GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATHICA 30, 1, BRATISLAVA, MARCH 1979

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SOME NEW FORAMINIFERA-SPECIES OF THE FATRA — FORMATION (UPPERMOST TRIASSIC) IN THE WEST CARPATHIANS

(Plates I—IV, Figs. 1—10)

Abstract: A concise characteristics of the Fatra-Formation and description of ten foraminifera species were given *Glomospira inconstans* n. sp., *Glomospira inflata* n. sp., *Glomospirella fatrica* n. sp., *Glomospirella minima* n. sp., *Glomospirella paucispira* n. sp., coming from the upper part ("Upper Biostrome" base) of two parastratotype profiles of the Fatra Formation.

Резюме: В статье приводятся краткая характеристика фатранской формации и описание десяти видов фораминифер: *Glomospira inconstans* n. sp., *Glomospira inflata* n. sp., *Glomospirella fatrica* n. sp., *Glomospirella minima* n. sp., *Glomospirella paucispira* n. sp., встречающих в верхней части (основа „Upper Biostrome") двух парастратотипических профилей Фатранской формации.

1. General geological part

a) Introduction

The first monographs on the development of the West Carpathian Uppermost Triassic have been written by D. Stur (1860) and G. Stache (1868). E. Suess (in E. Suess — E. Mojsisovics, 1868) named this complex "Carpathian Facies of Rhaetic" and V. Uhlig (1897) used a metaphor "guide star of Carpathian geologists". W. Goetel (1911, 1916, 1917) J. Koutek (1927), M. Mahel (1958), R. Kúšik (1957, 1967), P. Čepek (1970) and others investigated it more recently. Despite of numerous publications a detailed stratigraphical correlation remains unsolved owing to often washouts, local sedimentary gaps, instability of lithological horizons, variety of facies, but particularly owing to the fact that no one known species of rather diversified benthic fauna is appropriate for detailed regional correlations.

J. Michalík (1977) distinguished several developments of the Uppermost Triassic sediments in the West Carpathians: the Tomanová-Fmt. in the Tatric area of the High Tatra Mts., the "Fatra-Member of the Kössen Fmt." in the Fatric area, "Hybe-Member of the Kössen-Fmt." and "gray limestones" in the Hronic and "Dachstein-, ?Wetterstein- and Zlambach-Formations" in the southernmore paleogeographical areas.

b) Division of the Fatra-Formation

Development of the Uppermost Triassic sediments in the Fatric (named before "Koessener Schichten" or simplier, but incorrectly "Rhaetian") has been antitled by J. Michalík (1974) "Fatra-Schichten". Its type profile has been described by J. Michalík (1976) in the Dedošova-valley in the Veľká Fatra

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Mts. J. Michalík (1975, 1977, 1978) regarded the "Fatra-Member" and "Hybe-Member" as two (partially synchroneous) members of the "Carpathian Koessen Formation". However, more detailed study proved that the "Hybe--Member" is linked closer with the Dachstein-limestone development and it has no direct facial-, space- and stratigraphic connection with the "Fatra Member". Thus, the "Fatra-Member" remains only representative of the insufficiently defined "Carpathian Koessen Formation", which, despite of several almost identical features and of very similar faunal assemblages is still different from the typical "Koessener Schichten" of the Alps. Thus, it seems be more acceptable to consider this complex as independent formation.

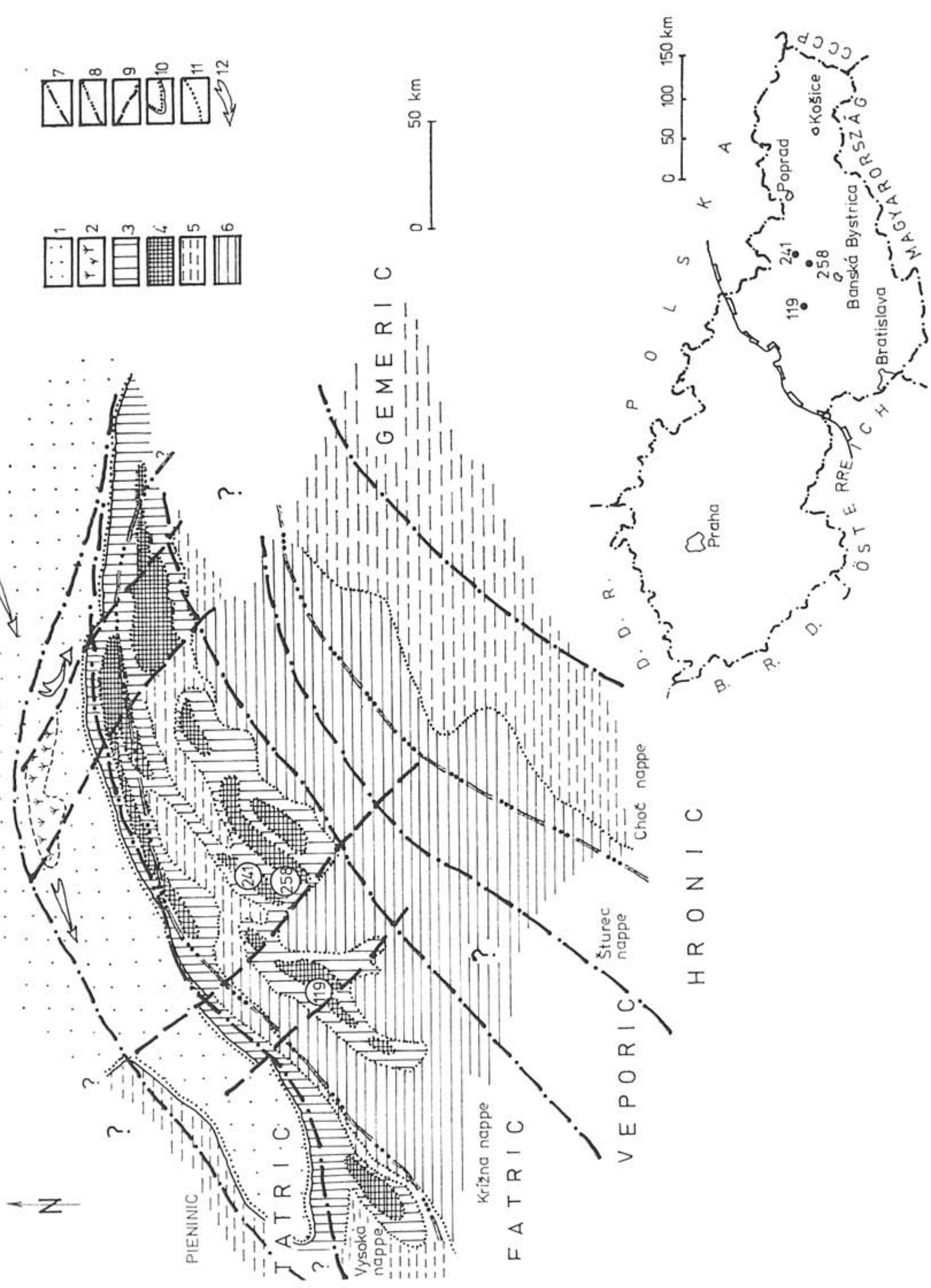
The name of the Fatra-Fmt. is derived from the Veľká – and Malá Fatra Mts.: the most instructive profiles of this formation have been founded in this area. All the Fatric area was situated in the sedimentary basin of the Fatra-Formation. The sediments of this basin form today a part of the nappe slices of the Vysoká--nappe (the Vysoká-, Belá-, Ďurčiná-, ?Malá Fatra-, Suchý wierch-, Havran- and other slices), Krížna-nappe s. s. (Zliechov-nappe sensu M. Maheľ, Bobrovec- and Bujačí-unit). The lithostratotype of this formation lies in a lavine--groove under Mt. Krížna in the closure of the Dedošova-valley (Veľká Fatra Mts., profile no. 258 in J. Michalík, 1974, see Figs. 1–2). The cutting of the road near Híreška-pub in the Strážov Mts. (no. 119 in J. Michalík, 1973, 1974; see Figs. 3–4), the cutting of a forest road in the Ráztoky valley (in Nolčovo valley in the northern Veľká Fatra Mts., no. 241 in J. Michalík, 1974; see Fig. 5) and the ravine on the western slope of Mt. Veľká Furkaška in the West Tatra Mts. (no. 352 in J. Michalík, 1977, A. Gaździcki et al. in press) are paralithostratotypes.

The average thickness of the Fatra-Fmt. is nearly 30 meters, however it is very variable: while in the nearshore area it reaches hardly 16 meters, it can overstep in the maximum subsidence zones 40–50 m.

The Fatra-Fmt. sequence consists of dark organodetrital- to brecciated-, crinoidal-, organodetrital-, broken shelly-, oolitic-, lumachellar bivalve- and brachiopod-, and porifera-limestones with dark marly intercalations, marlstones and laminated dark-gray dolomites. From the microfacial point of view the biosparites are most frequent, oobiosparites, biopelmicrites, biointramicrites and foraminiferal biomicrites are less abundant. A very small amount of terrigenous material is present in lithological horizons: the prevailing part of the detritus is derived from skeletons of organisms (corals, sponges, bivalves, crinoids, brachiopods, foraminifers, algae etc.) which lived in the sedimentary basin. Terrigenous quartz admixture is very low: it is more distinct in the northeast nearshore area (present Havran-nappe of the Belianske Tatry Mts.).

The lithological horizons occur in cycles beginning from the clastic limestones to the organogene and oolitic ones. Some cycles are terminated with a marly and dolomite horizon. Almost every new cycle begins with out-washing. This

Fig. 1. Localisation of the investigated profiles in Czechoslovakia (lower right corner) and in the paleogeographical scheme of the West Carpathian Uppermost Triassic (above it). Legend: 1 – dry land, 2 – lacustrine-limnic facies, 3 – nearshore and neritic zone facies, 4 – biostromal facies, 5 – deeper neritic facies, 6 – basinal facies, 7 – tectono-paleogeographic units, 8 – tectonic subunits, 9 – synsedimentary faults, 10 – shore line, 11 – limits of the facial zones, 12 – probable transport direction.


N
PIENINIC
TATRIC
Vysoká nappe
FATRIC
Križna nappe
VEPORIC
Šturec nappe
HRONIC
Choč nappe
GEMERIC
241
258
119
0
50 km
1
2
3
4
5
6
7
8
9
10
11
12
POLSKA
D. D. R.
B. R. D.
ÖSTERREICH
MAGYARORSZÁG
Praha
Bratislava
Banská Bystrica
Poprad
Košice
0 50 100 150 km

fact, combined with irregular space development of individual horizons leads to the origin of a very complicated and variable sequence. The individual cycles may be of several ten to several hundreds centimeters thick. The thickness of all the formation has been reduced by out-washings and local sedimentary gaps to a fraction of the possible value.

Ten lithofacial regions were distinguished in J. Michalík (1973, 1974, 1977): two littoral (Kysuca-, northern Tatra-) regions, two nearshore (Orava-, eastern Tatra-) regions, four open shoal (Strážov-, Magura-, Rajec-, Turiec-) regions and two deeper (Žiar-, Nitra-) regions. Several areas (Malé Karpaty Mts., Čierna hora Mts., Ružbašské pohorie Mts.) could not be placed to certain lithofacial region owing to lack of exposures.

