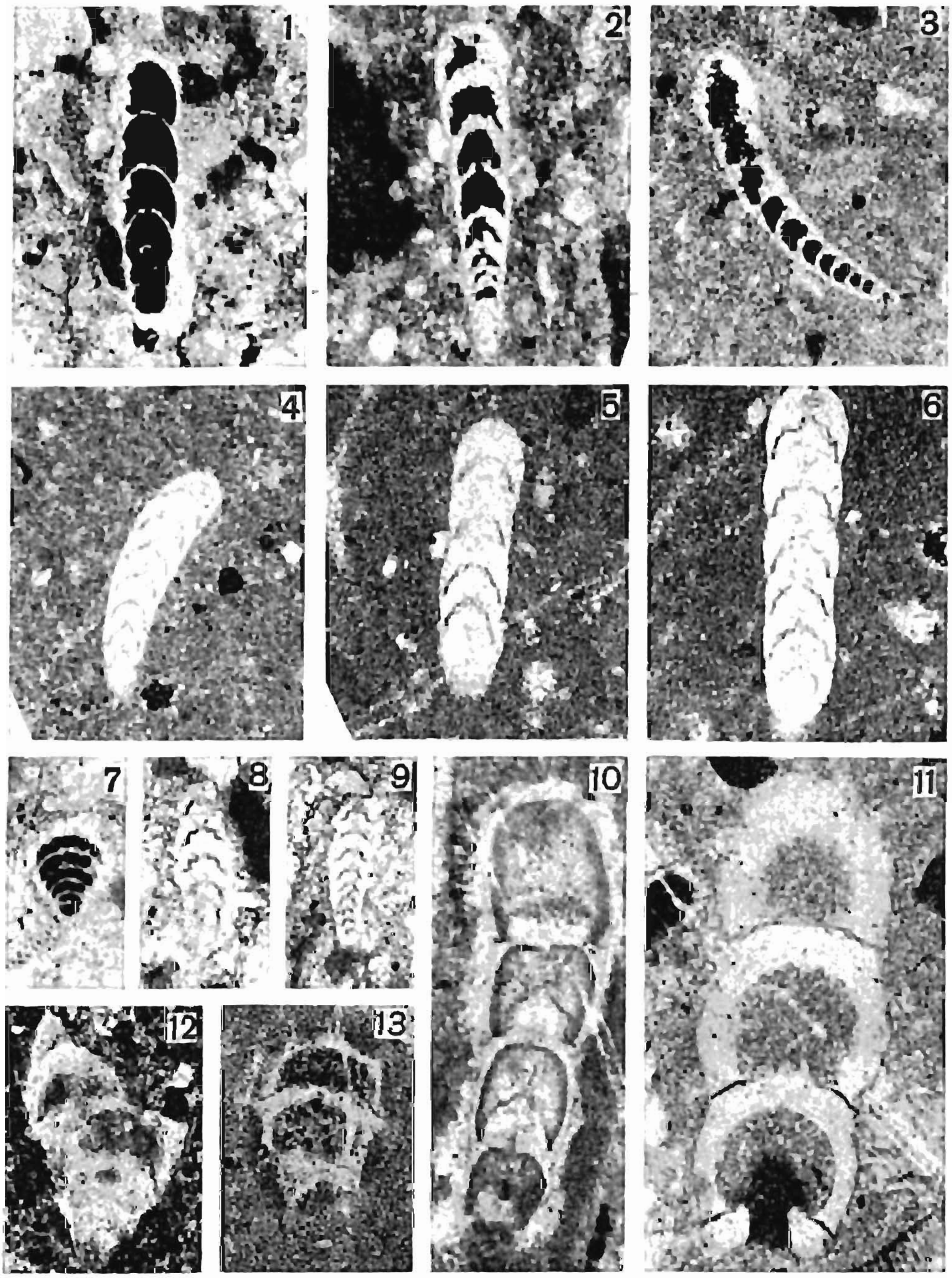
3—4 *Glomospirella* sp.; Javorina (*IV*, layer *4*), × 70.

5—7 *Glomospira tenuifistula* Ho: *5* from Mt. Palenica Lendacka (*VI*, layer *33*), *6—7* from Lejowa Valley (*I*, layer *5*); × 100.

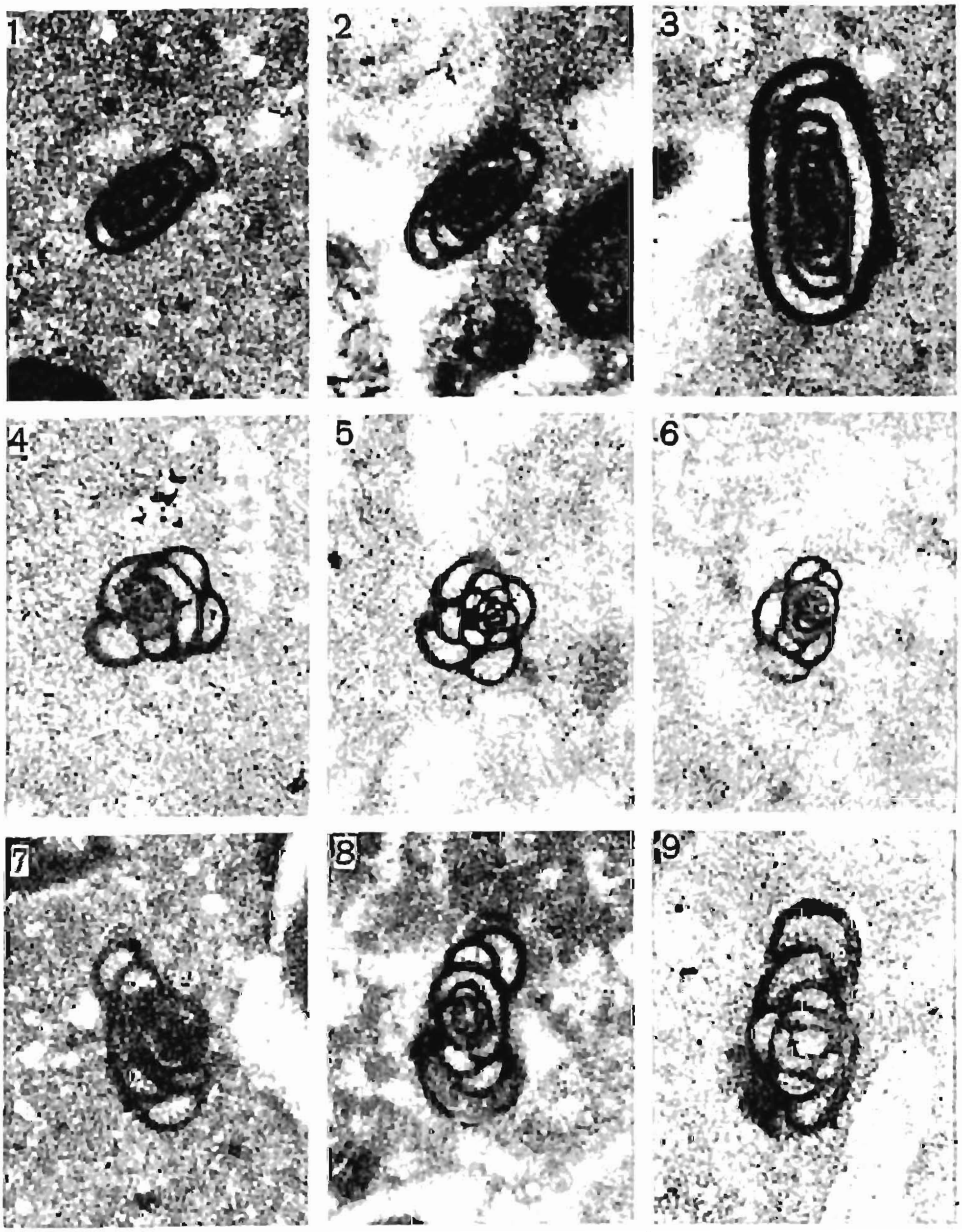
8—9 *Ophthalmidium* sp.: longitudinal sections — *8* from Mt. Palenica Lendacka (*VI*, layer *12*), *9* from Lejowa Valley (*I*, layer *3*), × 130.

