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ORGANISM COMMUNITIES AND BIOFACIES OF THE FATRA FORMATION (UPPERMOST TRIASSIC, FATRIC) IN THE WEST CARPATHIANS

(*Fig. 1—12*)

Abstract: The aim of evolution of mutal relations of common foraminifera, coral, brachiopod, bivalve and gastropod species of the uppermost Triassic was to try to present the characteristics of ecology of organism communities and their classification in relation to the lithofacies of sequences of that age in West Carpathians. Some species are also found in several biofacies, other are members of more firmly defined associations, forming zonal strips, where — as others are found only locally, in connection with special conditions of the evironment. The created model is the first attempt of this kind in Carpathian paleontological literature.
Key Words: Biocoenoses, biofacies, Uppermost Triassic, West Carpathians.

Резюме: Целью изучения взаимоотношений общих видов фораминифер, кораллов, брахиопод, бивалвий и гастропод самого верхнего триаса было дать характеристику экологии органических обществ и их классификацию по отношению к литофациям слоев этого периода в Западных Карпатах. Некоторые виды встречаются в нескольких биофациях, другие являются членами точнее определенных ассоциаций составляющих зональные пояса, затем что дальнейшие находятся только местами в связи со специальными условиями среды. Даже если составленная модель требует еще уточнения, она является первой своего рода в карпатской палеонтологической литературе.

Introduction

In spite of the fact that in many formations (mainly in the Early Paeozoic) of several regions of the world biofacial and biocenotic analyses with attempts for a reconstruction of relations and structures of biocoenoses are common, in Mesozoic sequences of the West Carpathians similar studies have not been carried out so far. The great amount of specimens of fauna in the Uppermost Triassic and the about regularities of common occurence, gathered in the last years, permit to make the first attempt of ranging of species into the probable original associations and communities. The model surely contains many inaccuracies, owing to up to present only incomplete collecting of faunas from detailed profiles in horizon after horizon, futher inaccuracies are caused by unequal investigation of groups of organisms present (not investigated remain porifera, worms, bryozoans, ostracodes, echinoderms and others). The study was based on information from 373 documentation points and profiles from the most tectonic units of the Central West Carpathians (with stress laid on the Krížna unit). Eighteen profiles were treated in detail: from each bed the macrofauna was collected and sample taken for micropaleontological investigation. From intercalations of marls and claystones samples were taken for palynological investigation, which has not been finished yet. The obtained paleontological

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material, which was the basis for paleobiocenotic study, on the whole consisted of 49 polished sections of corals, assigned to 14 species, 6242 specimens of brachiopods, belonging to 21 species, 13 genera, 3651 specimens of bivalves, belonging to 136 species, 53 specimens of gastropods, ranged to 11 species and of many other remnants of organism (worms, bryozoans, echinoderms, scaphopods etc.). The material for the analysis of representation of foraminifers was provided by the study of 852 pieces of thin sections from the investigated profiles of the Fatra formation. The studied material of brachiopods after their treatment is gradualy deposited in the collections of the Slovak National Museum in Bratislava, the material for the study of bivalves and gastropods is deposited in the collections of the Dionýz Štúr Institute of Geology in Bratislava.

The investigation of fossil biocoenoses, besides fossils, was also based on tentative makro- and microfacial analysis, analysis of textural and structural features of sediments, the study of rhythmicism and dynamics of environment, dependence of bio– and lithofacies, lithological and faunistic correlation of profiles.

Environmental dependence by Foraminifera

Relations of foraminifers and their extension in dependence on the type of lithofacies are studied in several formations and types of the sedimentation environment in the history of Earth. In Triassic foraminifer faunas tracing of these dependences was neglected for a long time. More often an apparent facial connection with the surrounding sediment was stated but the acutal ecological investigation started in the last five years only. Attention has been focused especially on the study of foraminifers from Upper Triassic carbonate complexes – the Aflenz and Dachstein limestones (J. Hohenegger et W. Lobitzer, 1971; J. Hohenegger et W. Piller, 1975). The results obtained, based on statistical methods, have shown quite a distinct dependence of the main groups and some foraminifer groups on the environment. The ecology of involutines, investigation of environmental influence on the morphology of their test was dealt with by L. Zaninetti (1976 p. 67–77).

The West Carpathian Triassic foraminifers have been studied from the viewpoint of their stratigraphic importance so far only. To questions of facial depencence attention has been paid only incidentally in works aimed at lithological and microfacial investigation (K. Borza 1973, manuscript). The amount of material gathered in the last years permits to carry out the first attempt of characterization of foraminifer communities in relation to lithofacies of the uppermost Triassic. Tracing of these dependences is based on faunal analyses from 7 important profiles through the Fatra formation (237 thin sections, $^1/_3$ of them positive), from the northern and northwestern part of its area. The thin sections containing characteristic foraminifer communities (12 pieces) were subjected to microfacial analysis. (Carried out by Dr. K. Borza).

The sequence of the Fatra formation was distinguished and defined by J. Michalík (1974 a) (as a member of the „Kőssen-fmt."). The characteristic of facial areas of this sequence as well as nearer data on the paleogeographical diferections and lithological description of the bed sequence of profiles are published in the works by J. Michalík (1974a, 1975, 1977, 1977).

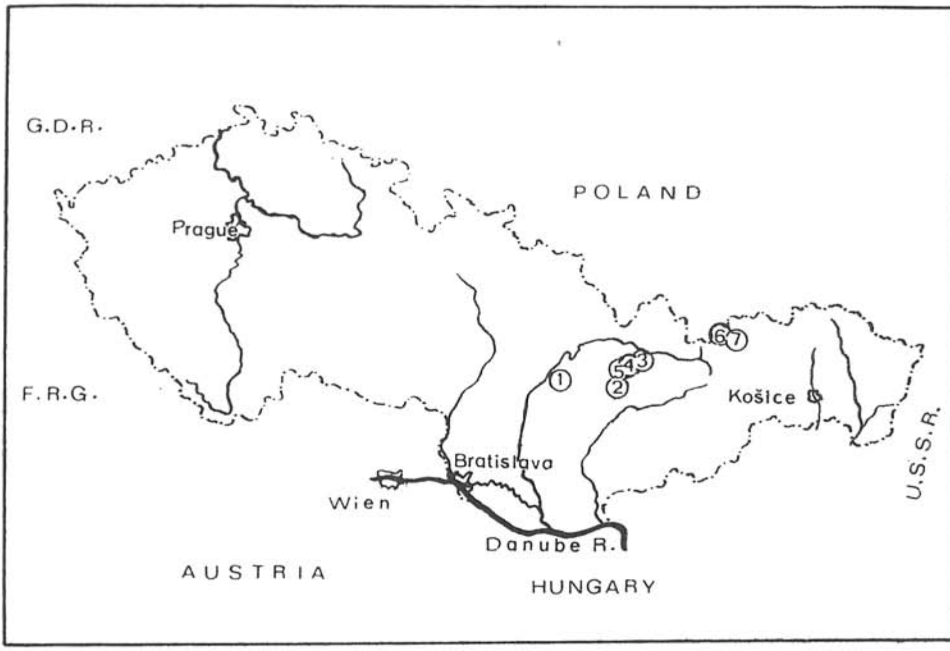


Fig. 1. Schematic map of Czechoslavakia with location of most important profiles of the Fatra formation.

The material for analyses of foraminifer assemblages comes from the following profiles (Fig. 1).

Profile No. 1. Híreška (Strážovské vrchy Mts., the locality is situated close to the inn Híreška in Valaská Belá in the cut of main road Ilava–Prievidza).

Profile No. 2. Dedošova valley (Veľká Fatra, upper part of the eastern branch of the Gaderská dolina valley, below the western slopes of mount Krížna). Type profile of the Fatra-Formation.

Profile No. 3. Bystrô (northern foothill of the Veľká Fatra Mts., cutting of the state road Žilina–Poprad in the left slope of the Váh river meander near the gamekeeeper's cotage Bystrô 50 m NW form the inflow of the Bystrý potok brook into the Váh).

Profile No. 4. Ráztoky (northern foothill of the Veľká Fatra Mts., cut of the forest road in the southern slope of the Lipová above the Ráztoky valley in the Nolčovská dolina valley near Krpeľany).

Profile No. 5. Belianska below Borišov (Veľká Fatra Mts., central part, upper part of the Belianska dolina valley, cut of the path from the Belianska dolina valley to the cottage below the Borišov, about 200 m below the cottage).

Profile No. 6. Groove below the Ždiarska Vidla (Belianske Tatry Mts.).

Profile No. 7. NE above the cottage Kardolína near Tatranská kotlina (Belianske Tatry) Mts.