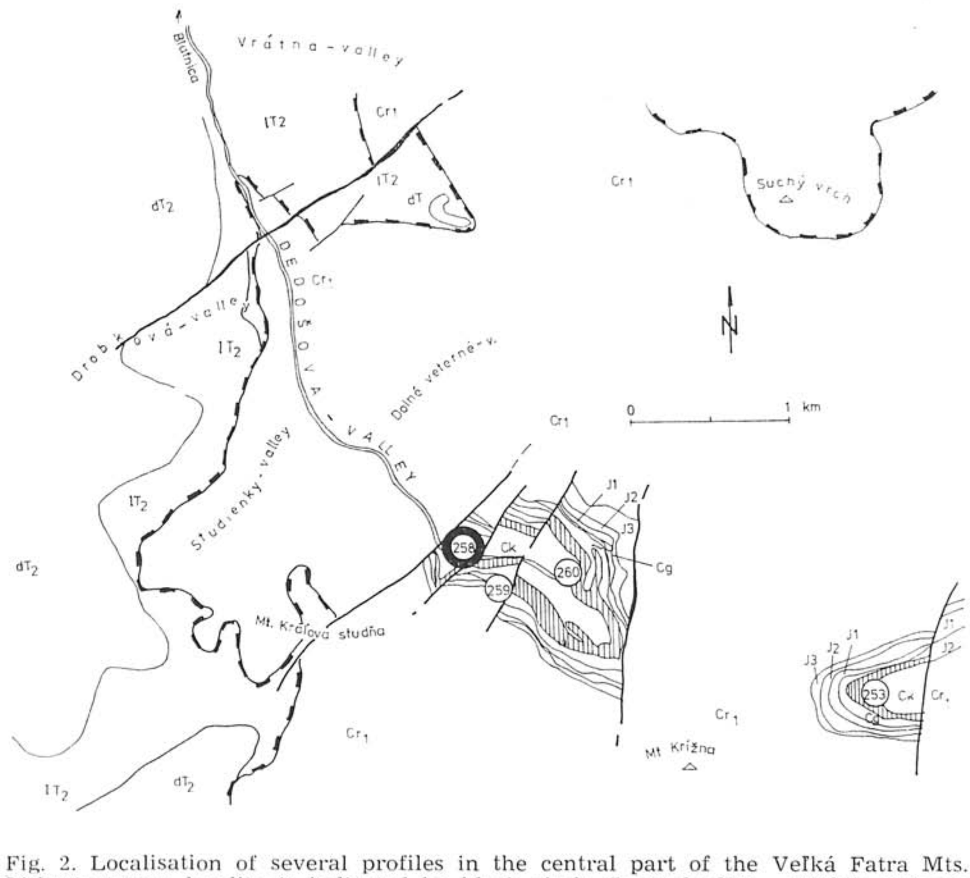


Fig. 2. Localisation of several profiles in the central part of the Veľká Fatra Mts. Lithostratotype locality is indicated by black circle. Legend: dT2 — Middle Triassic dolomites (Choč-nappe), 1T2 — Middle Triassic limestones (Choč-nappe), Ck — Carpathian Keuper Group (Krížna-nappe), hatched-Fatra Formation (Krížna-nappe), Cg — Kopienec Formation (Hettangian, Krížna-nappe), J1, J2, J3 — Lower, Middle and Upper Jurassic formations of the Krížna-nappe, Cr 1 — Lower Cretaceous sediments (Krížna-nappe).

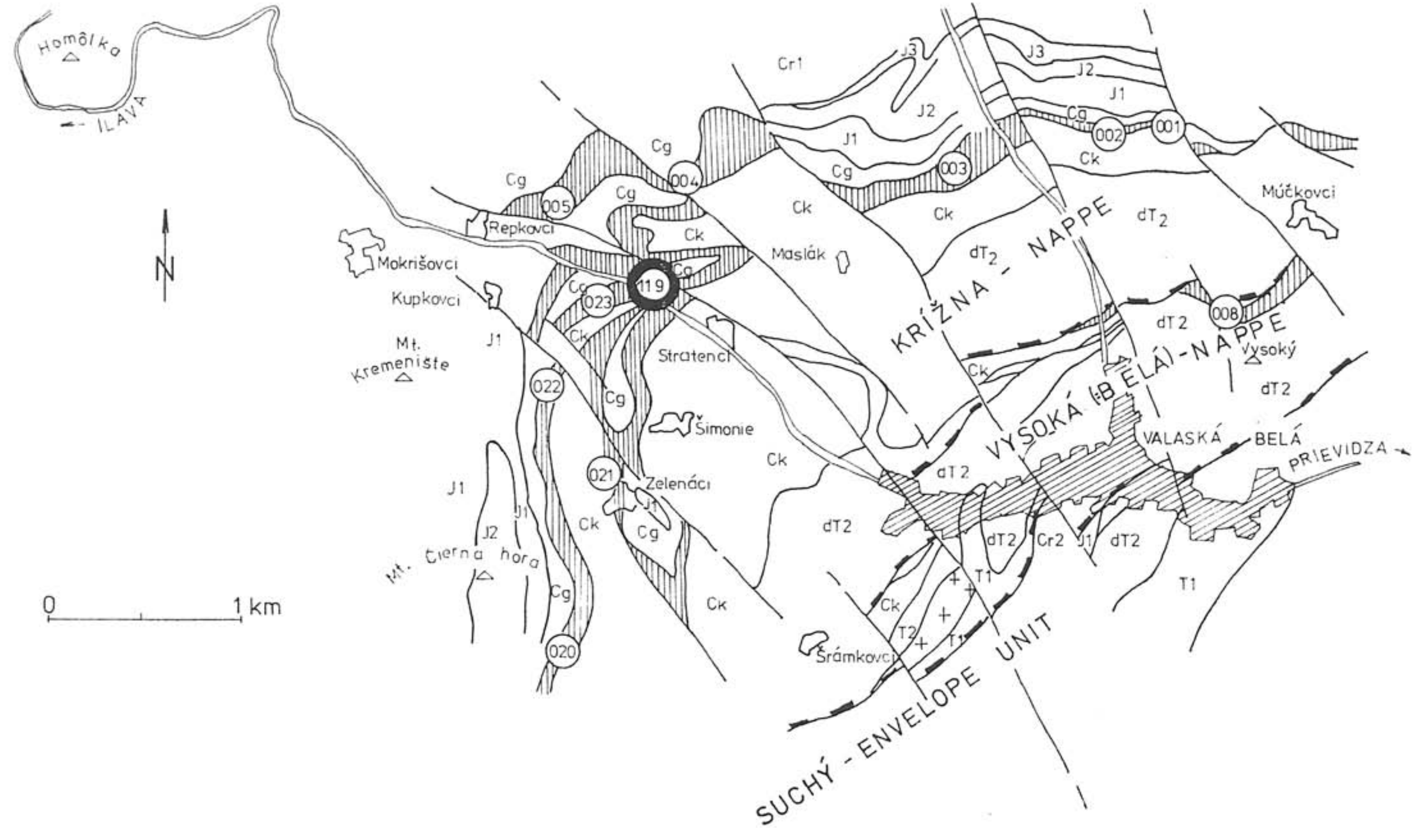


Fig. 3. Localisation of several profiles in the central part of the Strážov Mts. The parastratotype locality Híreška is indicated by black circle. Legend: crossed-crystalline, Tl – Lower Triassic, dT2 – Middle Triassic dolomites, Ck – Carpathian Keuper Group, vertically hatched-Fatra Formation, Cg – Kopieniec Formation (= Carpathian Gresten), J1, J2, J3 – Lower, Middle and Upper Jurassic formations, Crl – Lower Cretaceous, obliquely hatched- Valaská Belá municipal area.

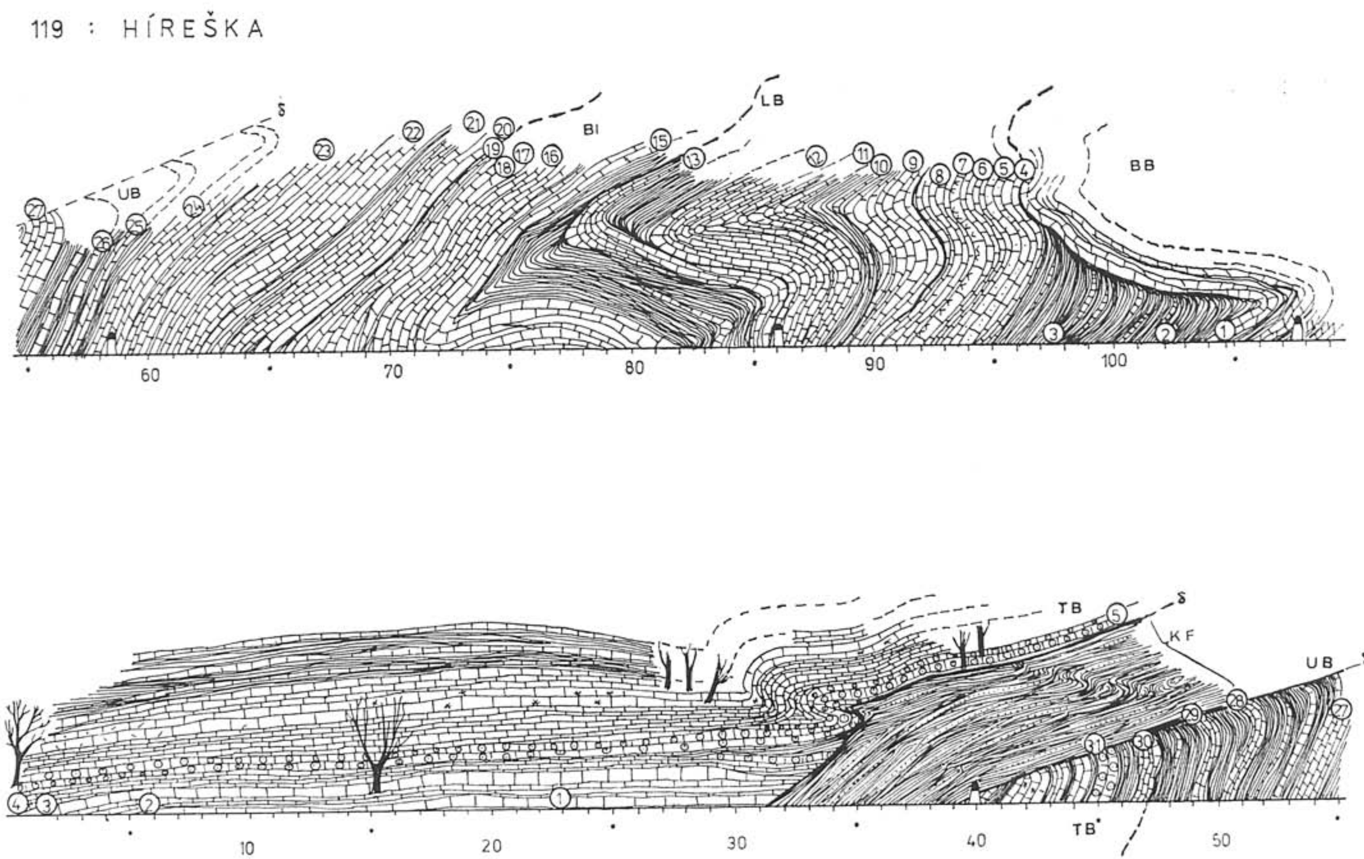


Fig. 4. Tectonic and lithostratigraphic situation of the main horizons in the profile of Híreška (119), Strážov Mts. BB – Basal beds, LB – Lower Biostrome, BI – Barren interval, UB – Upper Biostrome, TB – Transition beds, KF – tectonic slice of the Kopieniec Formation (Hettangian). The scale on the lower margin in meters. Compare with Figs. 6 and 8.

2. *Ecology and stratigraphy*
a) *Interpretation of life- and sedimentary environment*

All the organisms of the Fatra-Fmt. have not been systematically investigated as yet. A. Gaździcki (1973, 1974) and O. Jendrejáková (in J. Michalík – O. Jendrejáková, 1978) described some foraminifers, E. Roniewicz (1974) some corals, M. Kochanová (1967) some bivalves, A. Gaździcki (1971) some megalodons, J. Michalík (1975, 1976, 1978) brachiopods, A. Gaździcki – C. Duffin (1977) some vertebrate remains. The algae, calcisponges, ostracods, gastropods ad echinoderms remain practically unknown closer as yet. Despite of it, the basic features of biocenoses (J. Michalík – O. Jendrejáková, 1978), paleogeography (J. Michalík, 1978) and paleobiogeography (J. Michalík, 1979) of this area could have been reconsidered.