10 *Diplotremina* sp.; Lejowa Valley (*I*, layer *15*), × 130.

11 *Miliolipora* sp.; Lejowa Valley (*I*, layer *15*), × 130.



1—6 *Frondicularia woodwardi* Howchin; Lejowa Valley (section *I*, layer *3*), × 100.
7 *Frondicularia* sp.; Lejowa Valley (*I*, layer *6*), × 100.
8—9 *Nodosaria* cf. *ordinata* Trifonova; Lejowa Valley (*I*, layer *6*), × 100.
10—11 *Nodosaria* sp; *10* from Mt. Palenica Lendacka (*VI*, layer *18*), *11* from Strążyska Valley (*XI*, Lower Liassic); × 100.
12—13 *Austrocolomia* sp; *12* from Juráňova Valley (*VII*), *13* from Jaworzyna Alp (*VIII*); × 140.

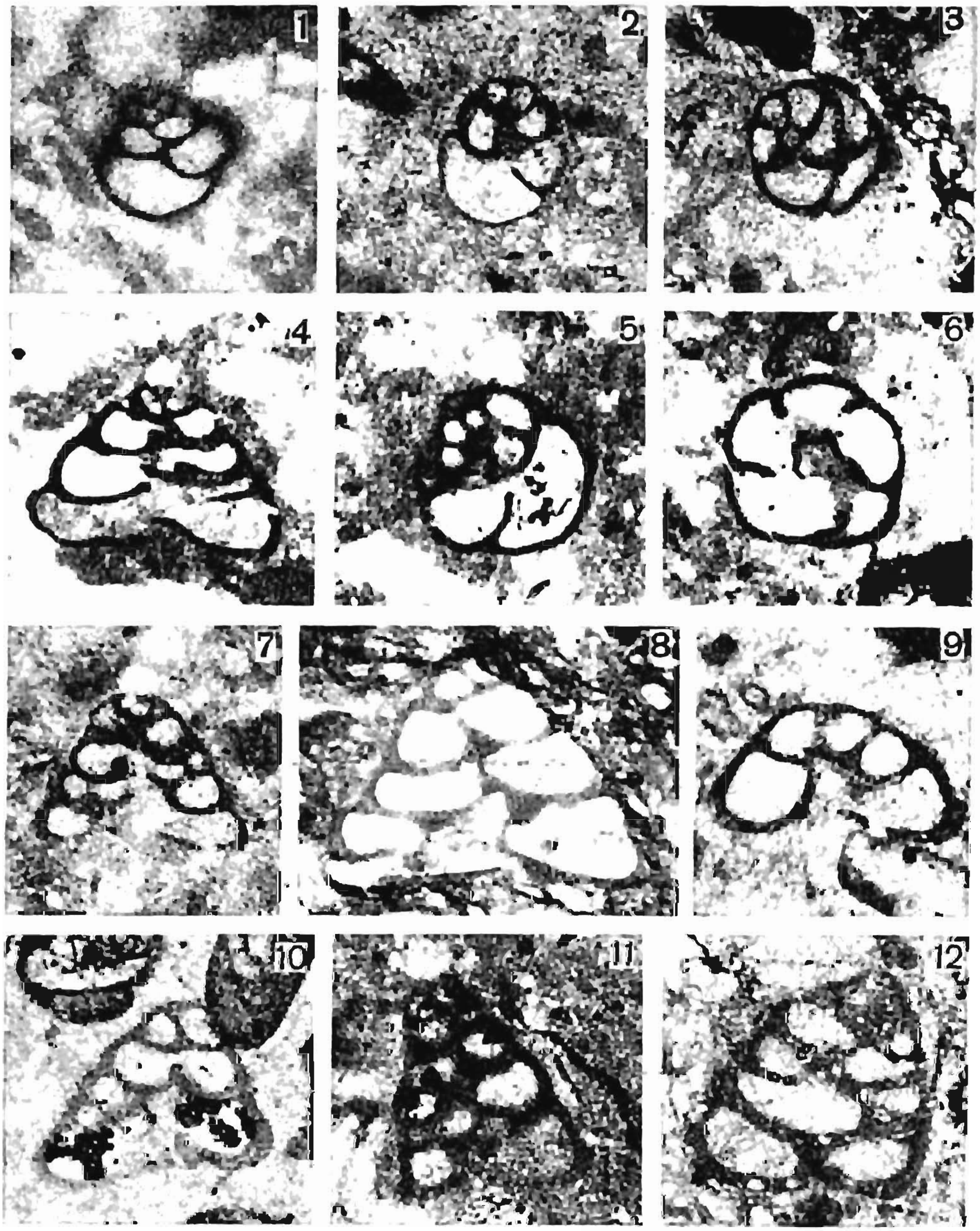


Agathammina austroalpina Kristan-Tollmann & Tollmann

1-3 — axial sections, Mt. Palenica Lendacka (section *VI*, layer 3), 4-6 — transverse sections, Lejowa Valley (*I*, layer *31*), 7 — oblique section, Mt. Palenica Lendacka (*VI*, layer 3); × 110

Agathammina? sp.

8 — oblique section, Mt. Palenica Lendacka (*VI*, layer 48), 9 — axial section, Mt. Gładkie Upłaziańskie (*IX*); × 110