The sedimentary environment of the Fatra formation is characterized (J. Michalík, 1977) as a typical marine area with carbonate sedimentation prevailing with manifestations of the influence of hot climate. The salinity of water was normal to slightly raised. In the fauna are typical assemblages of bivalves, ostracodes, foraminifers, gastropods and algae, corals and brachiopods, totaly lacking are cephalopods.

The foraminifers of the Fatra formation are very unequally represented in bed sequences and in the individual profiles. The richest assemblages are found in profiles No. 1 and 4 (Fig. 2). In general it may be stated that the spectrum of foraminifer species of the Fatra formation is relativelly low. A typical mark is the prevalence of species of the genera *Glomospira* and *Glomospirella* in relation to other foraminifer groups. Involutions often found associated with glomospires and glomospirels, are characterized by small number of species and individuals, small-medium-sized highly recrystalized tests. Their development in the sedimentation environment of the areas under study was markedly kept down. The species of sessile foramanifers dominate in basal and lower layers of profiles 2, 4, 5. Representation of other associated forms *(Agathamina, Nodosaria, Frondicularia, Ophtalmidium, Tetrataxis)* is insignificant.

Tracing of dependences of the occurrence of the individual forms in more complete profiles has shown that the majority of species are not strictly specialized to a limited type of facies. They are passing—through—forms, found in various facies of calm waters of the neritic sensu lato. It might be possible, however, to distinguish types of foraminifer associations, recurring in the bed sequence more or less regularly in dependence on the type of lithofacies.

1. Communities of sessile foraminifers: *Tolypammina gregaria, Tolypammina* sp., *Planiinvoluta deflexa, Nubecularia* sp., *Calcitornella* sp. In the Fatra formation they are bound to the sedimentary environments of organodetrital-crinoidal, crinoidal and crinoidal-pseudoolitic limestones with fragments of gastropods and bivalves. They are characteristic of basal, lower and midle layers of the Fatra form profiles. The microfacial associations of sessile foraminifers are bound to biosparites and intrabiosparites, being indicators for a shallow-water environment with stronger movement of marine water.

2. Communities with a relatively higher share of involutines. They are not very often. Present are exclusively forms with undifferentiated umbilical substance: *Involutina tumida, Involutina communis, Involutina tenuis, Ivolutina* cf. *impressa, Involutina sinuosa sinuosa.* In general a tendency towards thinning of the test wall and flattening may be observed in them. In the sense of L. Zaninetti (1976, p. 69) these marks are a good indicator of diminishing energy of marine water movement and are often in biomicrites pointing to a quiet sedimentation in lagoonal environment. The associations of involutines of the Fatra formation are usually associated with the species *Glomospirella friedli, Glomospirella tenuifistula.* They occur in gastropod, megalodon, coral-brachiopod to lumachelle limestones, are communities of lagoonal-biostromatic environment. Associations of this type were observed in the basal (profiles No. 1, 3), lower (profile No. 2) and upper (profile No. 5) layers. According to microfacial analyses the communities with relatively higher reach of involutines are most often represented in biomicrosparites, intrapelsparites, intrabiosparites.

3. Communities, in which of dominant position is *Glomospirella friedli* with associated forms *G. paralella. G. pokornyi, G. tenuifistula* and rare involutines: *Involutina communis. I. tumida,* are of the most widespread types of communities. They a are predominantly bound to the oolitic and pseudoolitic facies. They were found in basal (profile No. 7), middle (profile No. 4) and mainly upper layers (profiles No. 1, 2, 3, 7) (Fig. 3).

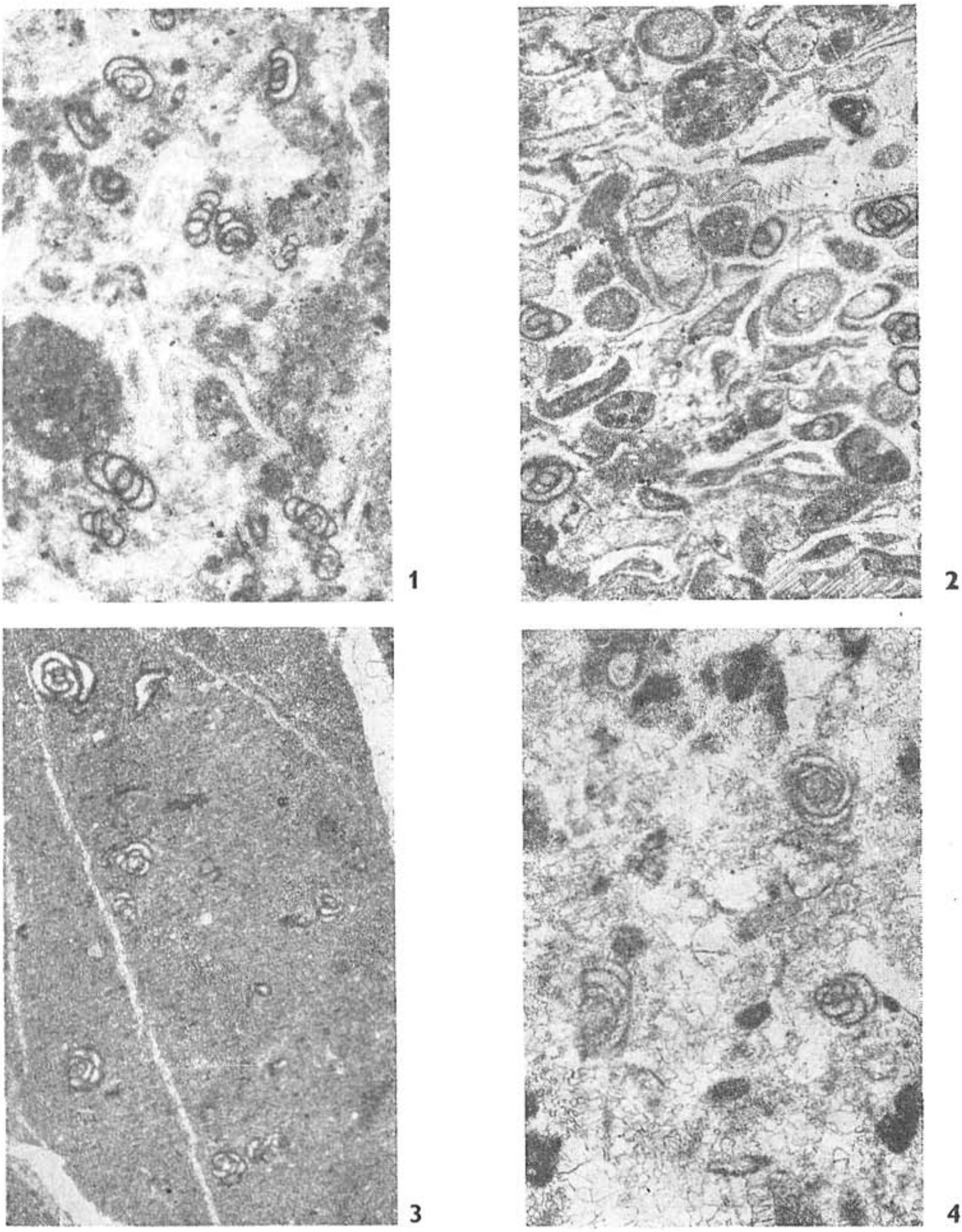


Fig. 2. 1. Profile 1 (119) Híreška, bed 23, foraminifer intrabiosparite with *Glomospirella shengi*. 2. Profile 4(241) Ráztoky, bed 33, biointrasparite with *Glomospira* cf. *sinensis*. 3. Profile 4(241) Ráztoky, bed 32, foraminifer biomicrosparite with *Glomospira* sp. 4. Profile 7(348) Kardolína, foraminifer biopelsparite with *Glomospira tenuifistula*. Magnification 60 x, photo F. Martančík.

4. A remarkable type are associations formed by small tests of the species *Glomispirella shengi, G. facilis, Glomospirella sp., Glomospira cf. simplex, G. sinensis, Glomospira* sp. Their characteristics and extension are equivalent to those of the communities of sessile foraminifers. Facially they are connected with fine compact crinoidal, more rarely with crinoidal-pseudoolitic limestones. As to microfacies, they are linked with biosparites and biomicrosparites. Their environment is restricted to calm areas or areas with slightly active movement of water. Largest extension they reach in the environment of deeper neritic. In mass occurrence observed in profiles No. I and 4 (lower third of the upper part).

5. Foraminifers of the group Miliolina: *Miliolina* sp., *Miliolipora* sp., *Ophthalmidium* sp. are of very little representation. A more noteworthy occurrence may be observed in the middle part of profile No. 7 only. They are found in dolomitized limestones, ostracode and bivalve limestones of the so called "Swabian facies" in the coastal zone with disturbed salinity.