The present state of knowledge allows to suppose that the Fatra Fmt. sedimented in partially isolated sea basin with normal to slightly higher salinity. The climate was rather dry, subtropical (the water temperature probably 21–28 °C in shallows, to 18–22 °C in deeper waters). Average depth of water in the oolite shallows was 0–15 meters, the coral biostromes grew in the depths between 2 and 50 meters, the maximum depth of the basin probably did not

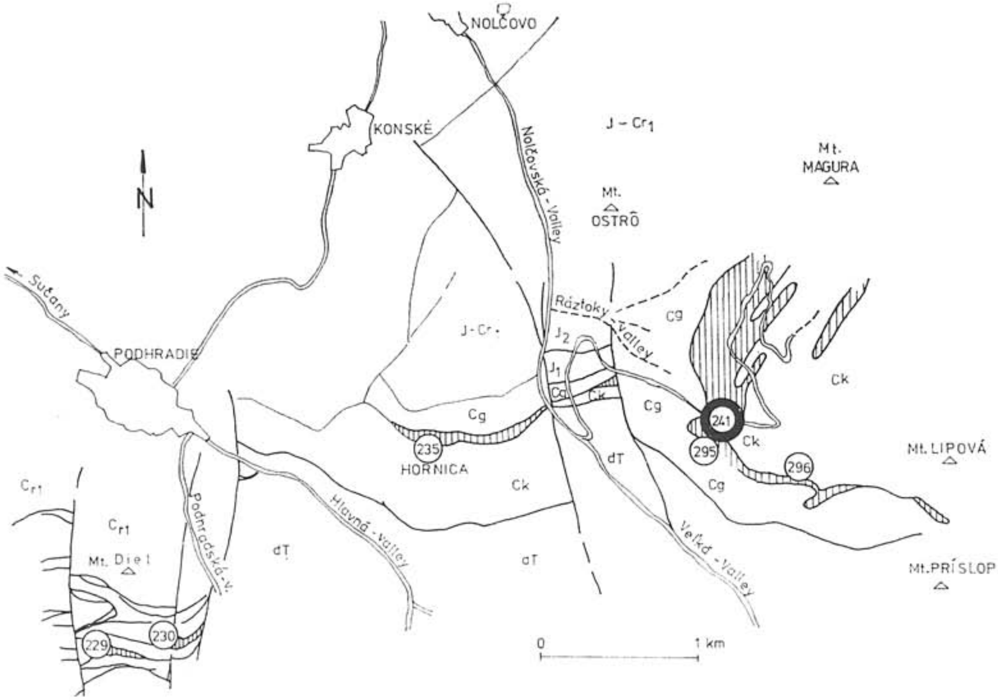


Fig. 5. Localisation of several profiles in the northern part of the Veľká Fatra Mts. The parastratotype locality is indicated by black circle. Legend: dT – Middle and Upper Triassic dolomites, Ck – Carpathian Keuper Group, vertically hatched-Fatra Formation, Cg – Kopieniec Formation (Carpathian Gresten, Hettangian), J1, J2, J3 – Lower, Middle and Upper Jurassic, Crl – Lower Cretaceous (Krížna-nappe).

exceed 100—200 meters. A broad lowland or flat arid basin with terrigenous sedimentation separated this sea basin from the continent.

A different tectonical activity and different subsidence of the various parts of the sea bottom have been caused by synsedimentary transversal faults: their course was described in J. Michalík (1977 in Fig. 5 and 1978).

Although the flat and shallow bottom, warmed and aerated water, and ensured nutrients support offered rather good conditions for the benthic faunas development, the frequent salinity and bathymetry fluctuations made the stabilization of the communities impossible. Unstable environment of the Fatra-Fmt. prefered the development of opportunistic species with low genetical variability and high fecundity. This is the reason why most of its communities belong to the immature communities category. They are consisting of the sets of eurytopic species with numerous posterity and short ontogeny. The ineffective exploitation of the sources, high population density, low diversity and unequal distribution of the taxa are most characteristic for them.

J. Michalík — O. Jendrejáková (1978) and J. Michalík (1978) distinguished seven biocenotic zones, which have characterized intertidal-, subtidal-, protected neritic-, proper biostromal-, biostromal fringe-, shallows border-, and deeper, open neritic-zone. Other communities were specialized on local, often short-timed conditions.

The types of the sedimentary- and life-environment, like this are rather frequent in the Earth history. A. K. Armstrong (1972) in the Late Palaeozoic of the U. S. A., A. Arnaud-Vanneau — H. Arnaud (1976) in the Urgonian of the French Fore-Alps, H. M. Pedley (1976) in the Tertiary of the Isle of Malta, G. Einsele et al. (1967) and G. Evans (1970) in the Recent Red Sea and Persian Gulf used a very similar sedimentologic-ecological model.

b) *Litho- and biostratigraphical remarks*

The preserved Fatra-Fmt. sequence is a very incomplete record of the Uppermost Triassic sedimentation. That is the reason why are the profiles only with difficulty correlable with one another. Thus, solving of the stratigraphy is an especially intricated problem.

Rhaetavicula contorta, which was defined originally as the Rhaetian index-species, has too wide stratigraphical range. The ammonite *Choristoceras marshi* has not been found in the West Carpathians as yet. A parastratigraphical correlation (as suggested by S. J. Morbey, 1975) has been made in the Tomanová-Formation only (High Tatra Mts., J. Michalík, E. Planderová, M. Sýkora, 1976). The microflora, found in its upper part is correlable with that from the Ch. marshi-zone of the Alpine Kendelbachgraben-profile. A. Gaździcki (1974), studying six profiles of the northern slope of the High Tatra Mts. made the first attempt to divide the Fatra Fmt. in detail. He has recognized three foraminiferal zones: the unnamed lower one ascribed to the Uppermost Sevatian, the *Glomospirella pokornyi* — *G. friedli*-zone compared with closer undefined "Lower Rhaetian" and *Triasina hantkeni*-zone regarded as the "Upper Rhaetian". However, the comparison of the A. Gaździcki's really well documented profiles already indicates that the "index species" are very inadequately distributed in the sequence. These irregularities have been caused, according to A. Gaździcki (1976), by diachronic distribution of the Rhaetic and Gresten

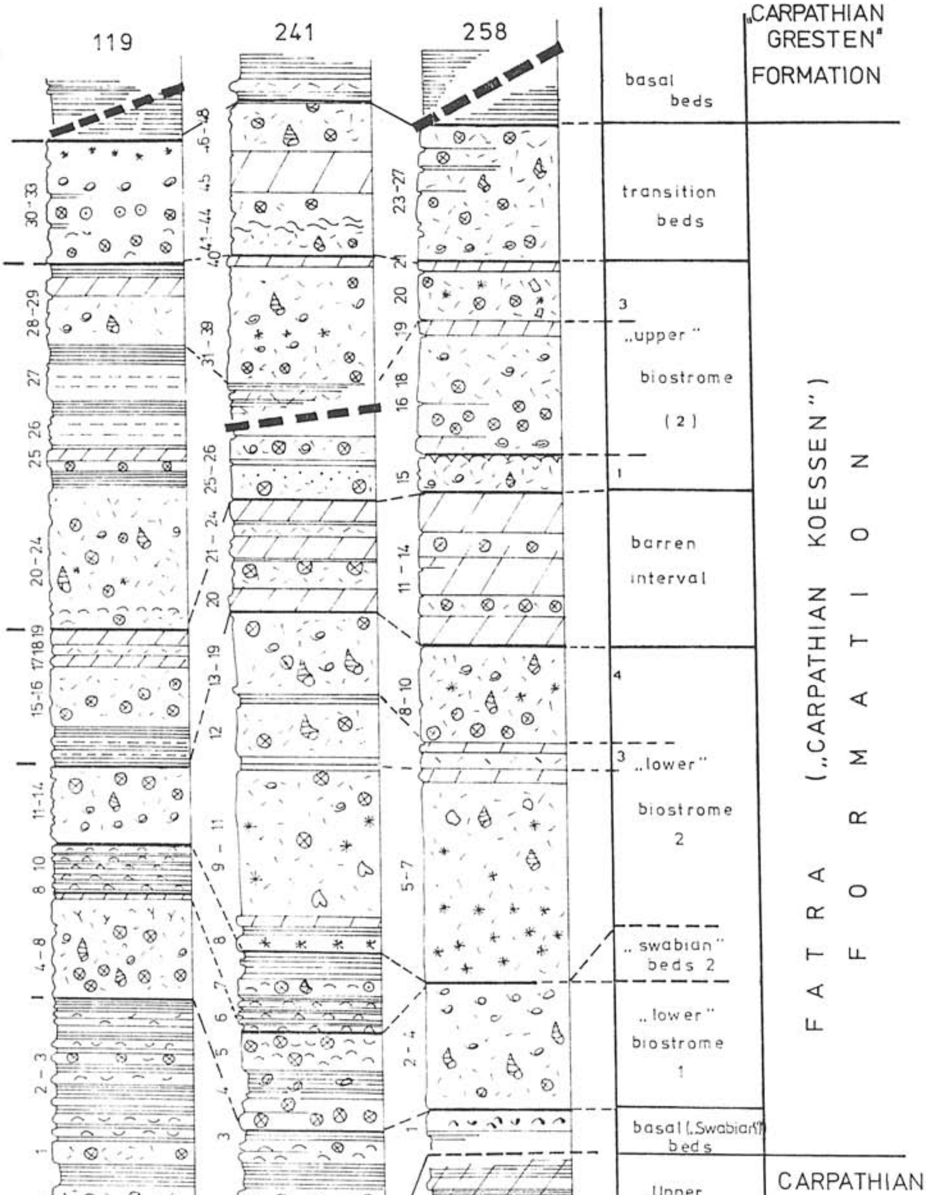


Fig. 6. Schematic correlation of the sequence in three investigated profiles (see Figs. 7–9 for explanation).

lithofacies (and by the effects of other phenomena: sedimentary gaps etc.). A. G a ż d z i c k i's "Upper Rhaetian" index species *Triasina hantkeni* M a j z o n occurs relatively very low (horizon no. 7 in profile 268) in the sequence. A palynologically productive horizon, correlable with *Ch. marshi* horizon of Kendelbachgraben (S. J. M o r b e y, 1975) has been found below the base of the Fatra-Fmt. in the West Tatra Mts. (profile 352, A. G a ż d z i c k i, J. M i c h a l í k, E. P l a n d e r o v á, M. S ý k o r a, in press). Thus, the Fatra-Fmt. may well represent the Uppermost Rhaetian, younger than the zone with *Choristoceras marshi* occurrences. However, the present investigation of the biostratigraphy of the Fatra-Fmt. confirms that there is a long way to definitive conclusions. Further investigations are inevitable.

Despite of limited correlability of the Fatra-Fmt. with other isochronous sedimentary formations at the present state of knowledge, some preliminary lithostratigraphic considerations could be made. The lithofacial, micro- and macrofaunal study allows to divide the recognized sequences into informal members as follows (see Fig. 6):

1. Basal beds are characterized by the shelly-limestone sequence with slight terrigenous supply and with bivalve fauna [*Chlamys favrii tatrica* (G o e t e l), *Ch. winkleri* (S t o p p.), *Modiolus minutus, Neoschizodus* sp. etc.] and foraminifers *(Trochammina alpina* K r i s t a n — T o l l m a n n, *Agathammina* sp., *Nubecularia* sp., *Ophthalmidium* sp. and other). This development is typical for so called "Swabian facies" (E. S u e s s — E. O p p e l, 1856).

2. The lower biostromatic member contains two-or more sedimentary cycles. The basal horizon of each of them can be developed in the facies, similar to the "basal beds". The bioclastic limestone above it, passing into coralligenous *(Pinacophyllum* sp., *Stylophyllum gracile* R o n., *Phacelostylophyllum medium* R o n., *P. robustum* R o n. etc.), porifera (calcisponges) — bearing, algal- (like Nipponophycus-type), megalodon-bearing *(Conchodon infraliasicus* S t o p p., *C. goeteli* G a ź d z., *Rhaetomegalodon tatricus* G a ź d z. etc.), gastropoda-bearing, foraminiferal [*Agathammina austroalpina* K r i s t a n - T o l l m a n n et T o l l m a n n, *Ammodiscus incertus* (d'O r b i g n y), *Tetrataxis inflata* K r i s t a n etc.] and brachiopoda-bearing [*Rhaetina gregaria* (S u e s s)] limestones are most frequent. The definition of this member is close to the "Carpathian facies" of E. S u e s s (1968), with "Lithodendronkalk" (=coral lst.) intercalations.

3. The barren interval is composed of dolomite, dolomitic limestone and redeposited clastic limestone layers, obviously with only poor fauna. Although the correlation of this member in the different profiles is sometimes ambiguous, it seems that probably a regresive phase, in which it originated, affected most of the shallow zone in the basin.