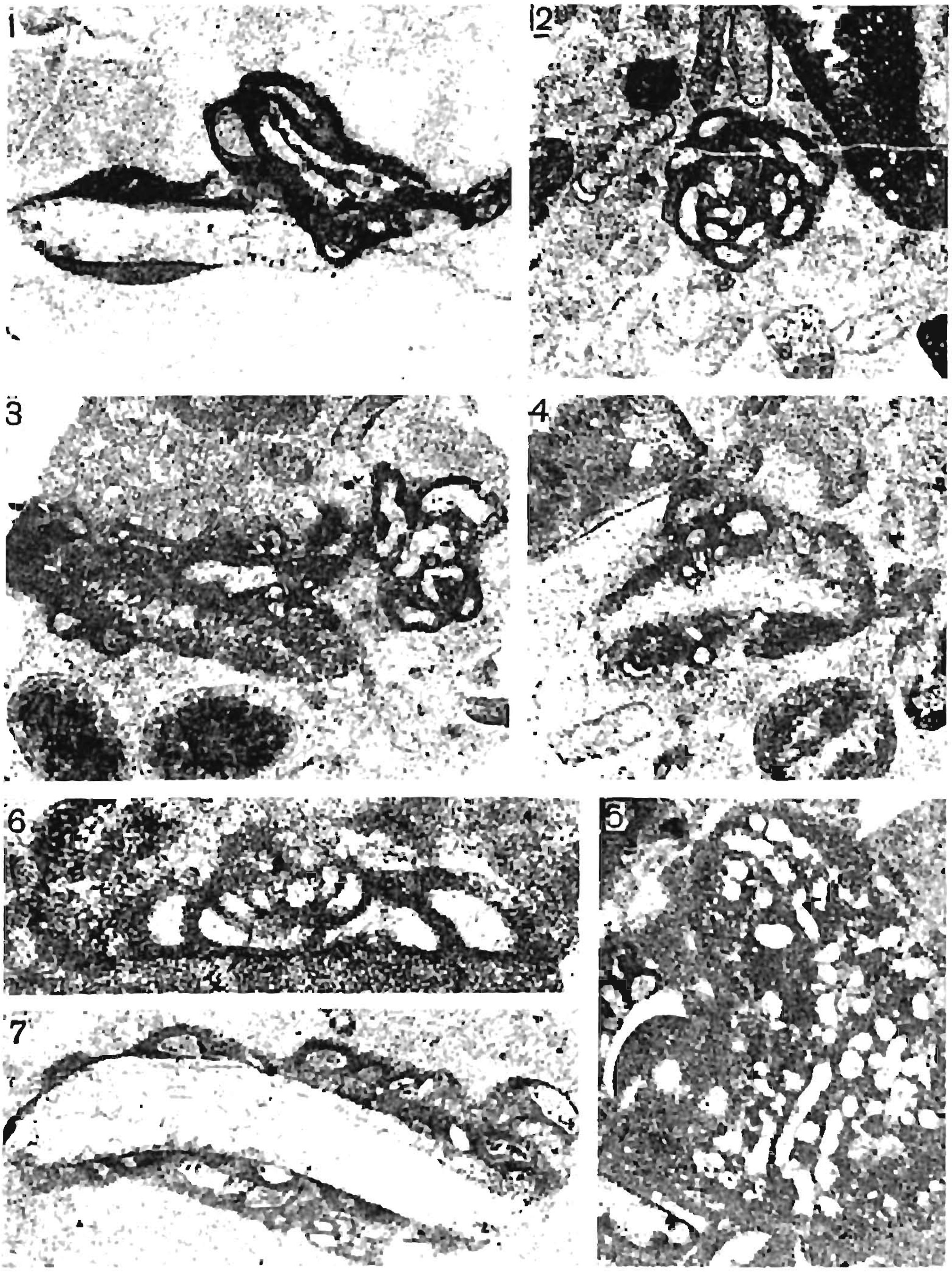


1—2 *Trochammina alpina* Kristan-Tollmann; vertical sections from Lejowa Valley (section *I*, layer *6*); × 100.

3 *Tetrataxis* sp; transverse section from Lejowa Valley (*I*, layer *6*); × 90.

4—10 *Tetrataxis inflata* Kristan: *4* vertical, *5* oblique, *6* transverse section from Lejowa Valley (*I*, layer *22*), *7* vertical section from Mt. Palenica Lendacka (*VI*, layer *37*), *8* vertical section from Lejowa Valley (*I*, layer *14*), *9* oblique section from Lejowa Valley (*I*, layer *6*), *10* vertical section from Lejowa Valley (*I*, layer *27*); × 90.

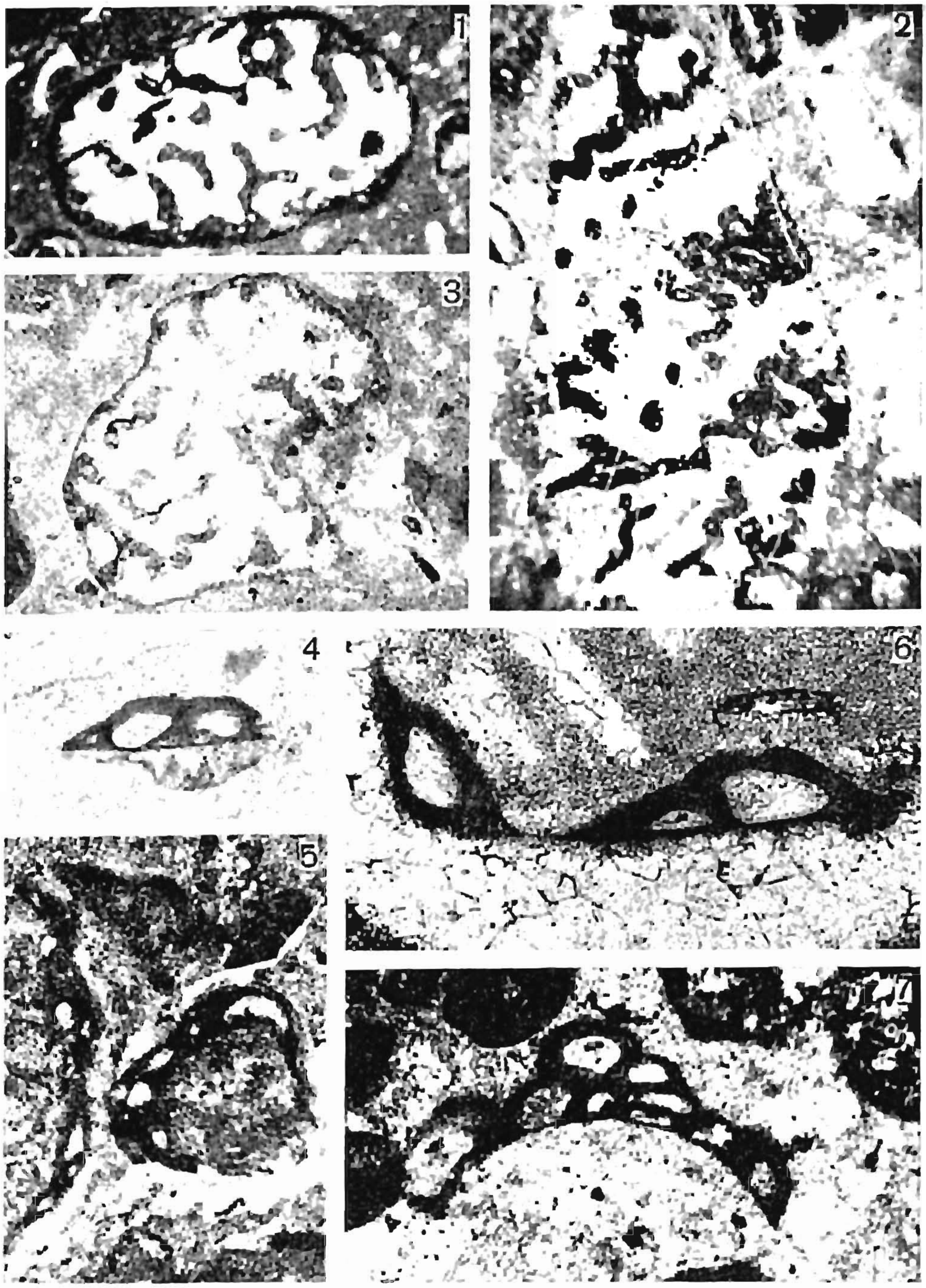
11—12 *Tetrataxis nanus* Kristan-Tollmann: vertical sections from Lejowa Valley (*11* from layer *27*, *12* from layer *6*); × 90.



1 and 7 — *Tolypammina*? sp.: vertical sections from Mt. Mała Świnica (section *II*, layer *18*), × 50.

2—5 *Tolypammina*? aff. *gregaria* Wendt from Mt. Palenica Lendacka (*VI*): *2* transverse, *3—4* vertical sections (layer *39*), *5* oblique section (layer *12*); × 50.

6 — *Planiinvoluta carinata* Leischner; vertical section, Mt. Palenica Lendacka (*VI*, layer *35*); × 110.