So far we cannot express our opinion to the facial relations of *Triasina hantkeni.* In the sedimentation area of the formation only one case of highly recrystallized tests of this species has been recorded (profile No. 5, upper third of the middle part) occurring in massive crinoidal limestones (Fig. 4).

Tracing the dependences of the occurrence of the individual forms the viewpoint of requirements to the environment three groups could be roughly distinghished:

1. Forms of the lagoonal-biostromatic environment are most abudant in gastropod–, megalodon–, porifera–, coral-brachiopod–, to shelly- limestones. They are mainly represented by involutines: *Involutina tumida, Involutina communis, Involutina impressa, Involutina tenuis* often associated with *Glomospirella friedli, Glomospira tenuifistula, Ophthalmidium* sp., *Tetrataxis inflata.*

2. Forms of extremely active shallow-water environment (or exposed neritic) restricted to the environment of formation of pseudoolitic and oolitic limestones are mainly represented by glomospirels: *Glomospirella friedli, Glomospirella pokornyi, Glomospirella paralella,* more rarely associated with *Glomospirella shengi* and *glomospira tenuifistula.*

Environment of deeper neritic, indicated by forms linked with organodetrital-crinoidal and crinoidal limestones. Typical species are *Glomospirella shengi. Glomospirella cf. vulgaris, Glomospira* sp. Less frequent are *Glomospira gordialis, Glomospira* cf. *simplex, Glomospirella expansa, Glomospirella* cf. *densa, Calcitornella* sp., *Planiinvoluta* sp.

Environmental dependence by Anthozoa

To corals of the Fatra formation of the West Carpathians minimum attention has been paid so far only. In the last fifty years only several works were published (V. Zázvorka, F. Prantl, 1936. V. Náprstek, 1957, E. Roniewicz, 1974), which by far could not exhaust the problem of this important component of the communities of the uppermost Triassic. It may be stated, on the contrary, that the coral faunas of that time remain little known and only preliminary determinations give us an idea of them. Tracing of the dependences of the occurrence of the individual forms has made possible to distinguish four groups of this-fauna:

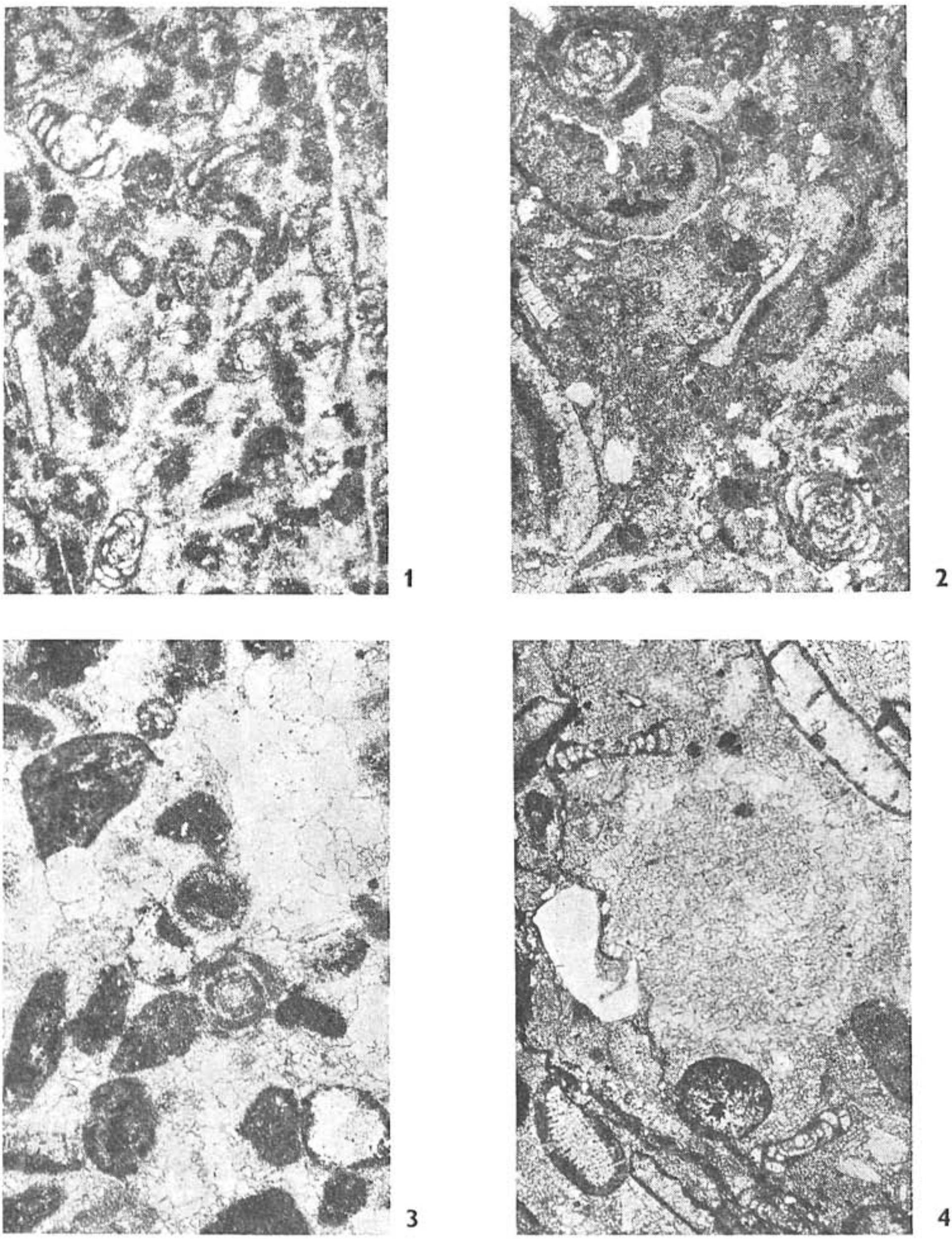


Fig. 3. 1. Profile 4(241) Ráztoky, bed 9, biopelsparite with *Glomospirella friedli*, 60 x magnif. 2. Profile 7(348) Kardolína, bed 1, biomicrosparite with *Glomospirela friedli*, magnif. 55 x. 3. Profile 7(348) Kardolína, bed 35, sandy intrasparite, *Glomospirella friedli*, magnif. 60 x. 4. Profile 6(301) Groove below the Mt. Ždiarska Vidla, bed 11, biosparite with *Glomospirella pokornyi*, magnif. 58 x. Photo F. Martančík.