4. The upper biostrome member is very similar to the lower one. It contains several sedimentary cycles, too. However, its coral-, foraminifera- and other fauna is slightly different (see Figs. 7—9). The new described foraminifera species are coming from the base of this member.

5. The transition beds contain several uncommon lithological horizons: mud limestones with nodular bedding planes and ostracode fauna, distinct oolitic limestone layers, bivalve shelly limestones with "mixed" Rhaeto-Hettangian fauna of bivalves [*Cardinia* sp., *Chlamys valoniensis* (D e f r.), *C. dispar* etc.] and foraminifers *(Ammodiscus multivolutus* R e i t l i n g e r, *Trocholina multispira* O b e r h a u s e r etc.).

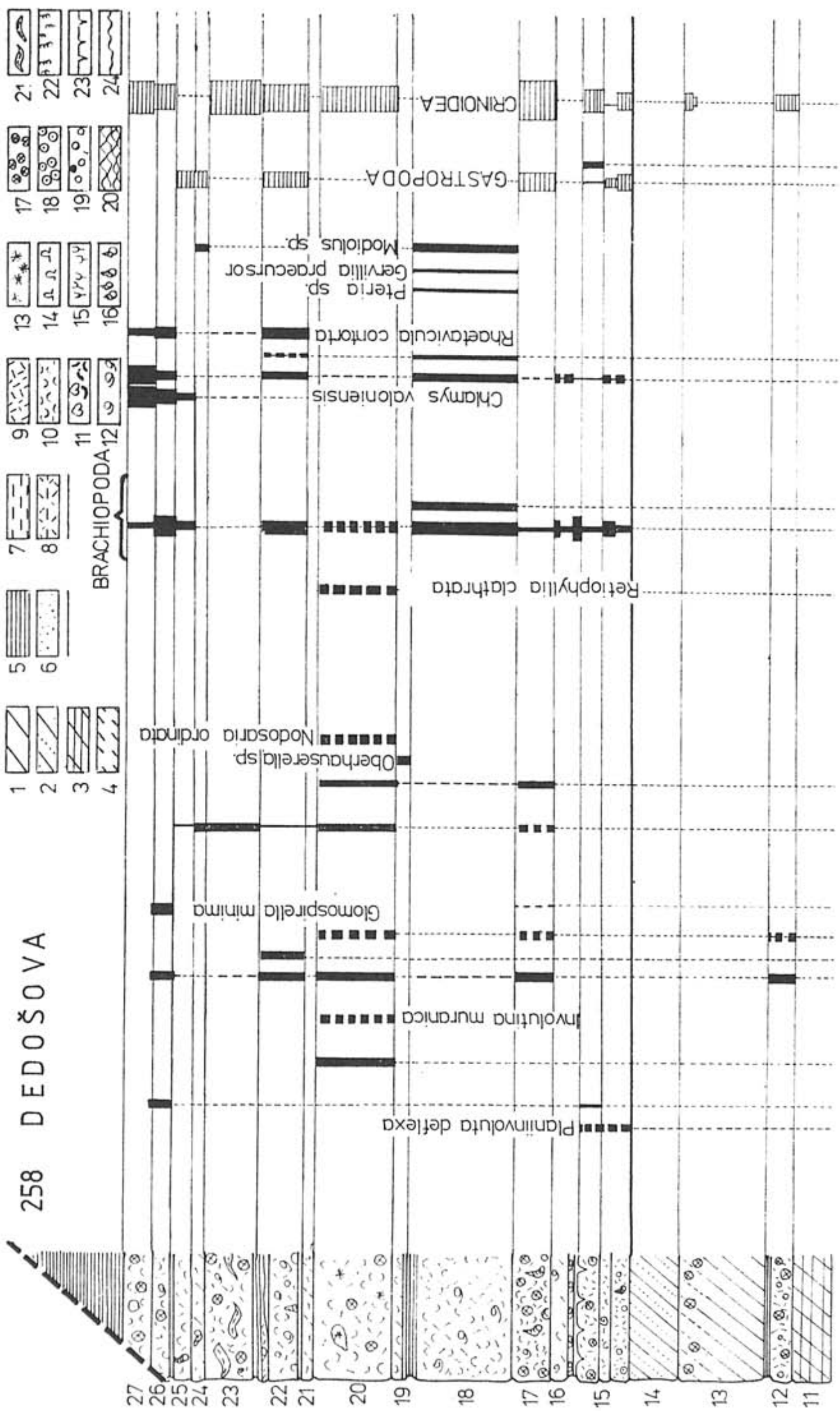
3. Micropaleontology
a) General remarks

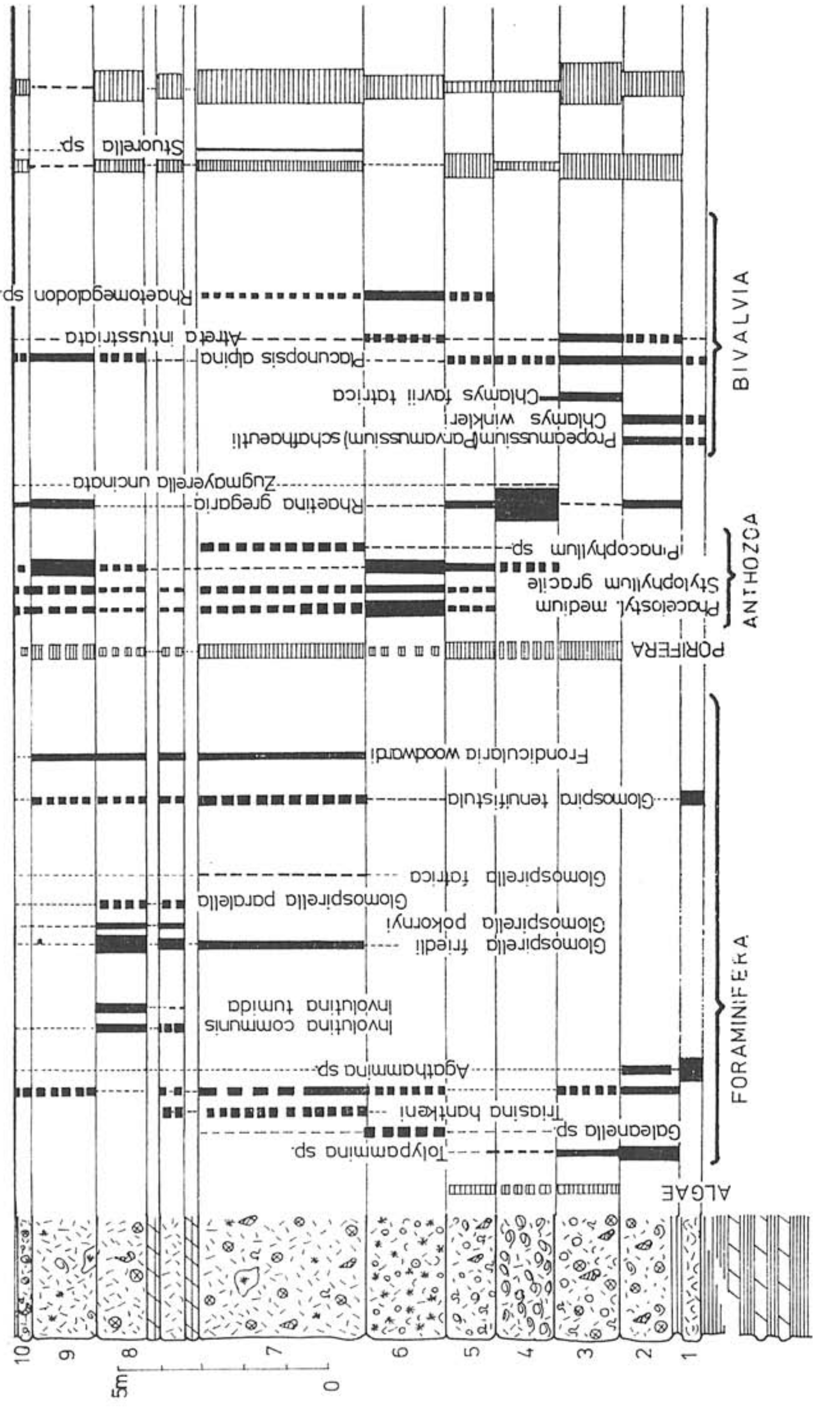
This paper is continuation of the paper of J. Michalík – O. Jendrejáková (1978) in which a concise characterization of the foraminiferal associations of the Fatra Fmt. were given. The aim of the paper was to investigate and describe the main biocenotic and biofacial dependences. The foraminifers were investigated from this view point predominantly, the principal foraminifer association types, regularly repeating in the sequence, were distinguished.

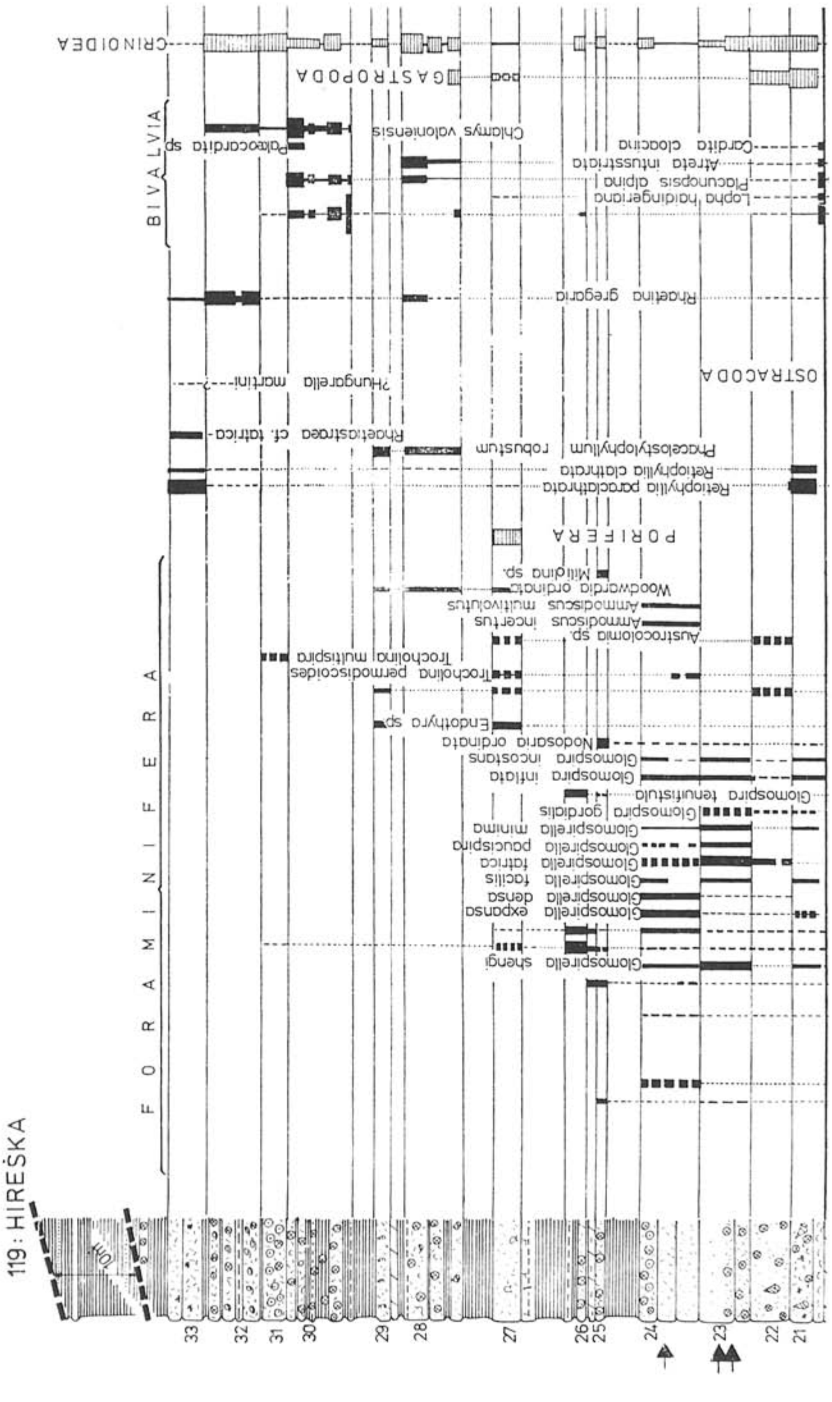
Individual taxa and foraminiferal associations are qualitatively and quantitatively best represented in the Híreška (119)–and Ráztoky (241)–sequence. Thus, we have focused our contribution more detailed on the Upper Biostrome base of three selected profiles particularly. The *Glomospira* and *Glomospirella* associations developed explosively in that time.