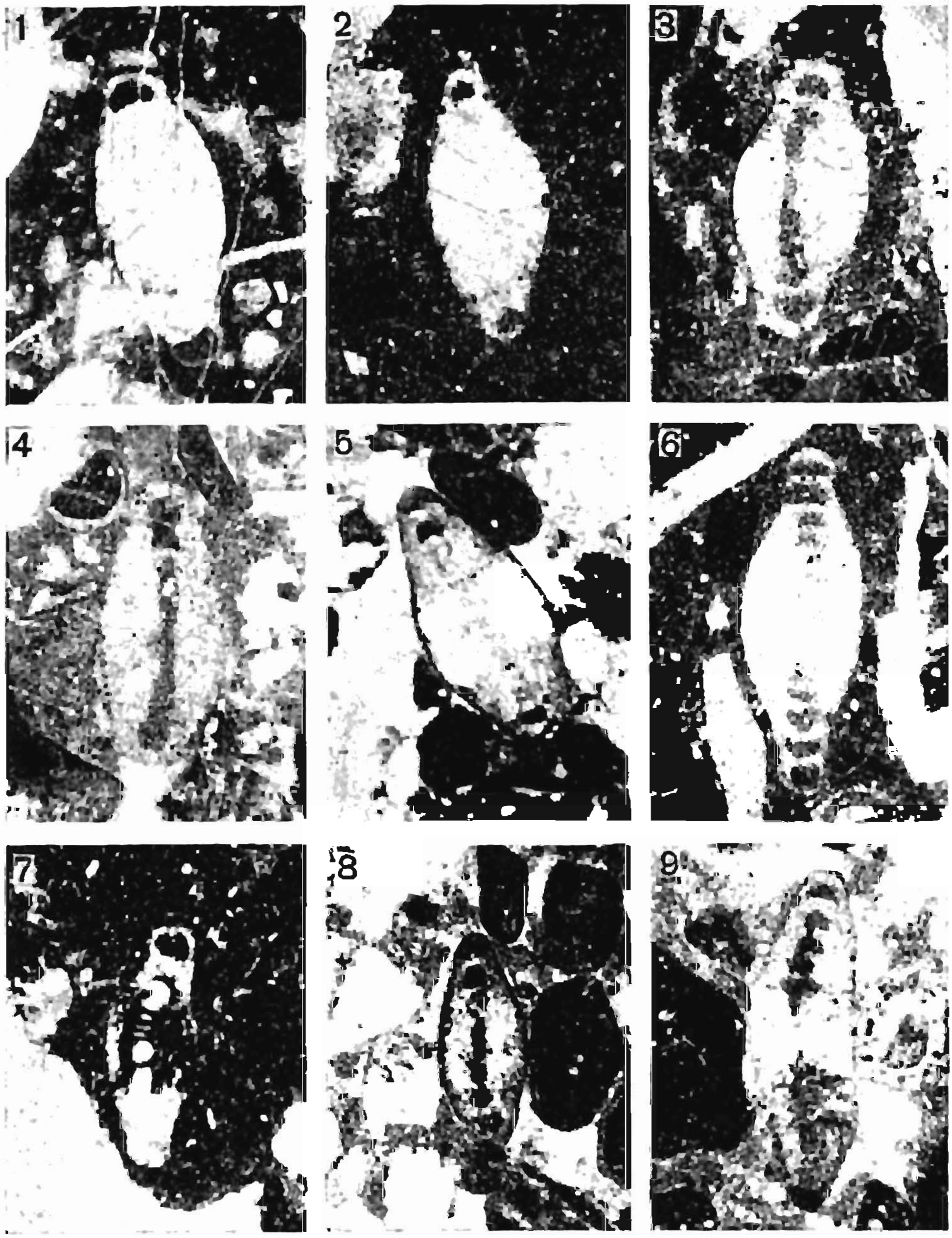


Alpinophragmium perforatum Flügel

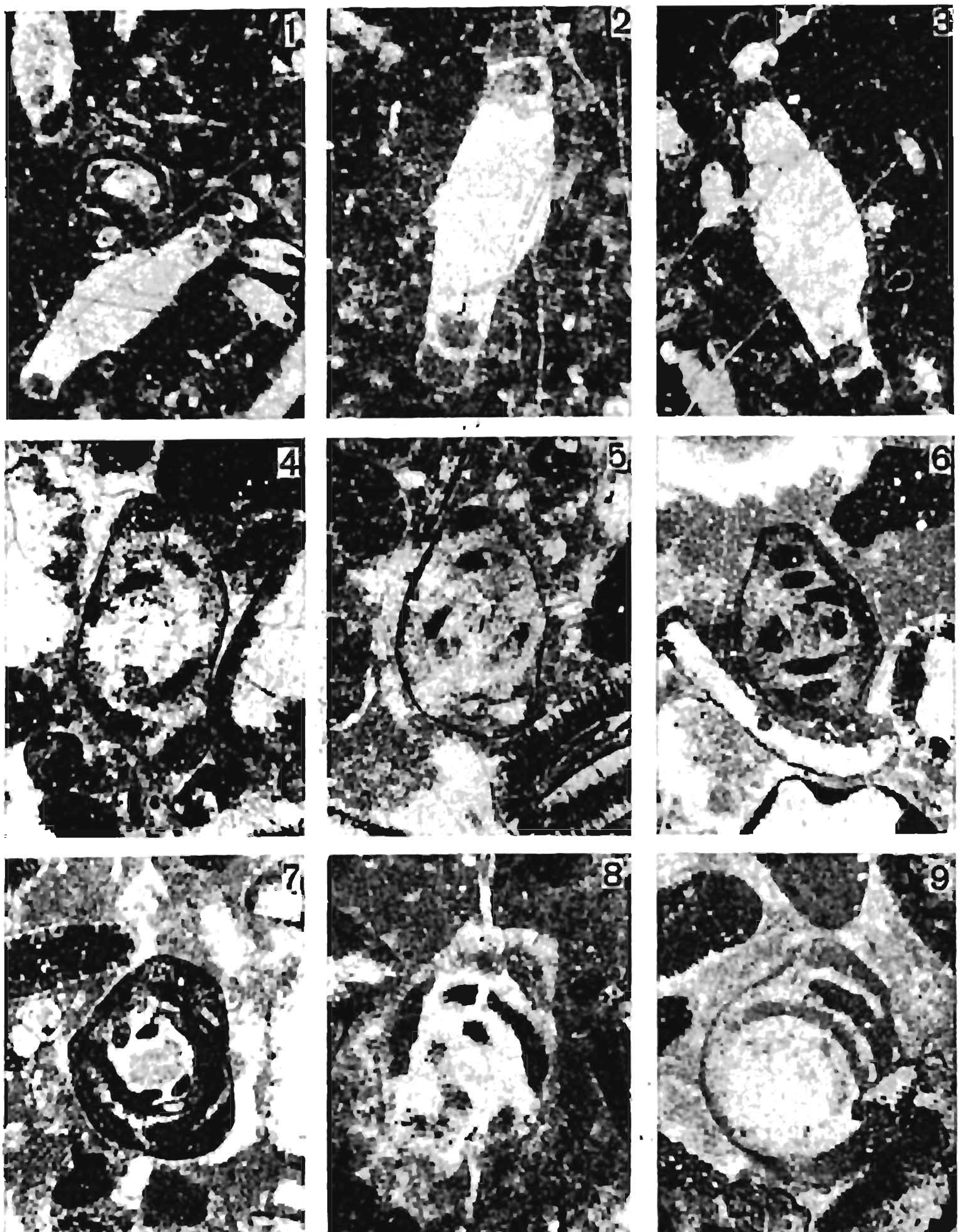
1 — transverse section, Lejowa Valley (section *I*, layer *20*), 2 — longitudinal section, Lejowa Valley (*I*, layer 24), 3 — transverse section, Mt. Gładkie Upłaziańskie (*IX*); × 25

Planiinvoluta deflexa Leischner

4-5 — vertical sections, Stólnia (*XII*), × 50; 6 — vertical section, Mt. Hradok (*XV*), × 110; 7 — vertical section, Lejowa Valley (*I*, layer 27), × 90