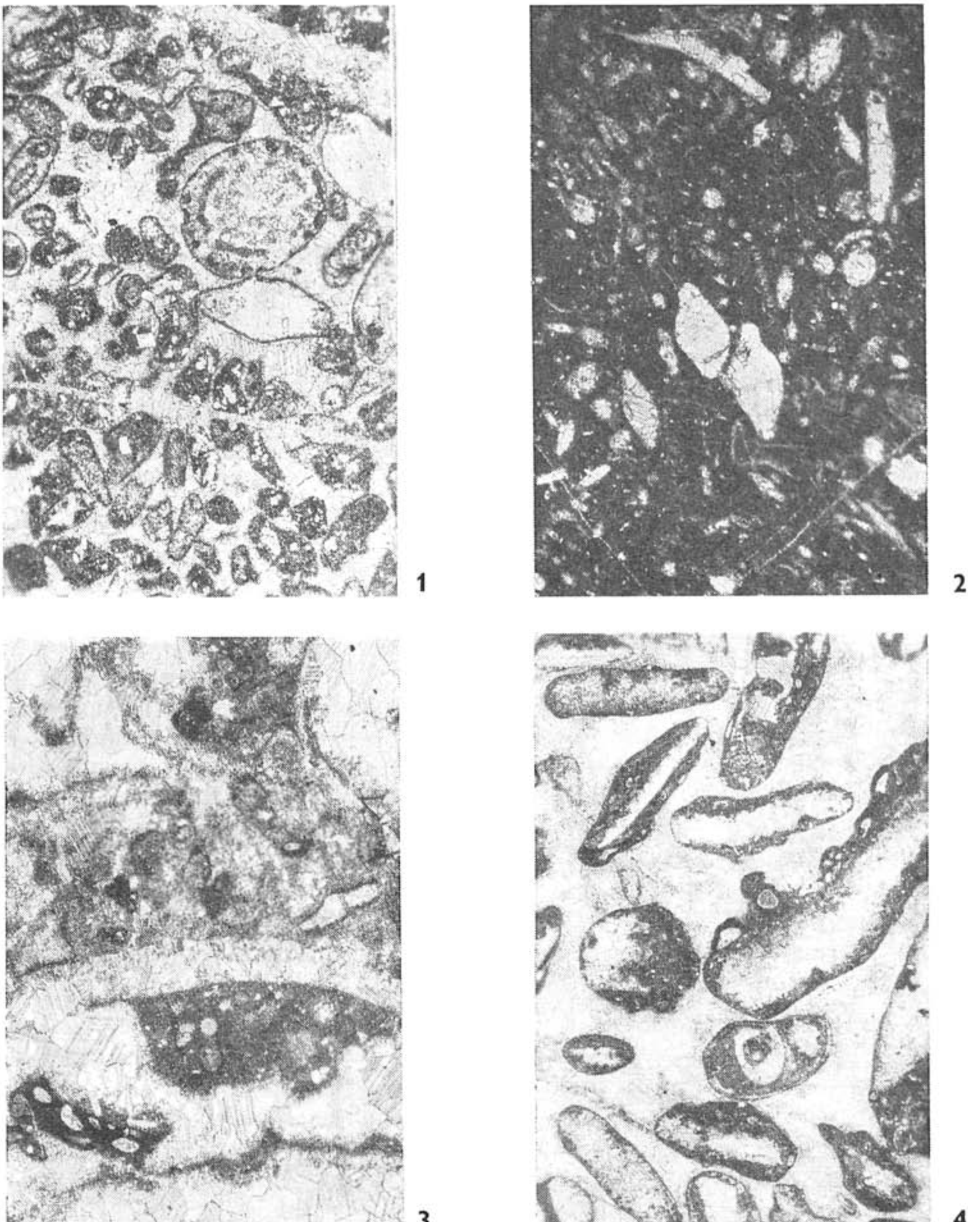


Fig. 4. 1. Profile 5(261) Belianska valley below Mt. Borišov, bed 22, biopelsparite *Triasina hantkeni, Involutina cf. communis, Glomospirella* sp. magnif. 35 x. 2. Profile 2(258) Dedošova valley, bed 8, biointramicrosparite with *Involutina cf. communis,* magnif. 20 x. 3. Profile 4(241) Ráztoky, bed 23, biosparite with *Planinvoluta carinata,* magnif. 35 x. 4. Profile 2(258) Dedošova valley, bed 3, biointrasparite with? *Tolypammina* sp., magnif. 17 x. Photo F. Martančík.

1. Form of lagoons and "lagoonal reefs" include species form marly and gastropod limestones, occurring scattered. Here belong the forms *Pinacophyllum lejovae, Pinacophyllum* sp., *Pamiroseris rectilamellosa* (Fig. 5c).

2. Forms of the inner side of biostroms are usually found associated with porifers, gastropods, calcareous algae (solenopores), brachiopods, megalodonts and other bivalves. Usually they do not form own larger bodies, are rather unintegrated component of many-species biostromatic growths. From known forms are: *Phacelostylophyllum robustum, Phacelostylophyllum medium* and *Stylophyllum gracille* (Fig. 5d).

3. Forms of biostroms proper (of the central part) form independent, massive bunches, plates, blocks to banks – thus the core proper of often extensive zones of biostroms. Only rarely associated with other organisms. Most abundant forms are: *Parathecosmilia sellae, Rhaetiastraea tatrica* and *Astraeomorpha crassisepta* (Fig. 6a, b).

4. Forms of the outher side of biostroms are often associated with the assemblage of *Rhaetina gregaria:* withering coral bunches were regularly densely inhabited by juvenile individuals of this brachiopod. Concerned are mainly the species *Retiophyllia paraclathrata* and *Retiophyllia clathrata* (Fig. 6c).

From the stratigraphic viewpoint, in corals, similary as in foraminifers, may be distinguished diachronous forms *(Retiophyllia clathrata, Retiophyllia paraclathrata).* forms of the "lower part" of profiles *(Pinacophyllum* sp., *Phacelostylophyllum medium, Stylophyllum gracile)* and forms of the "upper part" of profiles *(Pamiroseris rectilamellosa, Astraeomorpha crassisepta).* It seems, however, that the majority of coral species were much more dependent on the environment and appear in the bed sequence wherever a facies occurs, to which they were adapted. For clearing up of this question it is necessary to study more representation of this group and paleobiology of its representatives. The scale of species in the individual biocenoses would be surely extended distinctly after such a study.

Environmetal dependence by Brachiopoda

The question of Triassic brachiopod ecology have been very little studied in all-world scale. There is not work dealing with them systematically, in the best case only short chapters or mentions are devoted to them in works directed taxonomically, paleobiologically or paleobiogeographically (A. S. Dagys, 1963, 1974; C. Klören, 1974; J. Michalík, 1975, 1976 a, b and others). The questions of ecology and paleobiogeography of brachiopod faunas form a very extensive and complicated sphere of problems, solution of which is connected with solution of stratigraphy, sedimentology, climatology, paleogeography, paleobiocenotics and paleotectonics of sedimentary basins of that time. The most important brachiopod species of the Fatra Formation is *Rhaetina gregaria,* present in all brachiopod communities. In the sedimentation environment of the Fatra Formation it may be thus considered as a diachronous species. When tracing organisms associated with it, however, we may state that it occurs as a from of at least three environments:

1. Outer border of biostromes is characterized by constant link of the species *Rh. gregaria* to branched corals (Fig. 6c). The shells of *Rh. gregaria* are usually small, rarely dwarfed individuals of the species *Rh. pyriformis* are found.

2. Small depressions and interspaces in the biostrome proper are characterized by dense populations of *Rhaetina gregaria*.

3. Biostromatic lagoons gave space for the populations of *Rh. gregaria* with relatively large shells, asociated with the species *Rh. pyriformis, Zugmayerella uncinata, Lepismatina austriaca, Discina suessi,* more rarely also *Zeilleria norica* and *Austrirhynchia cornigera)* in areas near to the Orava depresion (see J. Michalík, 1973, 1974, 1977) (Fig. 7).

The brachiopod communities were preliminarily distinguished also in the Hybe beds, where they are much more varied and plentiful. From the viewpoint of requirements to the environment three groups of forms have been distinguished:

1. Forms of hard bottom may be found either independently or in other facies, where they inhabit microenvironments suiting the requirement of hard bottom (shells of other animals, fragments in detritus etc.). Here may be ranged the species *Bactrynium bicarinatum, Discina suessi, Thecospira haidingeri* (accompanied by the species *Atreta intusstriata* a. o.). A solid bottom needed probably also the rhynchonellid *Euxinella subrimosa*.

2. Forms of "grey calcareous marls" occur together with the group of bryozoan species *(Berenicea hybensis, Stomatopora* sp.), worms *(Serpula* aff. *colubrina?*, Pomatoceras sp.), bivalves, gastropods and echinoderms. They include *Fissirhynchia fissicostata, Sinucosta emmrichi, Zeilleria elliptica, Z. austriaca, Z. norica, Zugmayerella koessenensis, Rhaetina hybensis* and dominating *Rhaetina pyriformis*.

3. Forms of "dark-coloured marls" are only two *(Zeilleria norica* and *Oxycolpella oxycolpos)*. They occur, however, separatelly, often with *Pholadomya* sp. Their relations will have be cleared up in future.

Eurybiotic forms of the Hybe beds are thus *Rhaetina pyriformis* and mainly *Zeilleria norica,* which are not closely specialized to a limited type of facies.