The expressive dominant position of *Glomospira* and *Glomospirella* species (family *Ammodiscidae)* is typical for the foraminiferal associations in the investigated profiles. Some of them are widely distributed in the Uppermost Triassic of the Alps, Carpathians, Dinarides and some other European regions [*Glomospirella friedli* Kristan – Tollmann, G. *parallela* Kristan – Tollmann, *G. pokornyi* (Salaj)]. Beside them, the occurrence of the small-shelled glomospirelles and glomospirs [*Glomospira sinensis* Ho, *Glomospira tenuifistula* Ho, *Glomospirella facilis* Ho, *G. shengi* Ho, which have been originally described first from Middle Triassic limestones of the Szechuan district in China (Y. Ho, 1956), and several new species] is remarkable. A great number of variably oriented sections of well preserved *Glomospirella* and *Glomospira* tests allowed to recognize the mode of deuteroloculus coiling and to define several new species. Small dimensions and a small number of whorls are the common features of our new taxa. Two species *(Glomospira inflata* n. sp., *G. inconstans* n. sp.) belong to *Glomospira*, three others *(Glomospirella minima*, n. sp., *G. fatrica* n. sp., *G. paucispira* n. sp.) to *Glomospirella*. The association of these new species together with *Glomospira sinensis* Ho, Glomospirella shengi Ho and *G. facilis* Ho, is a typical feature of the basal horizon of the Upper Biostrome in the Híreška (119) and Ráztoky (241) profiles. The composition of these assemblages in both the profiles differs only insignificantly (see Figs. 8–9). Assemblages with stratigraphically important *Glomospirella friedli* Kristan – Tollmann, *G. pokornyi* (Salaj), *Involutina communis* (Kristan), *I. tumida* (Kristan – Tollmann) occur both above and below this specific horizon. Small *Glomospira* and *Glomospirella* tests are irregularly dispersed in other

Fig. 7. Detailed lithological column of the Fatra Formation in the profile 258 (lithostratotype, Dedošova-valley, Veľká Fatra Mts., see Fig. 2), with occurrences of the organic remains. 1 – dolomites, 2 – aleuritic and sandy dolomites, 3 – laminated dolostones, 4 – dolomitized limestones, 5 – marls and claystones, 6 – sandstones, 7 – marly limestones, 8 – marly organodetrital limestones, 9 – organodetrital limestones, 10 – shelly (bivalve) limestones, 11 – megalodon limestones, 12 – brachiopod shelly limestones, 13 – coral limestones, 14 – porifera (calcisponges) limestones, 15 – algal *(Nipponophycus)* limestones, 16 – gastropod shelly limestones, 17 – crinoidal limestones, 18 – oolitic limestones, 19 – gravel-like limestones, 20 – finegrained limestones with nodular bedding planes, 21 – marly laminae, 22 – yellow marly bodies (of laterite appearance), 23 – mud cracks, 24 – wash-outs.


258 DEDOŠOVA
BRACHIOPODA
CRINOIDEA
GASTROPODA
Modiolus sp.
Gervillia praecursor
Pteria sp.
Rhaetavicula contorta
Chlamys valoniensis
Retiophyllia clathrata
Nodosaria ordinata
Oberhauserella sp.
Glomospirella minima
Involutina muranica
Planiinvoluta deflexa


ALGAE
FORAMINIFERA
Tolypammina sp.
Galeanella sp.
Triasina hantkeni
Agathammina sp.
Involutina communis
Involutina tumida
Glomospirella friedli
Glomospirella pokornyi
Glomospirella paralella
Glomospirella fatrica
Glomospira tenuifistula
Frondicularia woodwardi
PORIFERA
ANTHOZOA
Phacelostyl. medium
Stylophyllum gracile
Pinacophyllum sp.
Rhaetina gregaria
Zugmayerella uncinata
BIVALVIA
Propeamussium(Parvamussium) schafhaeutli
Chlamys winkleri
Chlamys favrii fatrica
Placunopsis alpina
Atreta intusstriata
Rhaetomegalodon sp.
Stuorella sp.
1
2
3
4
5
6
7
8
9
10
0
5m


119: HIREŠKA
10m
FORAMINIFERA
Glomospirella shengi
Glomospirella expansa
Glomospirella densa
Glomospirella facilis
Glomospirella tatrica
Glomospirella paucispira
Glomospirella minima
Glomospira gordialis
Glomospira tenuifistula
Glomospira inflata
Glomospira incostans
Nodosaria ordinata
Endothyra sp.
Trocholina permodiscoides
Trocholina multispira
Austrocolomia sp.
Ammodiscus incertus
Ammodiscus multivolutus
Woodwardia ordinata
Miliolina sp.
PORIFERA
Retiophyllia paraclathrata
Retiophyllia clathrata
Phacelostylophyllum robustum
Rhaetiastraea cf. tatrica
?Hungarella martini
OSTRACODA
Rhaetina gregaria
BIVALVIA
Lopha haidingeriana
Placunopsis alpina
Atreta intusstriata
Cardita cloacina
Palaeocardita sp.
Chlamys valoniensis
GASTROPODA
CRINOIDEA
33 32 31 30 29 28 27 26 25 24 23 22 21

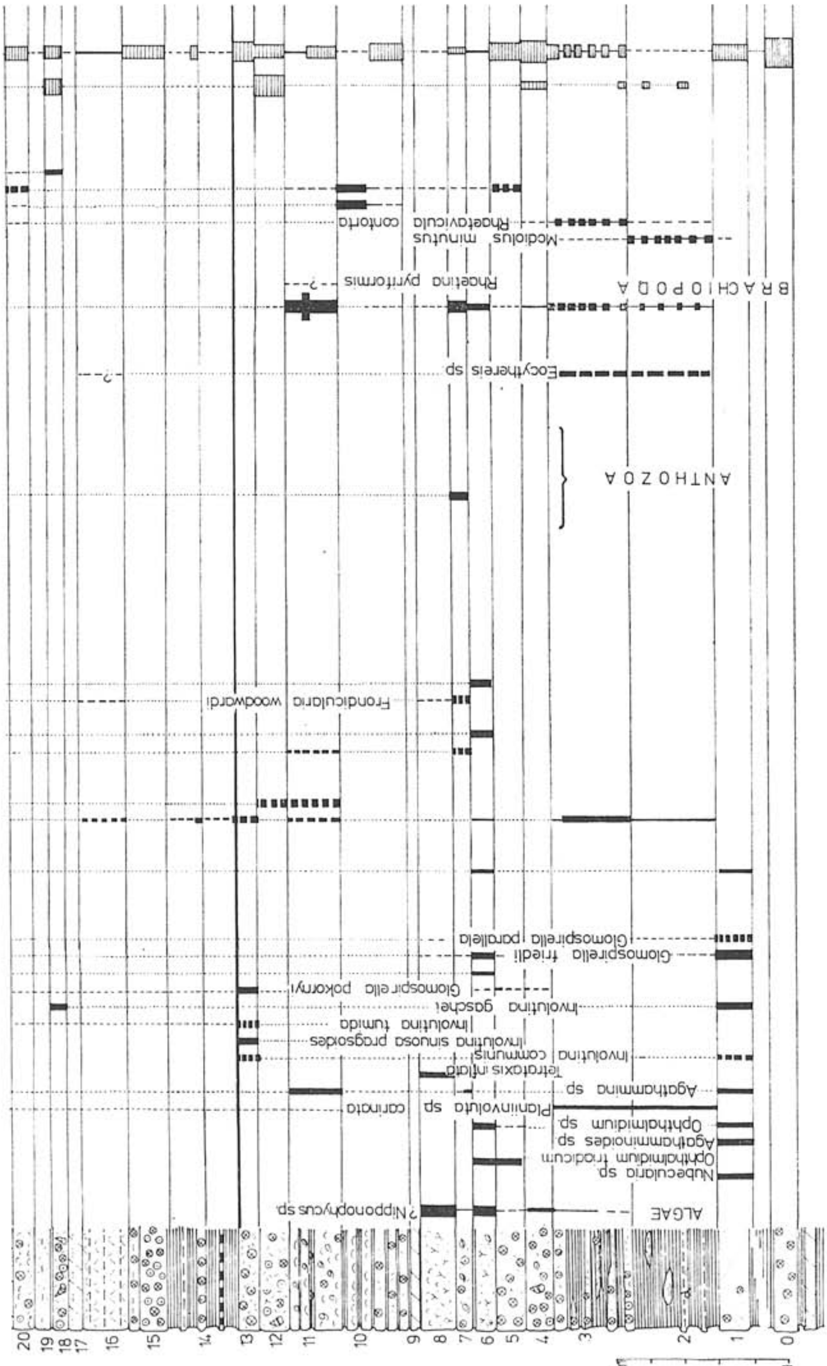
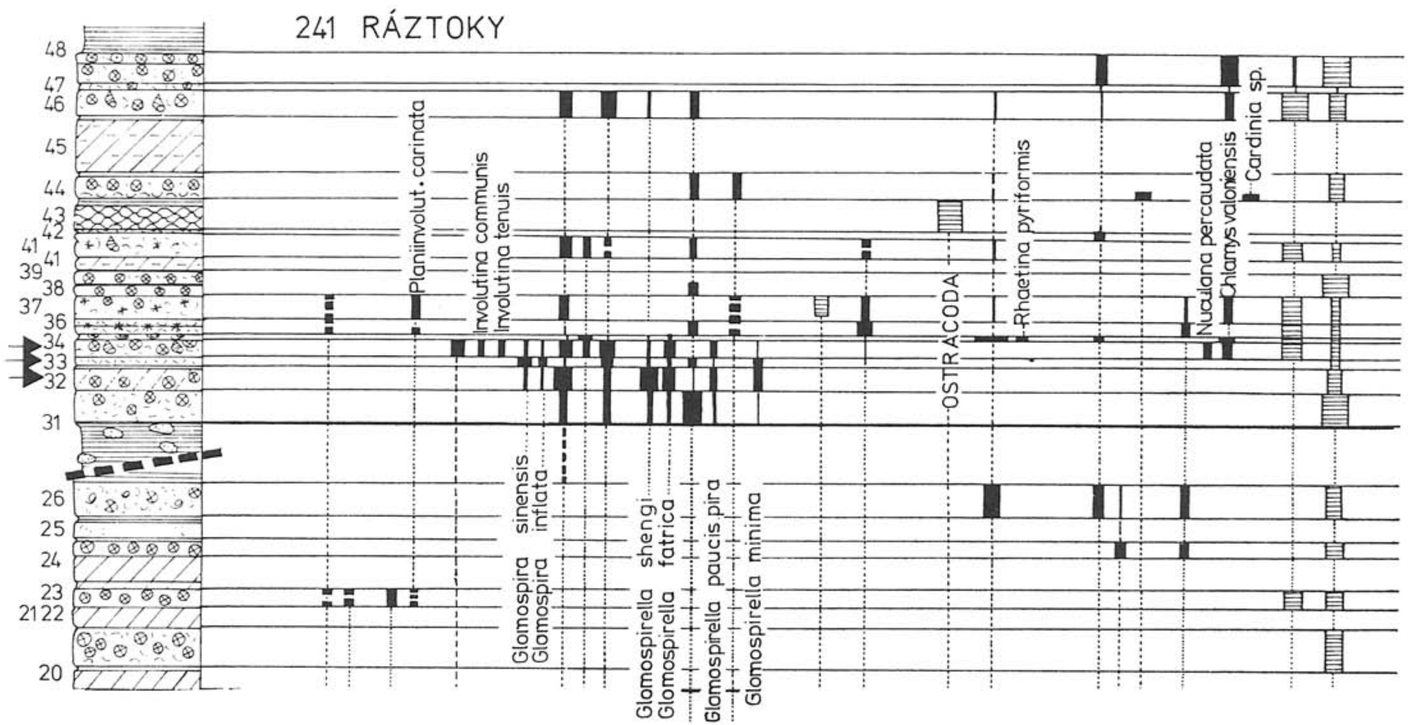
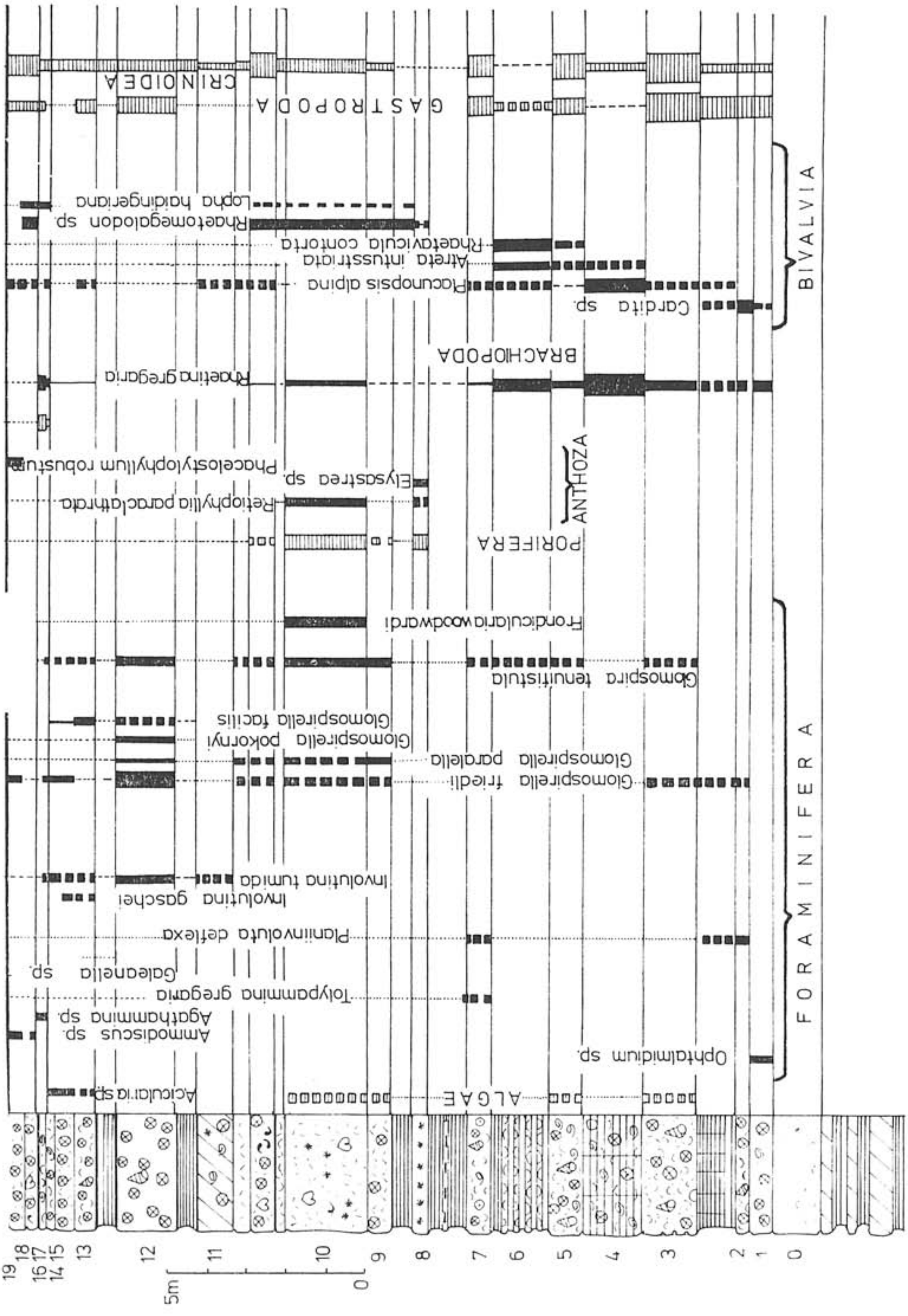