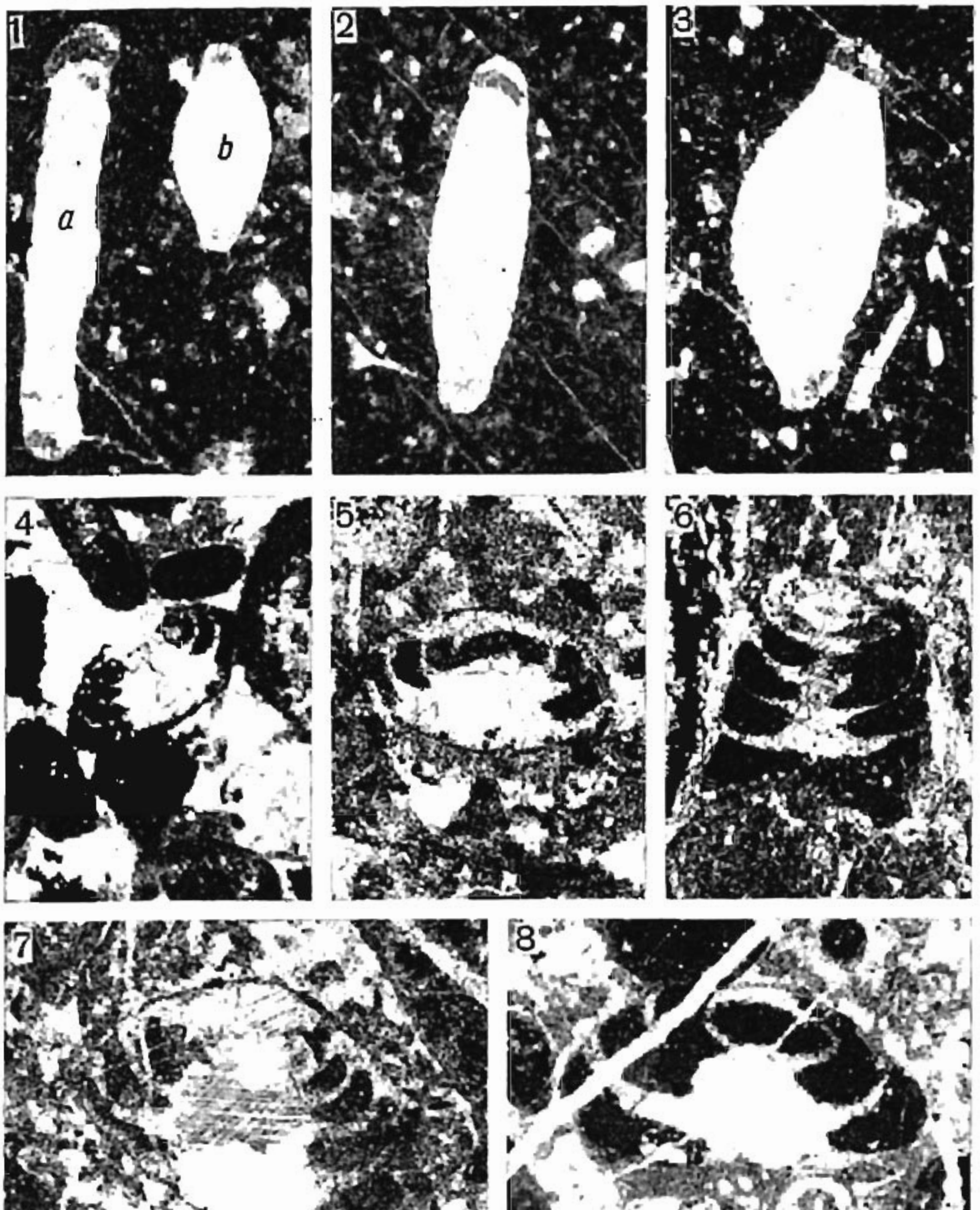


1-5 and 7-8 — *Involutina communis* (Kristan); axial sections, Lejowa Valley (section *I*, layers *6* and *15*), × 45.
6 — *Involutina tumida* (Kristan-Tollmann); axial section, Lejowa Valley (*I*, layer *15*), × 45.
7 — *Involutina* sp.; Lejowa Valley (*I*, layer *15*), × 45.

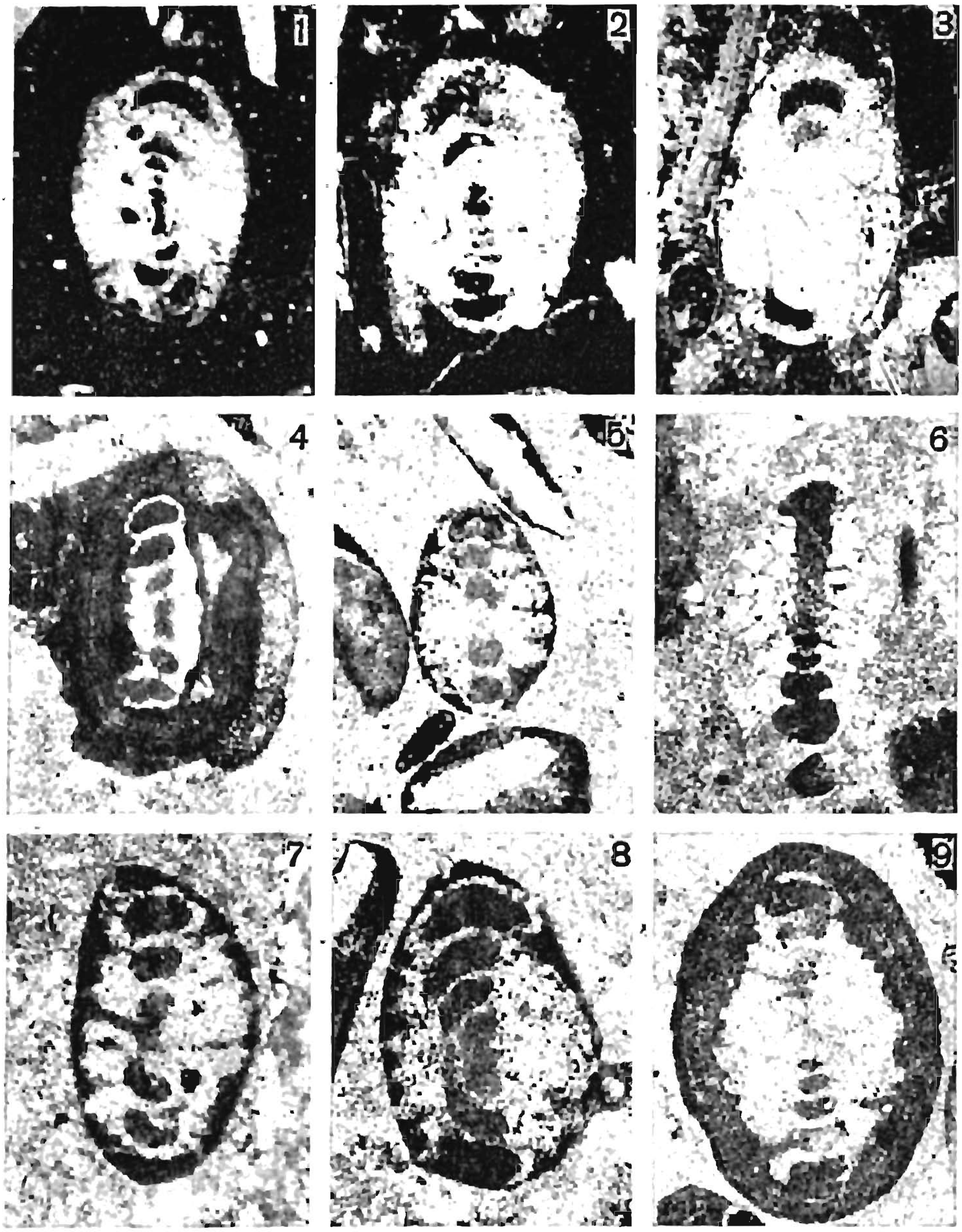


1-3 — *Involutina tumida* (Kristan-Tollmann); axial sections, Lejowa Valley (section *I*, layer *13*), × 50.