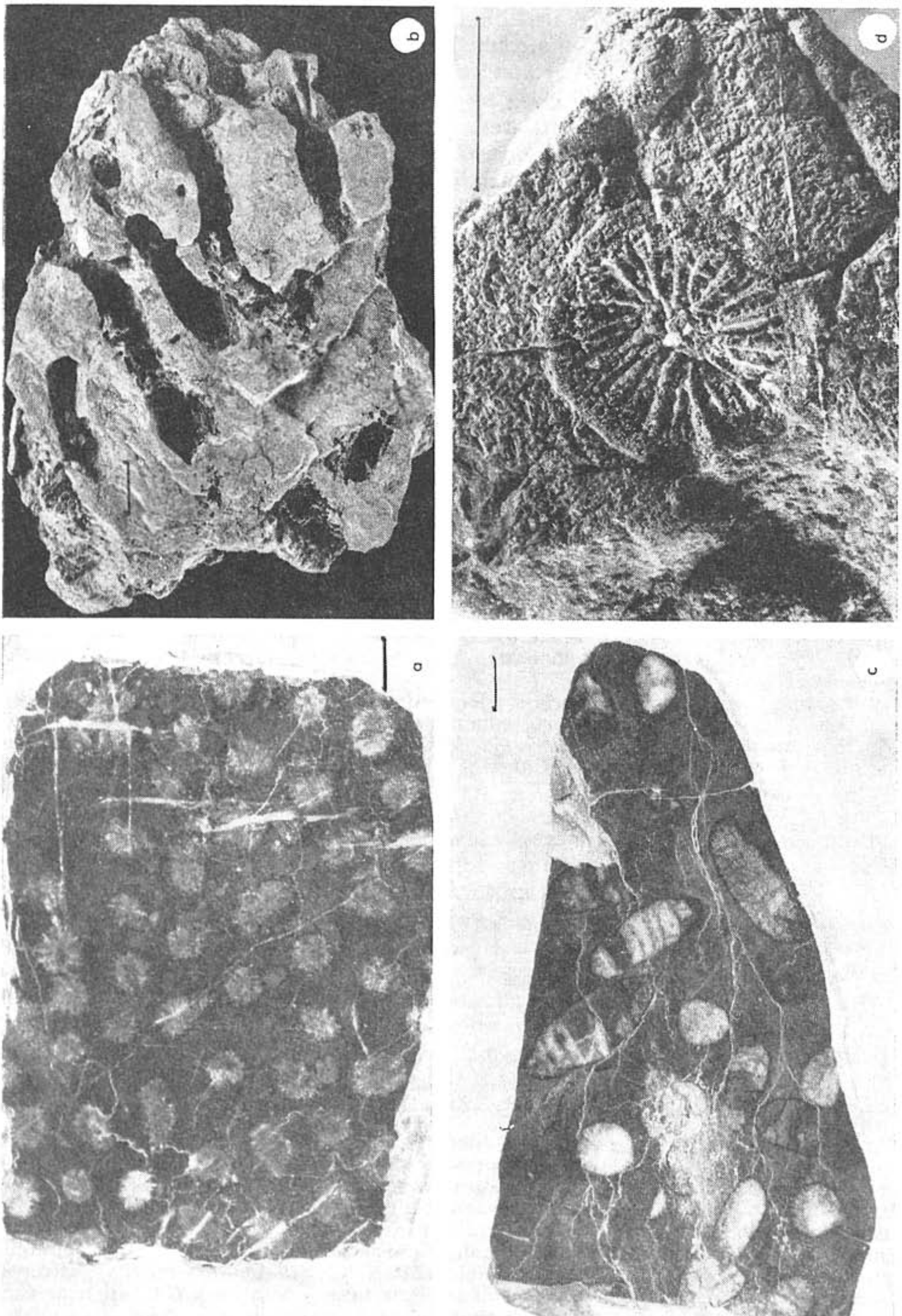
Environmental dependence by bivalve molluscs

In spite that bivalves form a relatively well investigated component of faunas of the Uppermost Triassic of the West Carpathians, their facial dependences are very unclear, just as their detailed stratigraphic range. Therefore also only a rough, provisional survey may be given about their biogeographic relations and dependences. With the composition of Uppermost Triassic bivalve faunas was dealing M. Kochanová (1967), who determined also the material of bivalves used in this work.

A. Diachronous forms include important "Rhaetic" fossils *Atreta intusstriata, Rhaetavicula contorta, Propeamussium (Parvamussium)* schafhaeutli and the practically "omnipresent" *Placunopsis alpina*.

→

Fig. 5. Polished sections of some coral colonies of the Fatra formation, West Carpathians. Scale – 1 cm, photo H. Jendeková. a – *Retiphyllia cf. paraclathrata* Ron. Suchá valley near Kláštor pod Znievom (group of Veľká Lúka, Malá Fatra Mts.), locality 072, b – ? *Retiophyllia* sp. Gonove Lazy near village Hubina (Považský Inovec Mts.), locality 139, c – *Pinacophyllum cf. lejovae Ron.* – valley above the village Diviaky nad Nitrou (group of Rokoš, Strážovské vrchy Mts.), locality 058, d – *Phacelostylophyllum robustum* Ron. Sokol valley near Zázrivá (Malá Fatra Mts.), locality 101.


a
b
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B. Facially more forms may be futher divided into the groups:

1. Forms of the littoral environment with disturbed salinity are mainly *Gervillia inflata, Myophoria emmrichi, Myophoria inflata,* to them may be (with doubts) assigned the species *Chlamys acuteaurita.*

2. Forms of biostromal lagoons are a very heterogeneous group, mainly consisting of the species *Cardita austriaca, C. cloacina, C. multiradiata, Chlamys winkleri, Gervillia praecursor, Gryphaea pictetiana, Isocyprina ewaldi, I. germari, Nuculana deffneri, Modiolus hybbensis, M. minuta, M. schafhaeutli, Mytilus psilonoti, Placunopsis mortilleti, Plicatula archiaci, Trapezium suevicum* (Fig. 8).

3. Forms of the inner border of biostromes are bound to the environment of biostromal platforms: *Corbula alpina, Lopha haidingeriana, Rhaetomegalondon incisus, Rhaetomegalodon sp., Conchodon infraliassicus.*

4. Forms of the margin of biostromal platforms can be found (possibly secondarily?) also in the innermost zones: *Chlamys favrii, Ch. trigeri, Eopecten zejszneri, Liostrea gracilis, L. koessenensis, Parallelodon hettangiensis, Protocardia rhaetica* (Fig. 8).

5. Forms of the deeper neritic are represented by pectenid bivalves *Chlamys bavarica, Chl. falgeri, Chl. mayeri, Chl. valoniensis.*

For comparison the arrangement observed in the Hybe beds may be mentioned, where the diachronous forms comprise the same species. Forms more dependent on facies may be dividied into the following groups:

1. Forms of gray marls, futher divided into the group of oysters *(Cassianella inaequiradiata. Lopha hadingeriana),* of "large" bivalves *(Mysidioptera acuta, M. globosa, M. incurvistriata, M. latifissa, Ctenostreon alpissordidae)* and bivalves with byssus *(Modiolus hybbensis, M. schafhaeutli, Gervillia inflata, Mytilus preacutus).*

2. Forms of dark-coloured marls are represented by the infaunal *Pholadomya* sp.

3. Forms of channel depressions comprise the group of "small bivalves" *(Avicula salomoni, Mantellum subdupla, Myophoria stenonis, Pleuromya suevica)* and the group of pectenides *(Chlamys winkleri, Ch. simkovicsi, Eopecten zejszneri).*

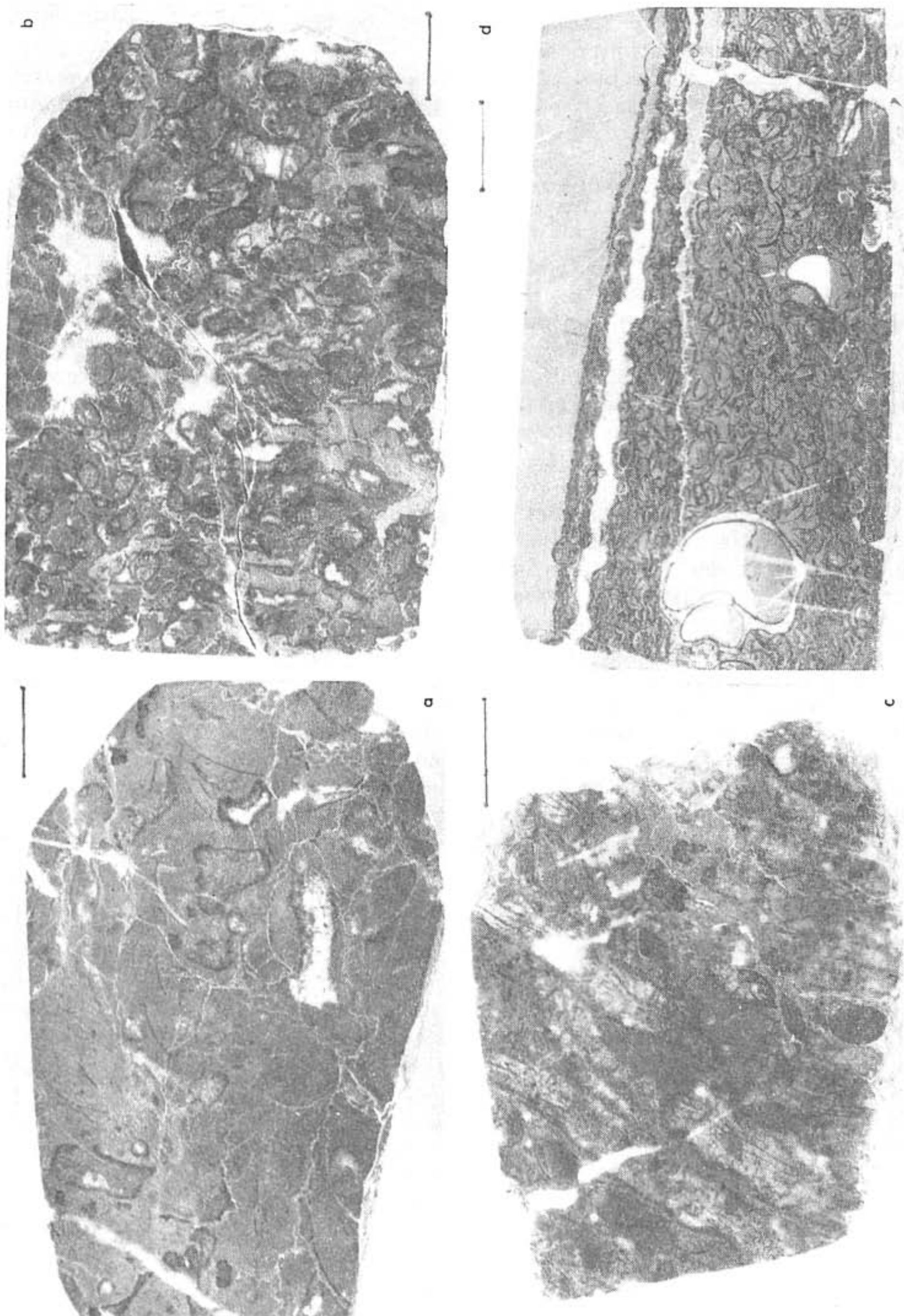
From the stratigraphic viewpoint several groups may be distinguished, found in various profile levels of the Fatra formation.