Fig. 8. Detailed lithological on the Fatra Formation in the profile no. 119 (paralithostratotype, Híreška, Strážov Mts., see Figs. 3 and 4), with occurrences of important organic remains. Explanations as in the Fig. 7.

Fig. 9. Detailed lithological column of the Fatra Formation in the profile no. 141 (paralithostratotype, Ráztoky, Veľká Fatra Mts., see Fig. 5), with occurences of some important organic remains. Explanations as in the Fig. 7.




CRINOIDEA
GASTROPODA
BIVALVIA
Lopha haidingeriana
Rhaetomegalodon sp.
Rhaetavicula contorta
Atreta intusstriata
Placunopsis alpina
Cardita sp.
BRACHIOPODA
Rhaetina gregaria
ANTHOZA
Phacelostylophyllum robustum
Elysastrea sp.
Retiophyllia paraclathrata
PORIFERA
FORAMINIFERA
Frondicularia woodwardi
Glomospira tenuifistula
Glomospirella facilis
Glomospirella pokornyi
Glomospirella paralella
Glomospirella friedli
Involutina tumida
Involutina gaschei
Planiinvoluta deflexa
Galeanella sp.
Tolypammina gregaria
Agathammina sp.
Ammodiscus sp.
Ophtalmidium sp.
Acicularia sp.
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horizons: they occur either as single specimens or together with other foraminifers (*Involutina*, sessile foraminifers etc.).

All the association defined by J. Michalík – O. Jendrejáková (1978) occur in the investigated profiles. The assemblage with *Glomospirella friedli* Kristan – Tollmann, accompanied with *G. parallela* Kristan – Tollmann, *G. pokornyi* (Salaj), *G. shengi* Ho and with single, damaged

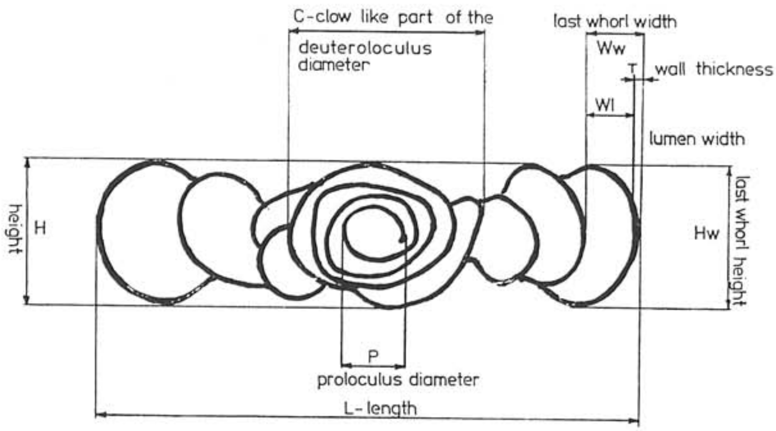


Fig. 10. Scheme of principal parameters of *Glomospira* and *Glomospirella* test morphology, measured on the investigated specimens. (All the drawings by M. Ružová).

shells of *Involutina communis* (Kristan), *I. tumida* (Kristan – Tollmann) and *I. sinuosa sinuosa* (Weynschenk) is most frequent. It alternates with the association of sessile foraminifers (*Planiinvoluta deflexa* Leischner, *Tolypammina* sp., *Nubecularia* sp.) and with the association, characterized by mass occurence of small glomospirelles and glomospirs as described above. The vertical distribution of the individual taxons is evident from Figs. 7–9.

b) *Systematic descriptions*

GLOMOSPIRA Rzehak, 1885

Glomospira inconstans n. sp.

Pl. I, Fig. 1–5

Holotype: Pl. I, Fig. 1. It is deposited in the collection of the Geological Institute of Slovak Academy of Sciences, thin section no. 119/23/M.

Paratypes: Pl. I, Figs. 2–4.

Derivatio nominis: Latin inconstans = unstable.

Stratum typicum: Fatra Formation (Uppermost Rhaetian?).

Locus typicus: Cut of the road Ilava–Prievidza near the Híreška (pub) in Valaská Belá, Strážov Mts.

Material: Twelve specimens in several thin sections.

Diagnosis: Small, irregularly triangular test formed by 4–6 whorls. The last two whorls are quite irregular.

D e s c r i p t i o n: The small irregular to irregularly triangular test consists of ball-shaped proloculus and undivided deuteroloculus. The inner 3–4 whorls are coiled more tightly, the two outermore ones are coiled very irregularly. Deuteroloculus becomes gradually larger in ontogeny. The wall is rather thin, formed by microgranular calcite.

D i m e n s i o n s of the test in mm (see Fig. 10):

	holotype	other specimens
length (L)	0,140	0,133–0,150
proloculus diameter (P)	0,048	0,036–0,048
width of the last whorl (Ww)	0,030	0,030–0,039
thickness of the wall (T)	0,006	0,006–0,008

O c c u r r e n c e: Type locality, horizons no 21 to 24 (see Fig. 8).

C o m p a r i s o n: *Glomospira inconstans* n. sp. differs from the other known *Glomospira* species in having irregular coiling and irregular outline of the test. Its deuteroloculus diameter (particularly of the last whorls) is smaller than those of *G. inflata* n. sp.

Glomospira inflata n. sp.
Pl. I, Figs. 6–8

H o l o t y p e: Figured in Pl. I, Fig. 6, deposited in the collection of the Geological Institute of Slovak Academy of Sciences in Bratislava. Thin section no. 119/23/M.

P a r a t y p e s: Pl. I, Figs. 7–8.

D e r i v a t i o n o m i n i s: Latine inflatus = inflated.

S t r a t u m t y p i c u m: Fatra Formation (Uppermost Rhaetian?).

L o c u s t y p i c u s: Cut of the road Ilava–Prievidza near the Híreška (pub) in Valaská Belá, Strážov Mts.

M a t e r i a l: 7 specimens in several thin sections.

D i a g n o s i s: Small, irregularly oval test, deuteroloculus with reduced number of whorls (5–6). The two oldest whorls are characteristically broadened. Coiling is irregular in all the ontogenetic stages.

D e s c r i p t i o n: The small irregular to irregularly oval test consists of a sphaerical proloculus and undivided deuteroloculus. The coiling is clow-like, irregular. The deuteroloculus in the final stage of development is, as a rule, typically broadened. The last two whorls are chamber-like inflated. The test wall consists of microgranular calcite.

D i m e n s i o n s of the test in mm:

	holotype	other specimens
length (L)	0,209	0,185–0,220
proloculus diameter (P)	0,057	0,042–0,060
height of the last whorl (Hw)	0,113	0,098–0,120
width of the last whorl (Ww)	0,048	0,040–0,062
thickness of the wall (T)	0,009	0,006–0.009

O c c u r r e n c e: Type locality (no. 119. horizons no. 21–24, see Fig. 8), locality Ráztoky, Veľká Fatra Mts. (no. 241, see Fig. 9).

Comparison: The only similar species, *Glomospira inconstans* n. sp. differs in a smaller test and deuteroloculus dimensions, and in the test shape as a whole.

Glomospira sinensis Ho, 1959
Pl. I, Figs. 8–16

1959 *Glomospira sinensis* sp. n., Y. Ho, p. 414, Pl. 6, Figs. 16–34.
1976 *Glomospira sinensis*, L. Zaninetti, p. 95, Pl. 2, Figs. 3–10 (cum syn.).

The West Carpathian specimens are indentical with the original description of this species. However, their dimensions are somewhat smaller. The length of the test is 0,20–0,24 mm, the smaller dimension is 0,10–0,14 mm, proloculus diameter 0,026–0,030 mm, last whorl width 0,033–0,040 mm.

Occurrence: Locality of Ráztoky (no. 241, see Fig. 9), Veľká Fatra Mts.

GLOMOSPIRELLA Plummer, 1945
Glomospirella facilis Ho, 1959
Pl. II, Figs. 1–5

1959 *Glomospirella facilis* sp. n., Y. Ho, p. 414, Pl. 6, Figs. 8–12.
1976 *Glomospirella facilis*, L. Zaninetti, p. 95, Pl. 2, Fig. 18 (cum syn.).