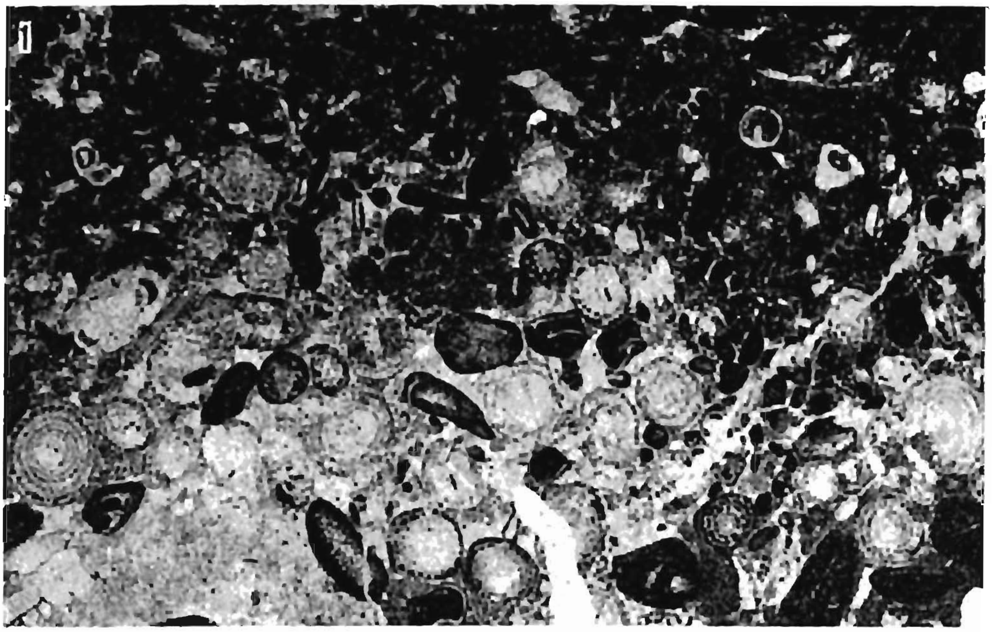
4-9 — *Involutina gaschei* (Koehn-Zaninetti & Brönnimann) from Lejowa Valley (*I*): *4* axial, *5—6* subaxial, *7* transverse, *8—9* oblique section (*4* and *8* from layer *15*, *5—7* and *9* from layer *20*), × 40.

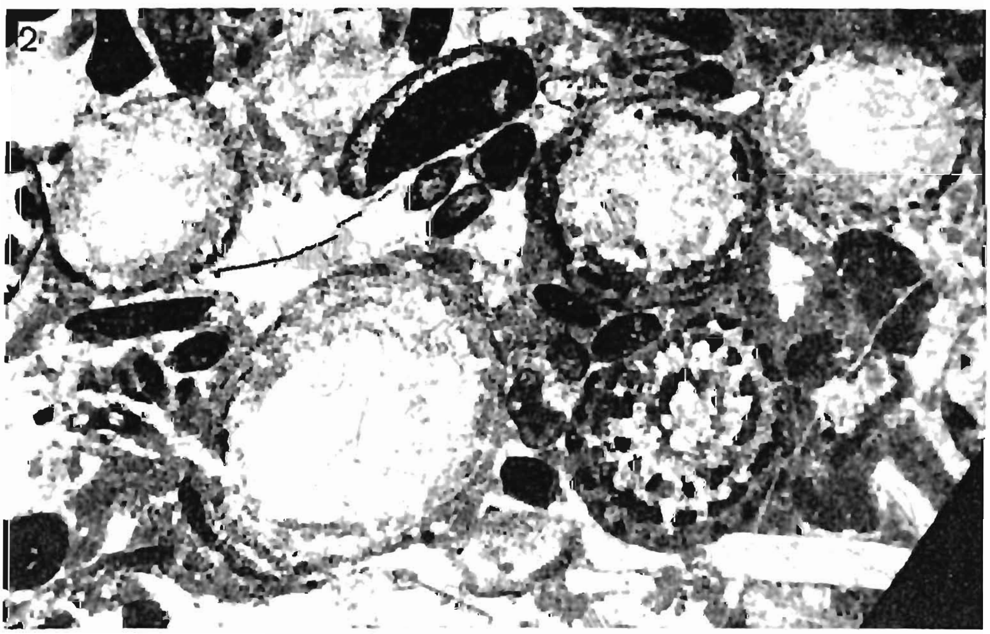


1a, 2 — *Involutina tenuis* (Kristan); axial section, Lejowa Valley (section *I*, layer *13*), × 50.
1b — *Involutina communis* (Kristan); Lejowa Valley (*I*, layer *13*), × 50.
3 — *Involutina* sp; Lejowa Valley (*I*, layer *13*), × 50.
4-5 and 7-8 — *Trocholina permodiscoides* Oberhauser; vertical sections from Lejowa Valley (*I*, layer *15*), × 50.
6 — *Trocholina* sp.; Lejowa Valley, × 50.



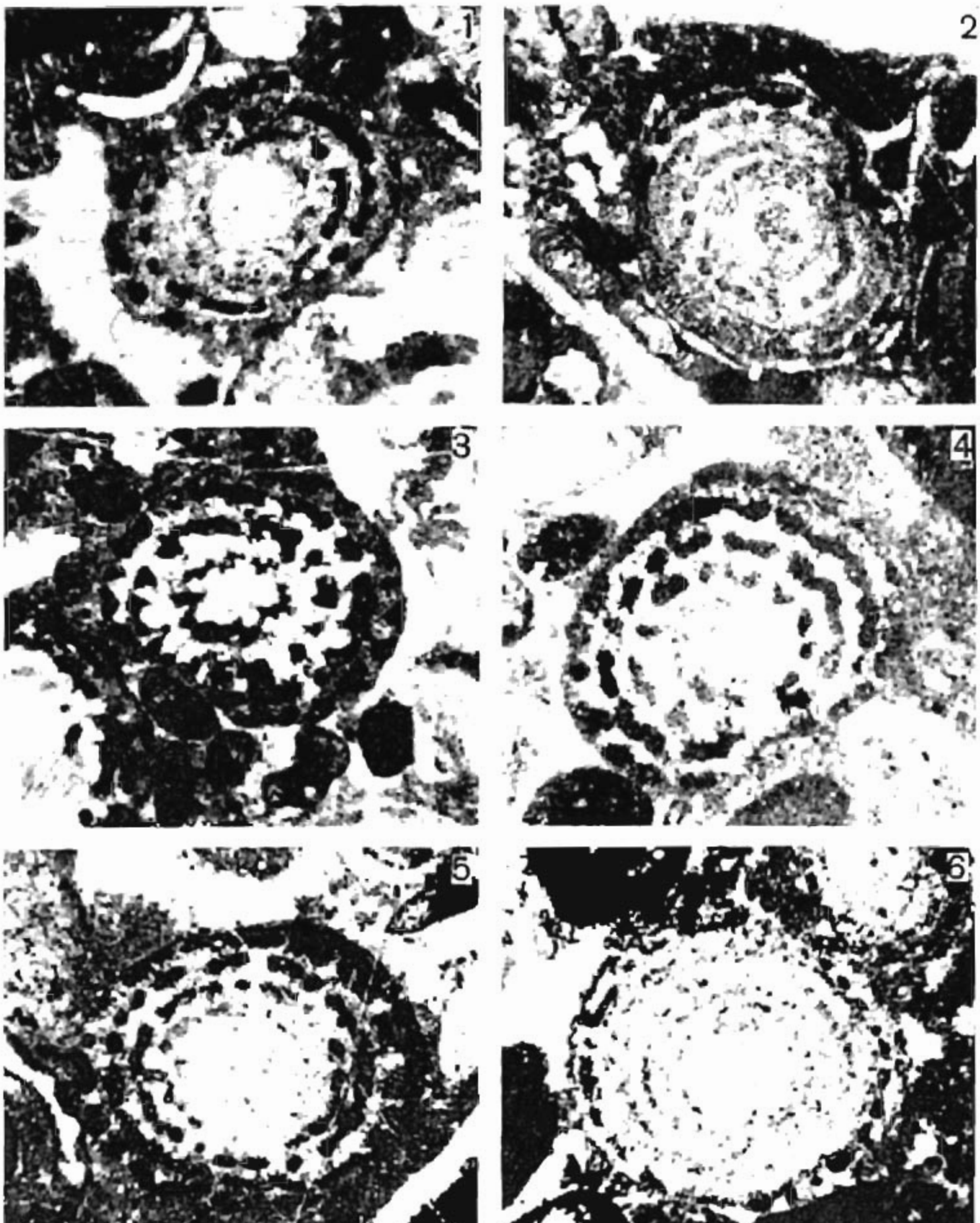
1-3 — *Involutina sinuosa sinuosa* (Weynschenk); subaxial sections Lejowa Valley (section *I*, layer *15*), × 30.
4 — *Involutina* cf. *liassica* (Jones); subaxial section, Strążyska Valley (*XI*, Lower Liassic), × 100.
5 — *Involutina farinacciae* Brönnimann & Koehn-Zaninetti; axial section, Strążyska Valley (*XI*, Lower Liassic), × 100.
6 and 9 — *Involutina* sp.; Strążyska Valley (*XI*, Lower Liassic), × 100.
7 — *Involutina* cf. *farinacciae* Brönnimann & Koehn-Zaninetti; subaxial section, Strążyska Valley (*XI*, Lower Liassic), × 100.
8 — *Involutina* cf. *turgida* Kristan; subaxial section, Strążyska Valley (*XI*, Lower Liassic), × 100.