A. Stratigraphically diachronous forms include *Cardita cloacina, Propeamussium (Parvamussium) schafhaeutli, Rhaetavicula contorta* (with the maximum occurence in the upper part of profiles) *Placunopsis alpina, Atreta intusstriata. Lopha haidingeriana.*

B. Forms with closer limited occurrence include:

1. Forms of the basal part of profiles: *Chlamys favrii tatrica, Ch. winkleri, Modius minutus, M. hybbensis, Myophoria sp., Plagiostoma praecursor, Neoschi-*

Fig. 6. Polished sections showing some biofacies of the Fatra formation. Scale = 1 cm, photo H. Jendeková. a – coral limestone with? *Parathecosmilia* cf. *sellae.* Panský vŕšok hill near Čičmany (Malá Magura Mts.), locality 029, b – coral limestone with *Rhaetiastrea tatrica* Ron. and *Pinacophyllum* sp. settlement Zelenáci near Valaská Belá (Strážovské vrchy Mts.), locality 021, c – *Colony of Retiophyllia clathrata* Emmr., inhabited by population of *Rhaetina gregaria* Suess. (a cavity sub-community). Istebnianska dolina valley (Malá Fatra Mts.), locality 108, d – shelly gastropod limestone, covered with a layer of compact limestone – Panský vŕšok hill near Čičmany (Malá Magura Mts.), locality 029.



zodus sp., Trigonodus sp. (found also below the base in the sequence of the Carpathian Keuper), *Isocyprina sp.*

2. Forms of the middle part of profiles: *Conchodon infraliassicus, C. goeteli, Rhaetomegalodon incissus, Rh. tatricus, Lima pectinoides, Nuculana percaudata, Corbula* sp., *Gervillia praecursor, Modiolus* sp. (schafhaeutli?) *Pteria* sp., *Cardita austriaca.*

3. Forms of the uppermost part of profiles: *Cardinia* sp., *Chlamys valoniensis, Chlamys dispar.*

Environmental dependence by gastropods

Gastropods are a group very neglected in Triassic paleontological literature. Even the authors dealing with gastropods, study them only incidentally. The gastropods are not the main subject of their interest. Knowledge of the gastropod faunas of the Uppermost Triassic fully corresponds to this state. Therefore only roughly the presence of several morphologically more distinct types of gastropods may be stated in the biofacies of the Fatra formation and Hybe beds.

Generally it may be stated that the prevailing majority of gastropods of the Fatra formation is linked with the biofacies of biostromal platforms and lagoons, where were the best conditions for development of algal flora and the largest amount of organic detritus. Connected with the fauna of sponges, corals and brachiopods are the occurrences of forms *Melania sp., "Turritella"* sp. (Fig. 6d). (The gastropods of the Hybe beds: *Straparollus szajnochae* and *Pseudomelania quenstedti* also come from the community of brachiopods and bivalves). Small gastropods as *Stuorella sp.* are rather found in organodetrital lagoonal facies, often together with the scaphopod ? *Dentalium sp.* (Fig. 7).

The number of gastropod forms in the biofacies of the Fatra formation is most probably, as a matter of fact, much larger and after systematic investigation it may be possible to establish more precise criterii of biofacial competence of these animals.

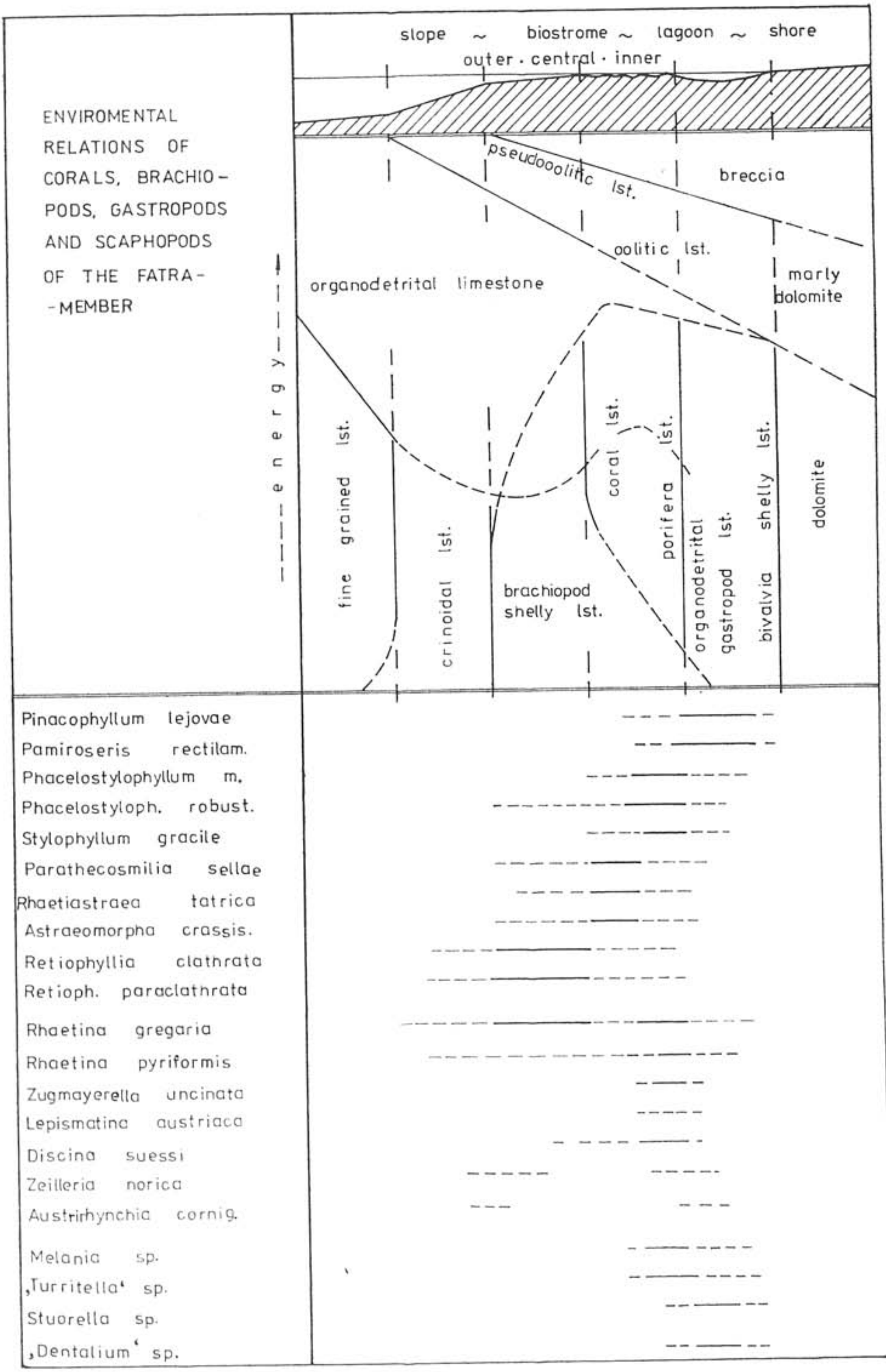
Biocoenoses

A. Communities of the nearshore zone

1. Communities of ostracods and foraminifers. They are found predominantly in dolomitic and dolomitized rocks, which fact might indicate an extreme salinity of the environment. The community of ostracods has not been studied more in detail, from foraminifers are present types of the environment with fluctuated salinity (see Chapter II).