The small, flat test, concave in its central part, consists of a ball-shaped proloculus and undivided deuteroloculus. The initial (2–3) whorls of the deuteroloculus are coiled in space, the final, planispiral, slightly alternating whorls increase very rapidly in width. The test length is 0,23–0,27 mm, the height of the last whorl is 0,09–0,12 mm, proloculus diameter 0,017–0,038 mm. The width of the deuterolocular lumen in the last whorl is 0,036–0,040 mm.

Comparison: Our specimens differs from the Chinese ones in the dimensions of the last whorl, greater height and width.

Occurrence: Fatra Formation, locality no 119 (Híreška, horizons no. 21–24, Fig. 8). J. Salaj – A. Biely – J. Bystrický (1967) described this species from the Carnian Tisovec Limestone of Veľká lúka on the Muráň Plateau (Gemeric, south Slovakia).

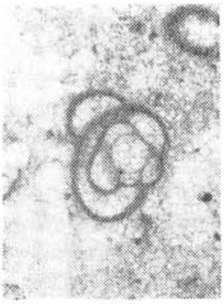
Glomospirella aff. *facilis* Ho, 1959
Pl. II, Figs. 6–8

The clow-like coiled part of our specimens exceed the height of the first planispiral whorls and is more expressive than in the true *Glomospirella facilis* Ho. Moreover, the last whorl is larger than that of *G. facilis*.

Occurrence: Locality of Híreška (no. 119, horizons no. 21–24).

Plate I

Figs. 1–5. *Glomospira inconstans* n. sp., loc. 119 (Híreška), Strážov Mts., thin section no 119/23/M. Holotype is in the Fig. Figs. 6–8. *Glomospira inflata* n. sp., the same locality. Holotype is on the Fig. 6, thin section no. 119/23/M. Figs. 9–16. *Glomospira sinensis* Ho. Locality 241 (Ráztoky), Veľká Fatra Mts., thin section no. 241/33/M. Magn. 115x, photo K. Borza.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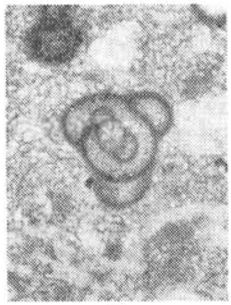
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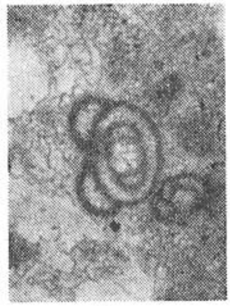
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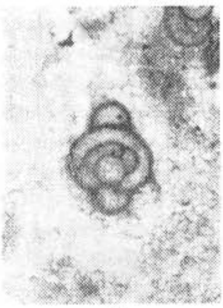
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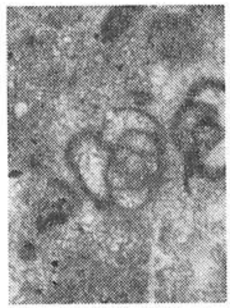
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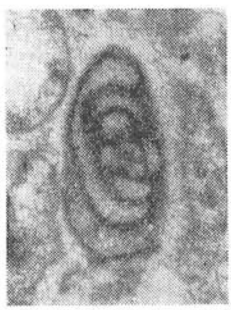
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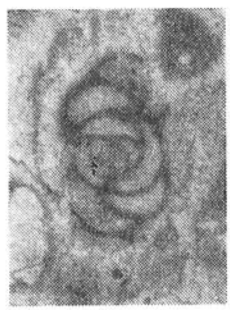
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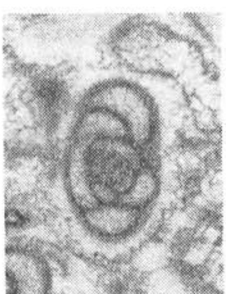
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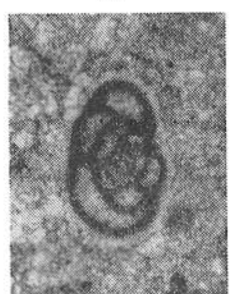
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Glomospirella fatrica n. sp.
Pl. II, Figs. 9–16

H o l o t y p e: specimen figured in Pl. II, Fig. 9 is deposited in the collection of the Geological Institute of Slovak Academy of Sciences, thin section no. 119/23/M.

P a r a t y p e s: Pl. II, Figs. 10–16.

D e r i v a t i o n o m i n i s: Name derived from the Veľká Fatra Mts.

S t r a t u m t y p i c u m: Fatra Formation (Uppermost Rhaetian?).

L o c u s t y p i c u s: Cut of the road Ilava–Prievidza near the Híreška (pub) in Valaská Belá, Strážov Mts.

M a t e r i a l: 17 specimens in several thin sections.

D i a g n o s i s: Small test with convex central part, irregularly oval in axial section. The deuteroloculus consists of 3–4 irregularly coiled and of 1 (or two) planispiral coiled whorl.

D e s c r i p t i o n: The small irregularly oval test is convex in its central part. A relatively thick deuteroloculus has a rather smaller number of whorls (5–6). The deuteroloculus diameter gradually increases, at the last whorl it is more or less stabilized. The first 3–4 whorls are coiled irregularly, the last whorl passes into the planispiral stage. The wall consists of microgranular calcite.

D i m e n s i o n s of the test in mm:

	holotype	other specimens
length (L)	0,183	0,173–0,246
height in the central part (H)	0,093	0,093–0,130
proloculus diameter (P)	0,033	0,033–0,040
height of last whorl (Hw)	0,080	0,070–0,087
width of the last whorl (Ww)	0,034	0,034–0,044
thickness of the wall (T)	0,007	0,005–0,007

O c c u r r e n c e: Localities no. 119 (Híreška, Strážov Mts., Fig. 8) and no. 241 (Ráztoky, Veľká Fatra Mts., Fig. 9).

C o m p a r i s o n: Our species has greater test dimensions, a higher deuteroloculus and more numerous whorls than the similar *Glomospirella shengi* H o. It has greater deuterolocus diameter and a more distinct convex central part of the test than *Glomospirella minima* n. sp., but its dimensions and the number of clow-like whorls are smaller than in *Glomospirella amplificata* K r i s t a n – T o l l m a n n.

Plate II

Figs. 1–5. *Glomospirella facilis* H o. Locality 119 (Híreška), Strážov Mts., thin section no. 119/23/M. Figs. 6–8. *Glomospirella* aff. *facilis* H o. from the same locality and thin section as the Figs. 1–5. Figs. 9–16. *Glomospirella fatrica* n. sp. The specimen in the Fig. 14 comes from locality no. 241 (Ráztoky), Veľká Fatra Mts., thin section 241/33/M, the others from loc. no. 119 (Híreška), Strážov Mts. The holotype is figured in the Fig. 9. Magn. 115x, photo K. B o r z a.


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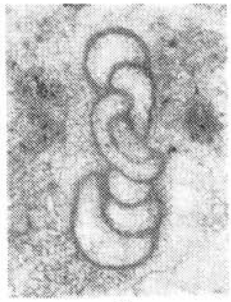
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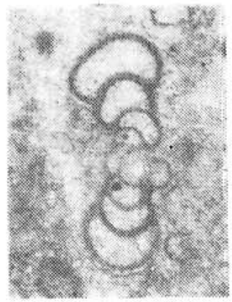
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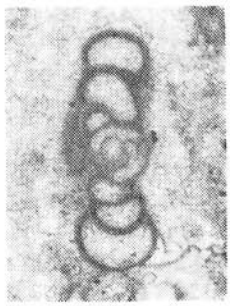
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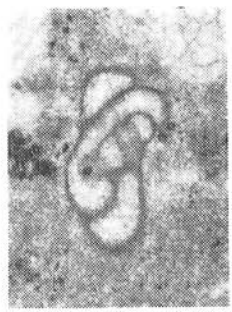
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Glomospirella minima n. sp.
Pl. III, Figs. 1–10

Holotype: The specimen figured in Pl. III, Fig. 1 is deposited in the collections of Geological Institute of Slovak Academy of Sciences, Bratislava, thin section no. 119/23/M.

Paratypes: Specimens figured in Pl. III, Figs. 2–10.

Derivatio nominis: Latin minimus = smallest.

Stratum typicum: Fatra Formation (Uppermost Rhaetian?).

Locus typicus: Cut of the road Ilava–Prievidza near the Híreška pub in Valaská Belá, Strážov Mts.

Material: 25 specimens in several thin sections.

Diagnosis: Small flat oval-shaped test, deuteroloculus consists of both irregular and sigmoid-planispiral stages. The diameter of deuteroloculus increases rapidly in the latter stage.

Description: The small flat oval-shaped proloculus and of 4–6 whorls of deuteroloculus. The initial, clow-like stage of deuteroloculus is clearly reduced on 2–3 whorls: their diameter does not exceed $^1/_4$ of all the test diameter. The second, sigmoid-planispiral stage has 3–4 whorls: their number depends on the ontogenetic age of individual specimens. Their diameter increases very rapidly. The wall consists of microgranular calcite. Its thickness in the middle and peripheral parts of test is equal, relatively small.

Dimensions of the test in mm:

	Holotype	other specimens
length (L)	0,193	0,150–0,196
height (H)	0,087	0,084–0,093
proloculus diameter (P)	0,040	0,030–0,043
height in the central part (C)	0,080	0,067–0,083
width of the last whorl (Ww)	0,080	0,070–0,087
height of the last whorl (Hw)	0,030	0,023–0,036
thickness of the wall (T)	0,006	0,005–0,007

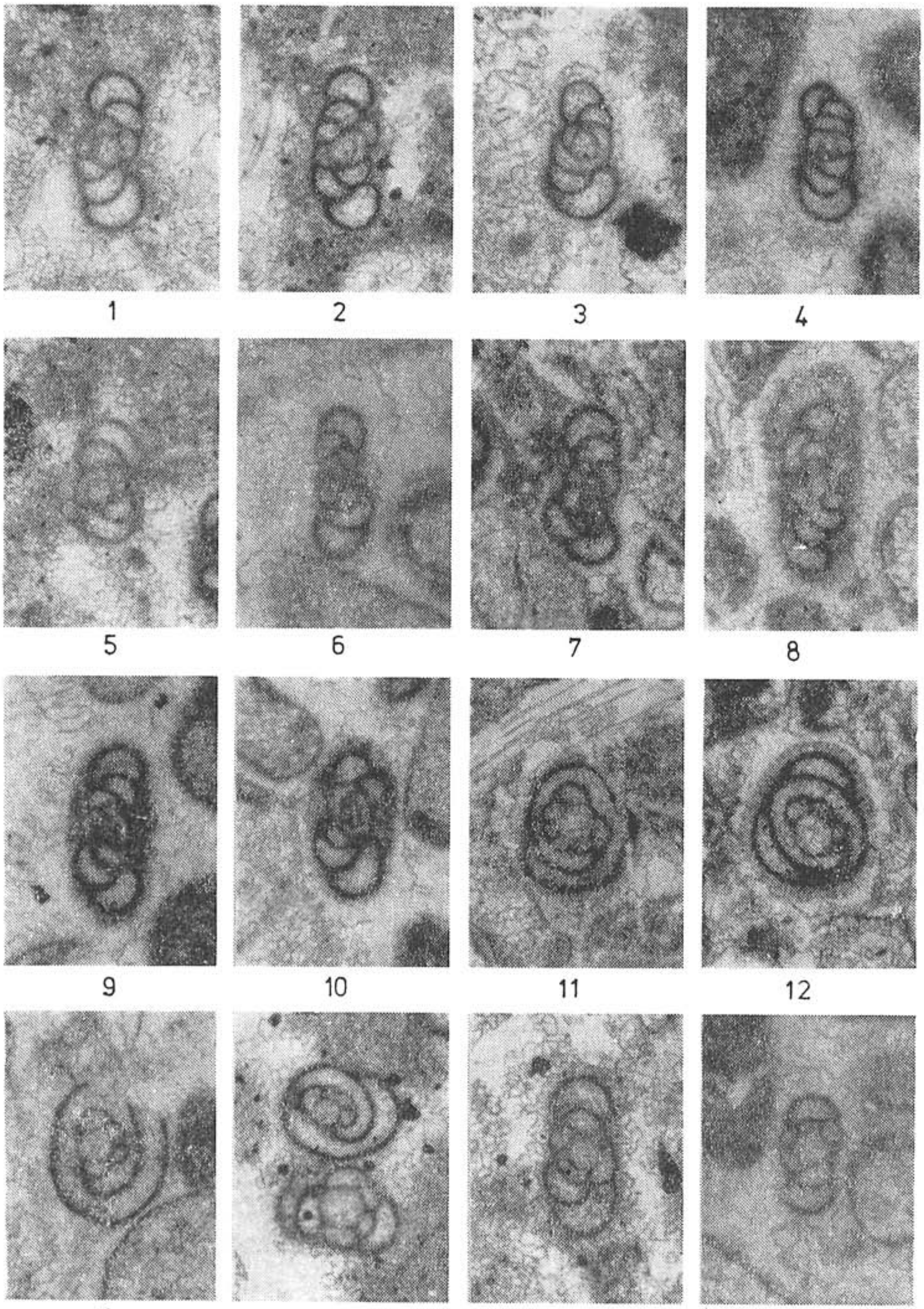
Occurrence: Localities no. 119 (Híreška, Fig. 8), Strážov Mts. and no. 241 (Ráztoky, Fig. 9), Veľká Fatra Mts.