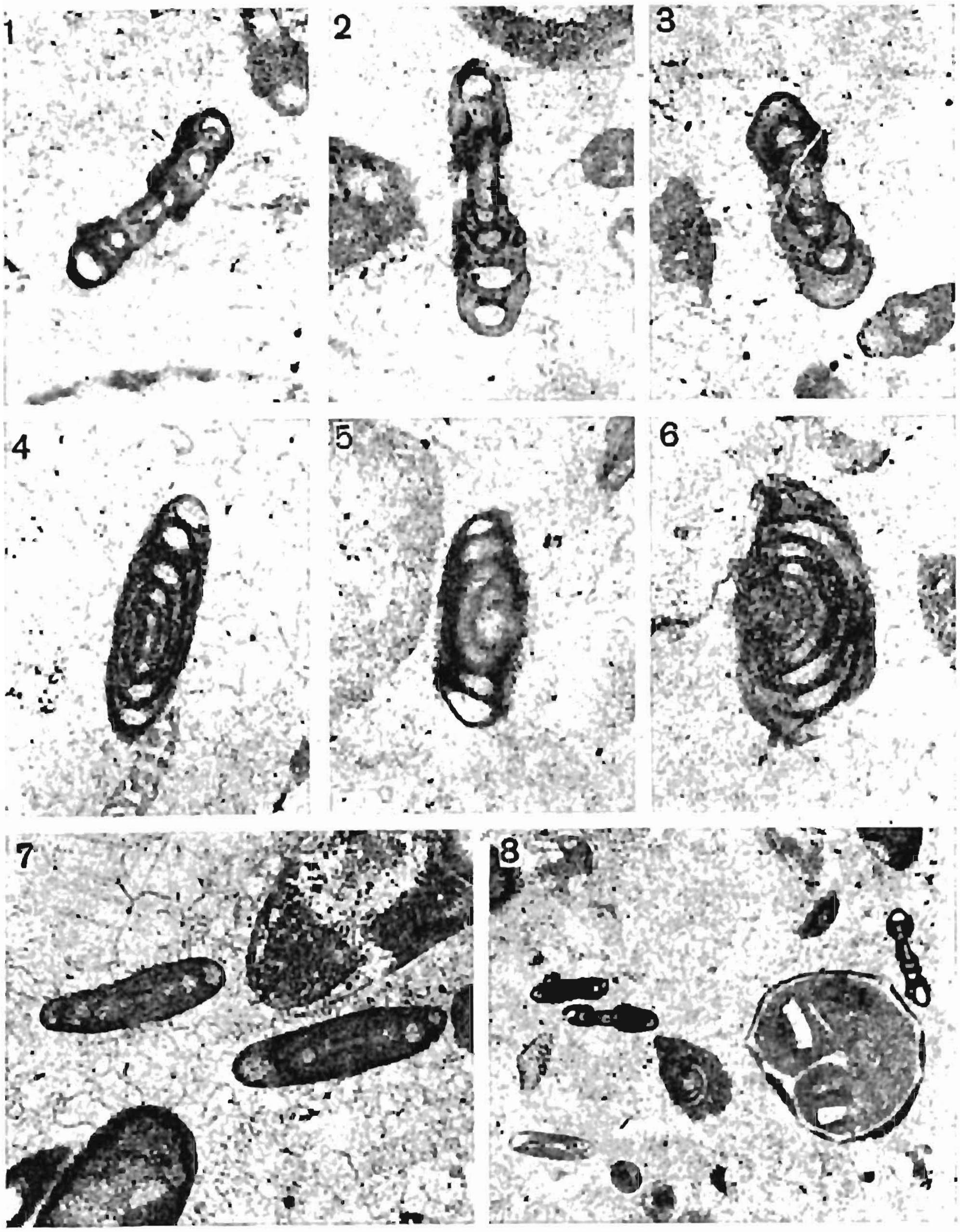
1 — Microfacies with *Triasina hantkeni* Majzon in organodetrital limestone, × 10.
2 — Detailed view of microfacies with *Triasina hantkeni* Majzon; visible are tests with chambers sparitized to a variable extent, × 40.

Lejowa Valley (section *I*, layer 15)