2. Communities of deposit- and sediment- eaters. Known only form the preserved burrows and traces after activity, conspicuous mainly in marly laminated limestones. The burrowing traces are also abundant in marly organodetrital and dolomitic rocks. The competence of the representatives of this group has not been studies more in detail.

Fig. 7. Schematic representation of relations of individual species of coral brachiopods, gastropods and scaphopods to the environment and lithofacies of the Fatra formation (Original).


ENVIROMENTAL RELATIONS OF CORALS, BRACHIO-PODS, GASTROPODS AND SCAPHOPODS OF THE FATRA--MEMBER
slope ~ biostrome ~ lagoon ~ shore
outer · central · inner
pseudooolitic lst.
breccia
oolitic lst.
organodetrital limestone
marly dolomite
energy
fine grained lst.
crinoidal lst.
brachiopod shelly lst.
coral lst.
porifera lst.
organodetrital gastropod lst.
bivalvia shelly lst.
dolomite
Pinacophyllum lejovae
Pamiroseris rectilam.
Phacelostylophyllum m.
Phacelostyloph. robust.
Stylophyllum gracile
Parathecosmilia sellae
Rhaetiastraea tatrica
Astraeomorpha crassis.
Retiophyllia clathrata
Retioph. paraclathrata
Rhaetina gregaria
Rhaetina pyriformis
Zugmayerella uncinata
Lepismatina austriaca
Discina suessi
Zeilleria norica
Austrirhynchia cornig.
Melania sp.
,Turritella' sp.
Stuorella sp.
,Dentalium' sp.

3. Community of *Gervillia* + *Myophoria.* It represents one of the typical communities of the so called "Swabian facies" (Fig. 8, 9). Its members are the characteristic bivalves *Gervillia inflata, Myophoria inflata* and *M. emmrichi,* occurring sometimes with valves of *Chlamys acuteaurita*. The community was probably living on intertidal of the coast.

B. Communities of biostronal lagoons

1. Community *Rhaetavicula+Placunopsis+Atreta.* It represents an immature community as the forms mentioned are a component of many communities of biostronal langoons. With further stabilization of the faunistic ecosystem some of the following communities might have developed from it (Fig. 9).

2. Community *Cardita* + *Nuculana* + gastropods (Fig. 9) includes the major part of bivalve forms of biostromal lagoons. It is found in grey marly shelly limestone. It contains burrowing types of byssate bivalves, which probably lived on shallow-water flast with algal covers. Known from thanatocoenoses only.

3. Community *Propeamussium* + *Gryphaea pictetiana* + *Gervillia* (Fig. 11). Occurring in bluishgrey crinoidal and oolitic limestone. It contains species requiring a more solide substratum in shallow-water environment *(Propeamussium (Parvamussium) schafhaeutli, G. pictetiana, Gervillia praecursor, Chlamys winklari.)* Often preserved in thanatocoenoses only.

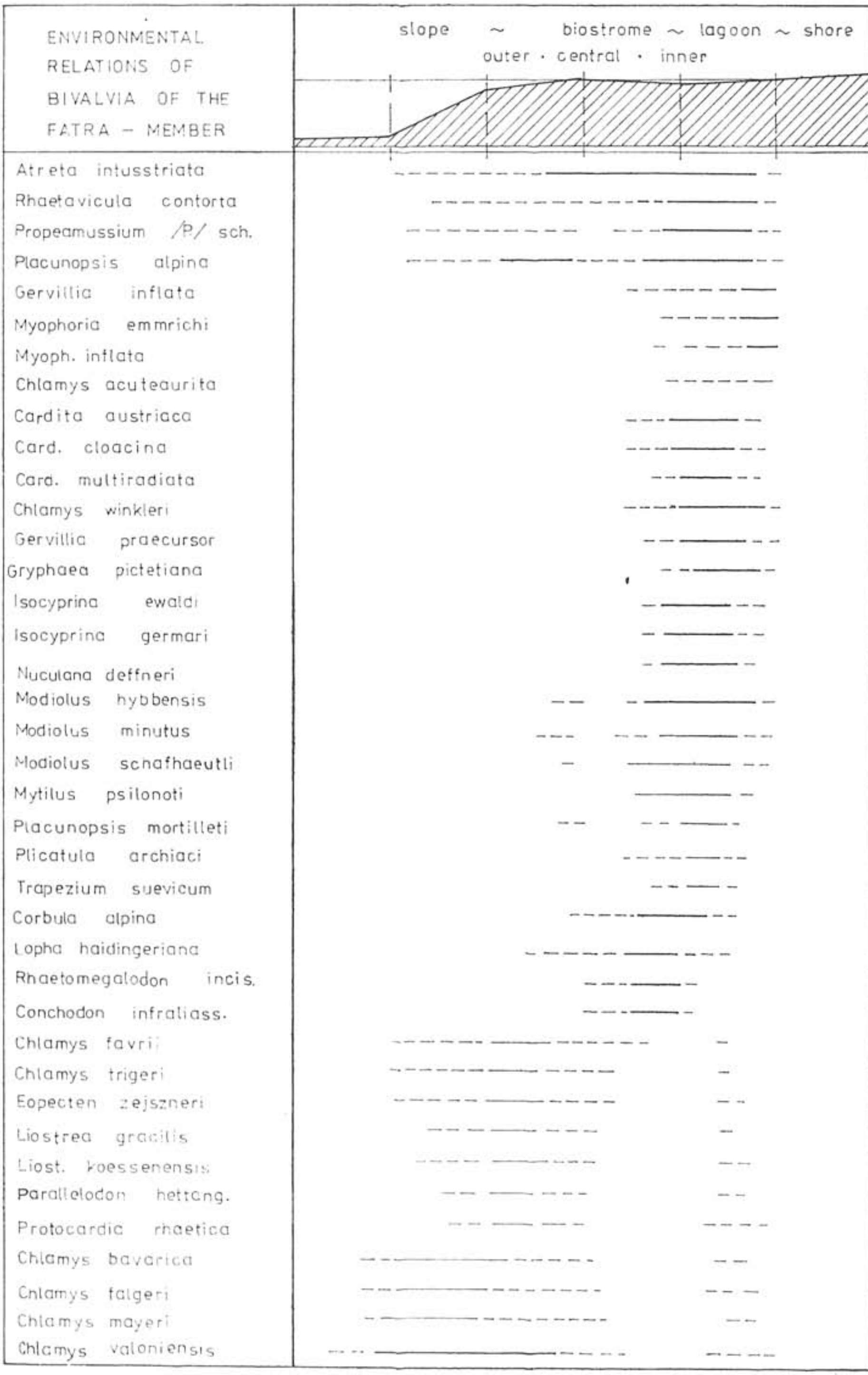
4. Community *Placunopsis* + *Isocyprina* is found in dark-grey lumachelle limestones, which in the environment of formation are very similar to community No. 2. Known from thanatocoenoses.

5. Community *Rhaetina* + *Zugmayerella* + *Modiolus* was living in shallow-water parts of lagoons (marly limestones and marls with intercalations of dolomites). Its typical representatives are, beside the brachiopod species *Rhaetina gregaria* and *Rh. pyriformis, Zugmayerella uncinata,* also the less frequent *Lepismatina austriaca, Discina suessi* and *Zeilleria norica.* In areas near to the channel-like "Orava depression" (J. Michalík, 1974) is also found the brachiopod *Austrirhynchia cornigera.* Beside brachiopods the bivalves *Modiolus minutus, M. hybbensis, M. schafhäutli* (thus byssate forms), *Lopha haidingeriana and* others are bound to the community. Preserved are parts of original biocoenoses.

C. Communities of the inner biostrome zone

1. Community of megalodonts + *Lopha* + *Corbula.* The community of megalodontid bivalves was investigated most thorougly by A. Gaździcki (1971, 1974) from the northern slopes of the High Tatra. The megalodonts formed cluster-like groups of shells, oriented with their umbos downward, partly diving into the sediment. The bottom was relatively solid, coherent, formed by calcareous, rapidly solidifying mud (Fig. 10). The biocoenoses are partly preserved.

Fig. 8. Schematic representation of relations of the individual species of bivalves to the environment of the Fatra formation. Scale of lithofacies as for. Fig. 5. Original, according to data of M. Kochanová.