Comparisons: *Glomospirella minima* n. sp. is very similar to *G. fatrica* n. sp.: they are distinguishable in appropriate oriented axial sections. The central clow-like part of *G. fatrica* test is strongly convex, composed of a greater number of whorls. The otherwise similar *G. paucispira* n. sp. is not sigmoid-planispi-

→

Plate III

Figs. 1–10. *Glomospirella minima* n. sp. Specimens in Figs. 1–3 and 5 come from loc. no. 119 (Híreška), Strážov Mts., thin section no. 119/23/M (the holotype is in Fig. 1), the other specimens are from loc. no. 241 (Ráztoky), Veľká Fatra Mts., thin section 241/33/M. (Figs. 7, 8) and 241/34/M (Figs. 4, 6, 9, 10). Figs. 11–16. *Glomospierella paucispira* n. sp. (the holotype in Fig. 11), thin section no. 241/33/M (Figs. 11, 12), no. 241/34/M (Figs. 13, 16), locality no 241 (Ráztoky), Veľká Fatra Mts. The specimens, figured in Figs. 14, 15 are from loc. 119 (Híreška), Strážov Mts., thin section no. 119/23/M. Magn. 115x, photo K. Borza.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rally coiled. The mode of coiling in *G. minima* is analogical to immature specimens of *Glomospirella vulgaris* H o with incompletely developed planispiral stage. The related species *G. shengi* H o differs in having different test outline and mode of coiling of the last three whorls.

Glomospirella paucispira n. sp.
Pl. III, Figs. 11–16

Holotype: The specimen figured in Pl. III, Fig. 11, deposited in the collections of the Geological Institute of Slovak Academy of Sciences, Bratislava, thin section no. 241/33/M.

Paratypes: Figured in Pl. III, Fig. 12–16.

Derivatio nominis: Latin pauci = a few; spira = whorl, spire.

Stratum typicum: Fatra Formation (Uppermost Rhaetian?).

Locus typicus: Cut of a forest road on the left slope of the Ráztoky valley, south of Mt. Ostré, Veľká Fatra Mts.

Material: 15 specimens in several thin sections.

Diagnosis: The small ellipsoidal to rounded test consists of ball-like proloculus and deuteroloculus. The clow-like stage has 3–5 whorls, the planispiral stage is very short (1 to 1,5 whorl).

Description: The small test is ellipsoidal in axial section and widely oval to subcircular in equatorial section. It consists of the sphaerical proloculus and undivided deuteroloculus. The deuteroloculus developed in two stages: the initial, clow-like, unidirectionally coiled and the second planispiral, sometimes slow alternating stage. The clow-like stage, as a rule, 3–5 whorls, it is nearly sphaerical and forms $^1/_2$ to $^2/_3$ of all the test diameter. The deuteroloculus diameter at the first four whorls is almost stabilized, the fifth and next whorls increase more rapidly. The mouth is simple, terminal. The wall is thin, consisting of microgranular calcite.

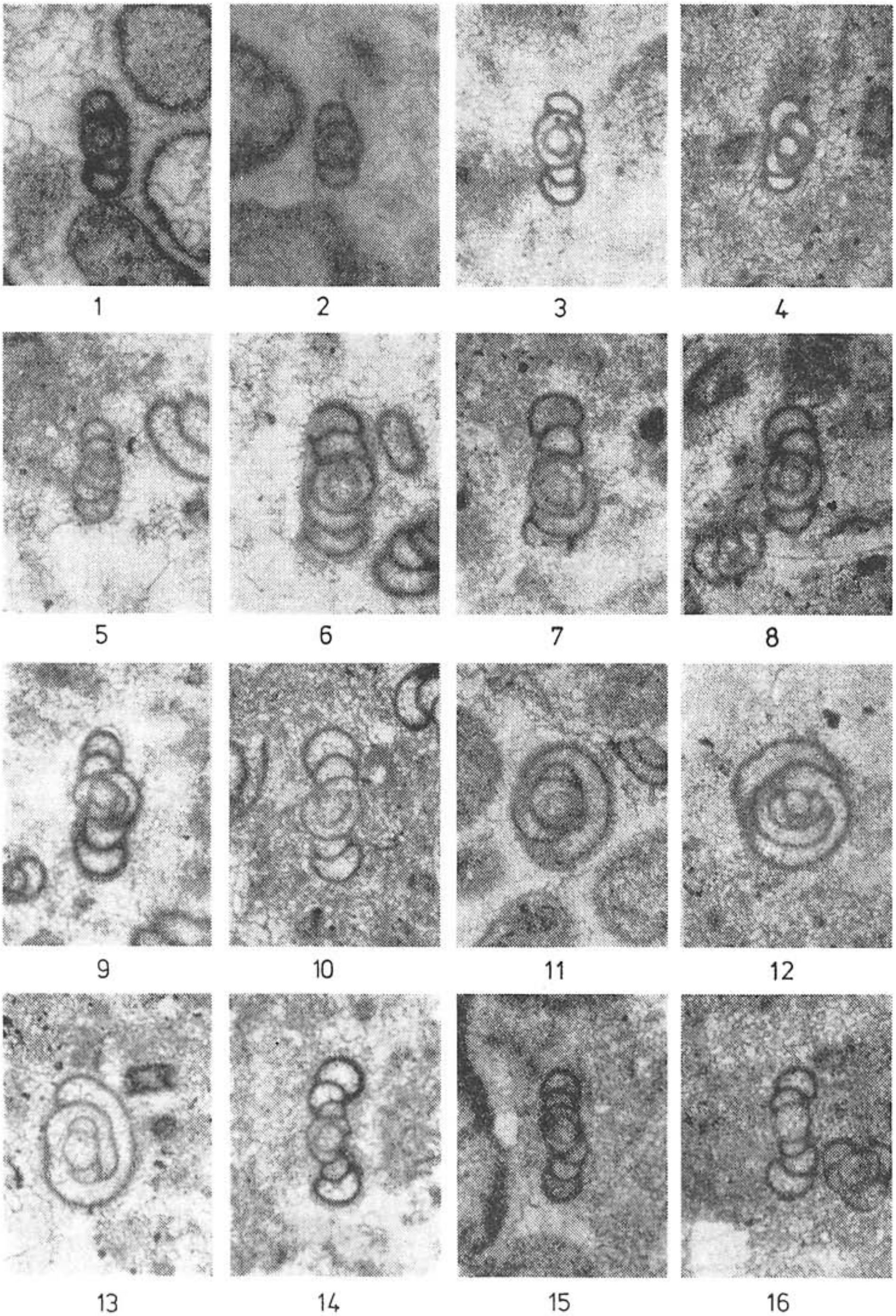
Test dimensions in mm:

	holotype	other specimens
length (L)	0,153	0,150–0,175
height (H)	0,130	0,130–0,155
proloculus diameter (P)	0,043	0,043–0,055
last whorl width (Ww)	0,020	0,020–0,035
wall thickness (T)	0,006	0,005–0,007

Occurrence: Localities 119 (Híreška, Fig. 8), Strážov Mts. and 241 (Ráztoky, Fig. 9), Veľká Fatra Mts., Fatra Formation. Some forms, found in the Ladinian Wetterstein-limestone and Carnian Tisovec-limestone of the Gemeric belong probably to this species, too.

Plate IV

Figs. 1–13. *Glomospirella shengi* H o, locality 241 (Ráztoky), Veľká Fatra Mts., Figs. 1–2, thin. section 241/34/M and locality 119 (Híreška), Strážov Mts., Figs. 3–13, thin section 119/23/M. Figs. 14–16. *Glomospirella* aff. *shengi* H o. Figs. 14, 16 from the thin section 119/23/M, Fig. 15 from thin section 241/34/M. Magn. 115x, photo K. Borza.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Comparison: *Glomospirella paucispira* n. sp. differs from *Glomospirella shengi* H o in having a different mode of the clow-like part and less number of coils in planispiral stage. *Glomospirella minima* n. sp. differs from *Glomospirella paucispira* n. sp. having sigmoidal coiling of the last whorls.

Glomospirella shengi H o, 1959
Pl. IV, Figs. 1–13

1959 *Glomospirella shengi* n. sp., Y. H o, p. 413, Pl. V, Figs. 20–25.
1977 *Glomospirella shengi*, E. T r i f o n o v á, Pl.I, Figs. 9–11.

Small test in axial section slightly flattened (with the central part partially projecting), in equatorial section subsphaerical, has a lesser number of whorls only. It consists of the ball-shaped proloculus and undivided deuteroloculus, developed in two very short stages. The irregular clow-like stage has 1,5 to 3 whorls, the planispiral stage consists of 1 to 2,5 whorls. The deuteroloculus diameter increases gradually. The wall is thin, formed by microgranular calcite.

Test dimensions in mm:

lenght (L)	0,120–0,193
clow-like part (C)	0,054–0,086
last whorl heigth (Hw)	0,050–0,076
last whorl width (Ww)	0,024–0,035
proloculus diameter (P)	0,027–0,047
wall thickness (T)	0,006–0,008

Our specimens have lesser dimensions than those in H o's paper.

Occurrence: Localities 119 (Híreška, see Fig. 8), Strážov Mts. and 241 (Ráztoky, see Fig. 9), Veľká Fatra Mts., Fatra Formation.

Glomospirella ? aff. *shengi* H o, 1959
Pl. IV, Figs. 14–16

The small, flattened, moderately sigmoidally bent test is composed of a rather large globular proloculus and undivided, almost planispiral deuteroloculus, which consists of about 3–4 whorls. The first whorl runs irregularly, the next ones partially alternate. Deuteroloculus diameter gradually increases. The wall is thin, consists of microgranular calcite.

Test dimensions in mm:

lenght (L)	0,158–0,182
height (H)	0,045–0,055
proloculus diameter (P)	0,033–0,052
last whorl height (Hw)	0,050–0,061
last whorl width (Ww)	0,020–0,035
wall thickness (T)	0,005–0,006

Occurrence: Localities 119 (Híreška, see Fig. 8), Strážov Mts. and 241 (Ráztoky, see Fig. 9) Veľká Fatra Mts.

4. *Conclusions*

a) The sedimentary complex of Uppermost Triassic age in the West Carpathian Fatric area was reclassified – the name Fatra-Formation was proposed for it.

b) A short survey on the Fatra Formation paleogeography, sedimentology, ecology and paleoclimatology was given.

c) A schema of lithostratigraphical division of the Fatra-Formation into the following members: Basal beds–Lower Biostrome–Barren interval–Upper Biostrome–Transition beds was proposed.

d) A description of ten foraminifera species was given, five species are new.

e) The new described foraminifera occur very frequently at the base of the Upper Biostrome. They are facially linked with the dark gray biomicritic and biopelmicritic limestones, which sedimented in a quiet environment and in an environment with slightly moving water. The "explosive" development of the small glomospiras and glomospirellas association indicates a short period of favourable conditions, which follows after the Barren interval.

Translated by J. Michalík.

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Review by O. SAMUEL

Manuscript received March 13, 1978