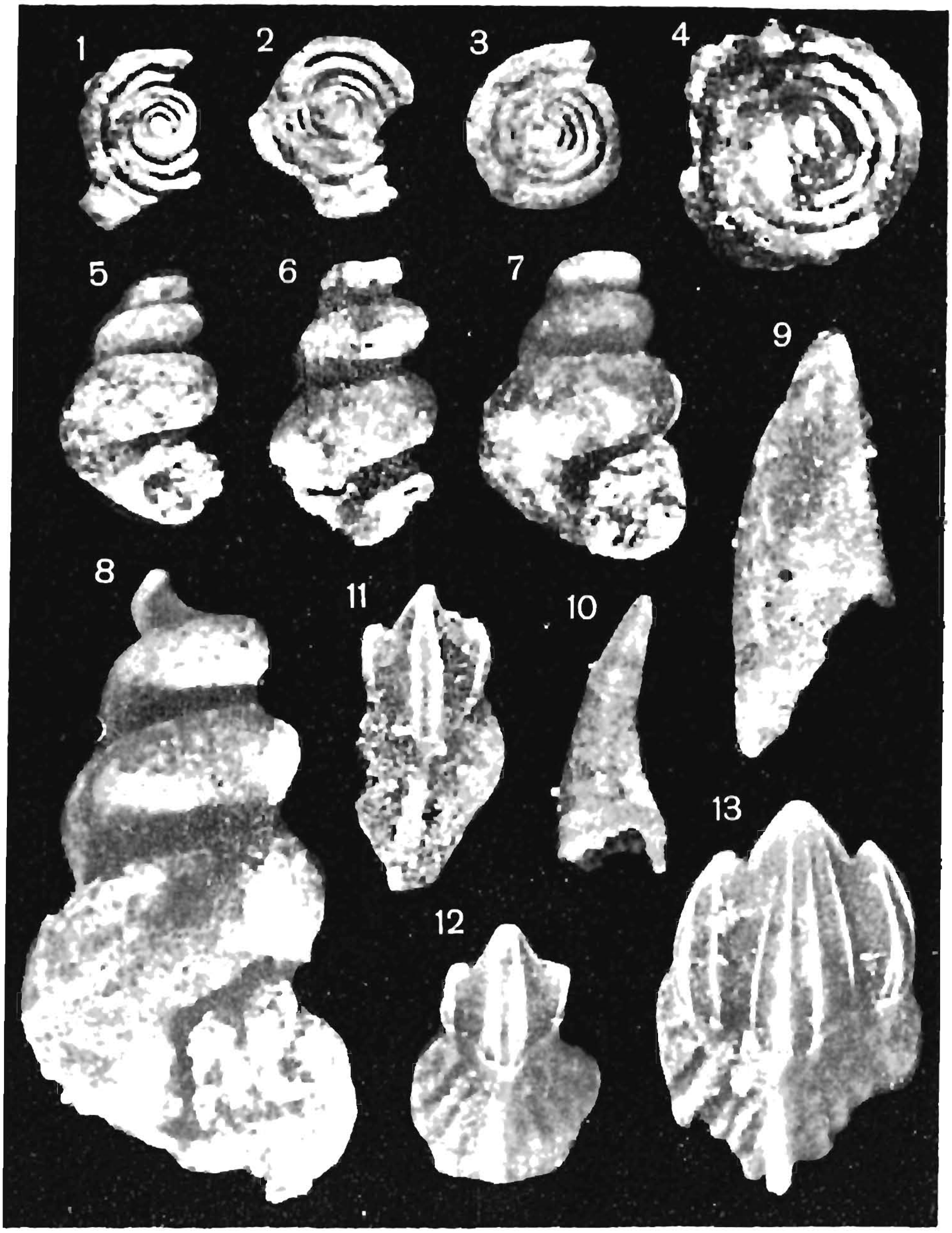
Triasina hantkeni Majzon

1 — subaxial section, Javorina (section *IV*, layer *2*), 2 — axial section Mt. Palenica Lendacka (*VI*, layer *48*), 3—5 — oblique and 6 — equatorial section, Lejowa Valley (*I*, layer *15*); × 45



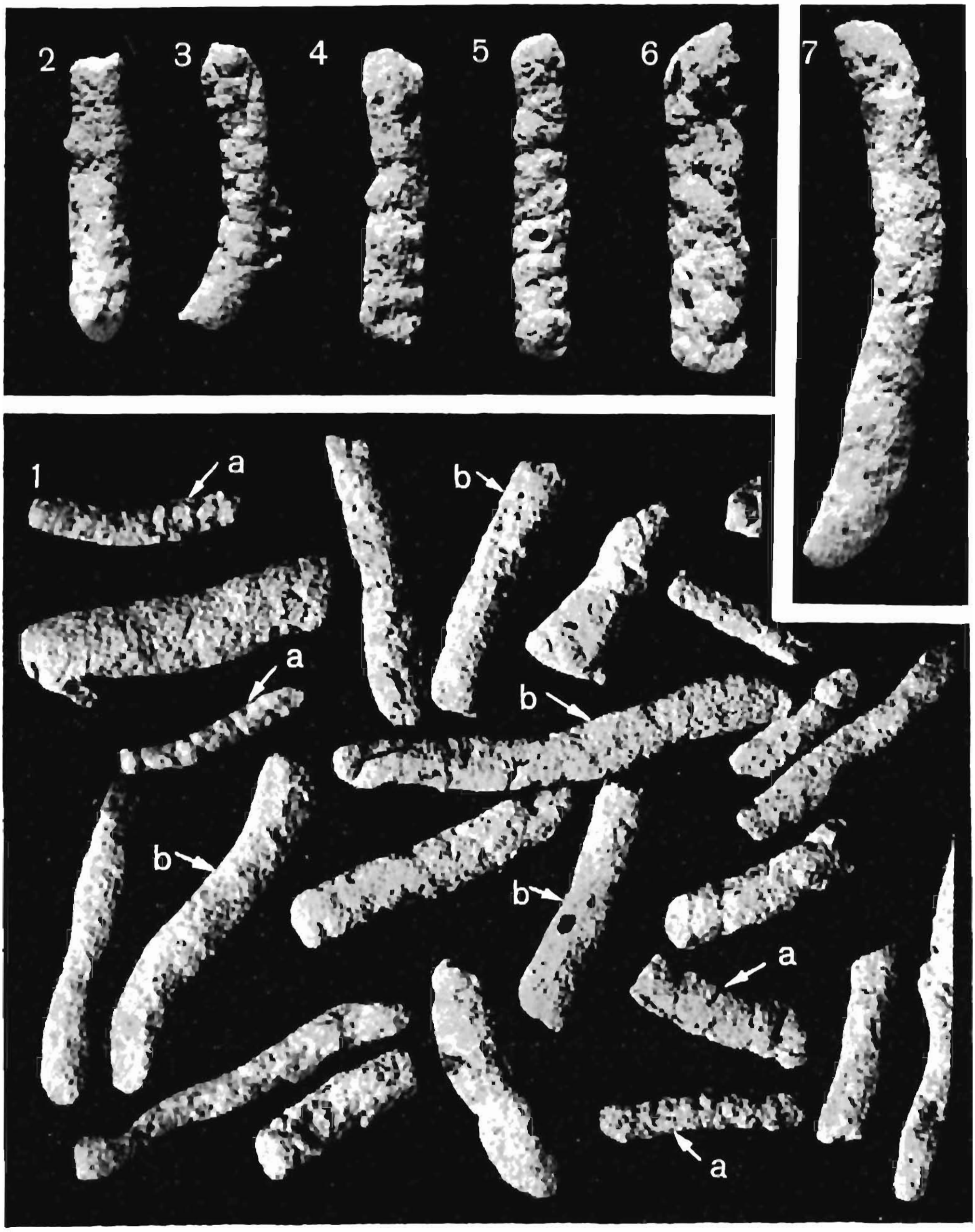
"*Vidalina*" *leischneri* (Kristan-Tollmann)

1-3 — axial, 4-5 — oblique, 6 — equatorial section; × 130
7 and 8 — frequent tests in biosparite, × 50
Strążyska Valley (section *XI*, Lower Liassic)



1-4 — Moulds of *Ammodiscus* sp.; Juráňova Valley (section VII).
5-8 — Moulds of small gastropods (*5—6* from Juráňova Valley, *VII*; *7—8* from Mt. Hradok, *XV*).
9-10 — Small teeth of fish, Mt. Hradok (*XV*).
11-13 — Elasmobranch shagreen ("*Nurrella*" sp.), Mt. Hradok (XV).

All figures are × 60



1 — Assemblage of coprolites: a — *Bactryllium ornatum* sp. n. and b — *Bactryllium elongatum* sp. n., × 15.
2-6 — *Bactryllium ornatum* sp. n. (5 presents the holotype), × 25.
7 — *Bactryllium elongatum* sp. n. (holotype), × 25.

Mt. Mały Kopieniec (section *III*, layer 2)