ENVIRONMENTAL RELATIONS OF BIVALVIA OF THE FATRA – MEMBER
slope ~ biostrome ~ lagoon ~ shore
outer · central · inner
Atreta intusstriata
Rhaetavicula contorta
Propeamussium /P/ sch.
Placunopsis alpina
Gervillia inflata
Myophoria emmrichi
Myoph. inflata
Chlamys acuteaurita
Cardita austriaca
Card. cloacina
Card. multiradiata
Chlamys winkleri
Gervillia praecursor
Gryphaea pictetiana
Isocyprina ewaldi
Isocyprina germari
Nuculana deffneri
Modiolus hybbensis
Modiolus minutus
Modiolus schafhaeutli
Mytilus psilonoti
Placunopsis mortilleti
Plicatula archiaci
Trapezium suevicum
Corbula alpina
Lopha haidingeriana
Rhaetomegalodon incis.
Conchodon infraliass.
Chlamys favrii
Chlamys trigeri
Eopecten zejszneri
Liostrea gracilis
Liost. koessenensis
Parallelodon hettang.
Protocardia rhaetica
Chlamys bavarica
Chlamys falgeri
Chlamys mayeri
Chlamys valoniensis

2. Communities of gastropods and algae. The fauna is mostly formed by small (herbivorous?) gastropods, found in fragmentary shelly to organodetrital limestone. Sometimes in nest-like clusters are found small shells of scaphopods. The plant component-probably green algae-have not preserved in fossil state.

3. Community of corals + sponges + gastropods (Fig. 10) forms already the transition to actual biostromal growths. It contains abundant forms of calcareous sponges (not investigated so far), corals *Phacelostylophyllum robustum, Ph. medium, Stylophyllum gracile* a. o., populations of the brachiopod *Rhaetina gregaria*, large gastropods *(Pseudomelania* sp., *Melania* sp. a. o.) and bivalves *(Lopha haidingeriana)*.

D. Communities of the central biostrome zone

1. Communities of corals. They have not been investigated more in detail. From the forms determined are present here *Parathecosmilia sellae, Rhaetiastraea tatrica and Astraeomorpha crassisepta*. The number of the present species is perhaps higher. Regarding to the fact that the communities were living in the zone of highest turbulence, a large part of coral skeletons was destroyed immediately after death (sometimes also before) of coral polyps.

2. Community of *Rhaetina gregaria* was living in channel-like depressions and small interspaces of the zone of biostromes. The brachiopods inhabited in dense populations the bottom of small depressions (J. Michalík 1975, Fig. 22), where they were protected wave action. The bottom was formed by calcareous organic detritus, possibly solidified by algal covers (?) (Fig. 10).

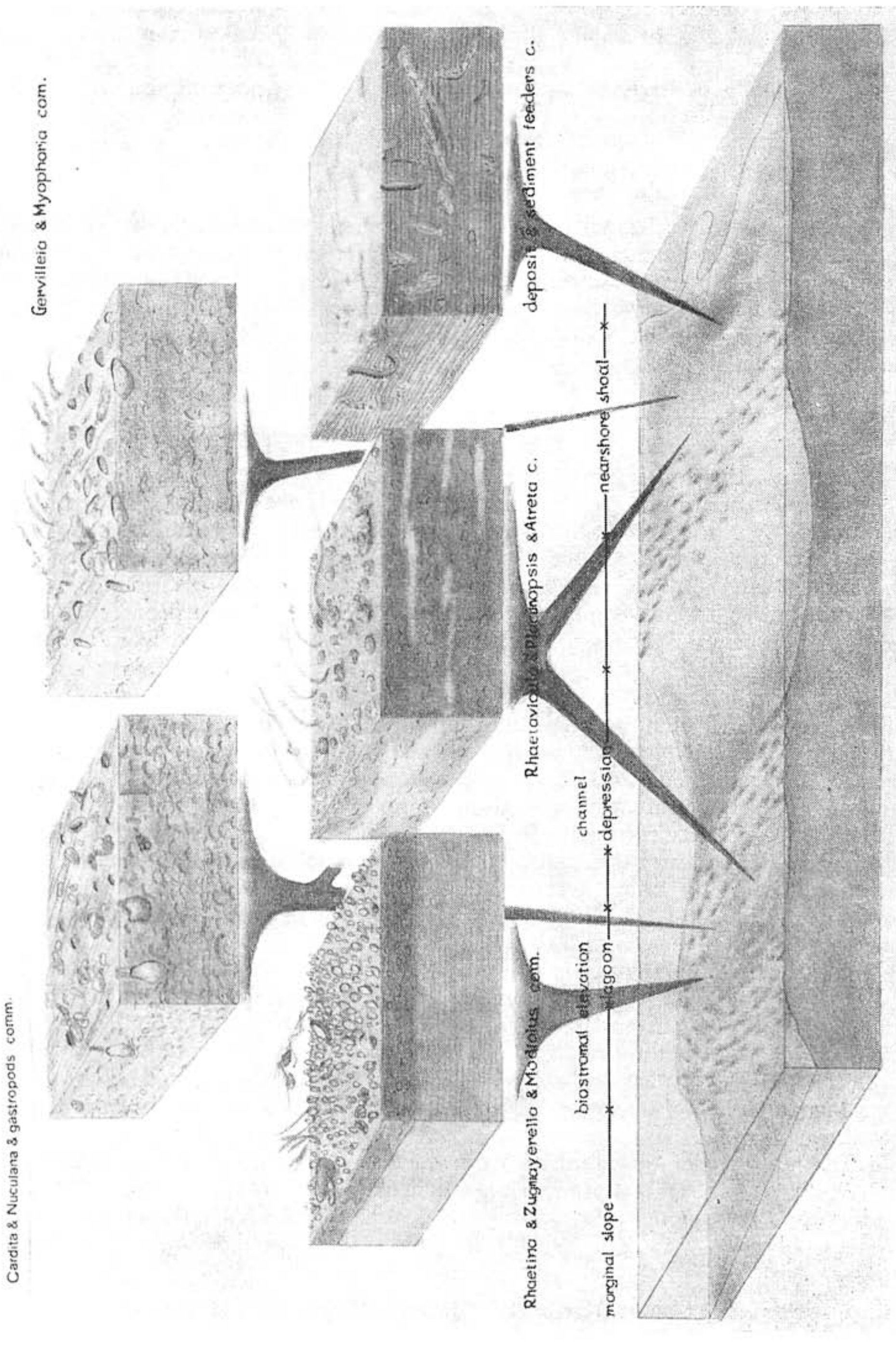
E. Communites of the inner zone of biostromes

1. Community *Rhaetina + corals* (Fig. 10) represents a population of the species *Rhaetina gregaria* (rarely with dwarfed individuals of *Rh. pyriformis)*, living in the environment of high turbulence at the margin of coral biostromes. The brachiopods were mostly attached by pedicle to dead corallites in interspaces of coral bunches sometimes their shells have preserved in original orientation up to present (J. Michalík, 1975; Fig. 22). Comparison with the recent community of *Terebratulina* (J. P. A. Noble et al., 1976) indicates that also this "comunity" could be a cavity subcommunity of the original community of Rhaetina gregaria (D—2).

F. Communities (?) of the biostromatic complex margin.

1. Association of *Protocardia + Chlamys favrii* found in dark-coloured organodetrital to fragmentary shelly limestone: it typical species is *Protocardia rhaetica*, found together with valves of the pectenid *Ch. favrii* (the possibility cannot be excluded that there is a postmortal association only) (Fig. 11).

Fig. 9. Scheme of communities of near-shore and biostromatic-lagoonal facies of the Fatra formation. Original.


Cardita & Nuculana & gastropods comm.
Gervilleia & Myophoria com.
deposit & sediment feeders c.
Rhaetavicula & Placunopsis & Atreta c.
Rhaetina & Zugmayerella & Modiolus com.
marginal slope
biostromal elevation
lagoon
channel
depression
nearshore shoal

2. Communities (?) of *Liostrea gracilis* and *L. koessenensis* occuring in light-grey organodetrical to shelly limestone. Bound to the occurrence of *L. gracilis* are *Parallelodon hettangiensis* and the pectenids *Chl. trigeri* and *Eopecten zejszneri*. Their occurrence is, however, mostly known from thanatocoenoses (Fig. 11).

G. Communities of the open neritic

1. Association of *Chlamys* + crinoids. A typical species is *Chlamys valoniensis* together with *Ch. falgeri*, *Ch. bavarica*, *Ch. trigeri* (in organodetrital to fragmentary shelly limestone) and *Ch. mayeri* (in grey compact limestone). The remants of crinoids have not been studied nearer. All fauna remants are found in redeposited position so that the composition of the original biocoenoses can be supposed only (Fig. 11).

Summary

1. The investigation of fossil organism remains of the Fatra formation is not complete: Foraminifers, corals, brachiopods, bivalves and gastropods could be evaluated. Even their study, however, cannot be consideret as finished.

2. The picture obtained about facial and biocenotic relations of organisms of the Fatra formation has been fragmentary so far: from the preliminary scheme of communities, from seventeen are four insufficiently, five are present only as remnants in necrocoenoses and only eight may be considered as remnants of biocoenoses in situ.

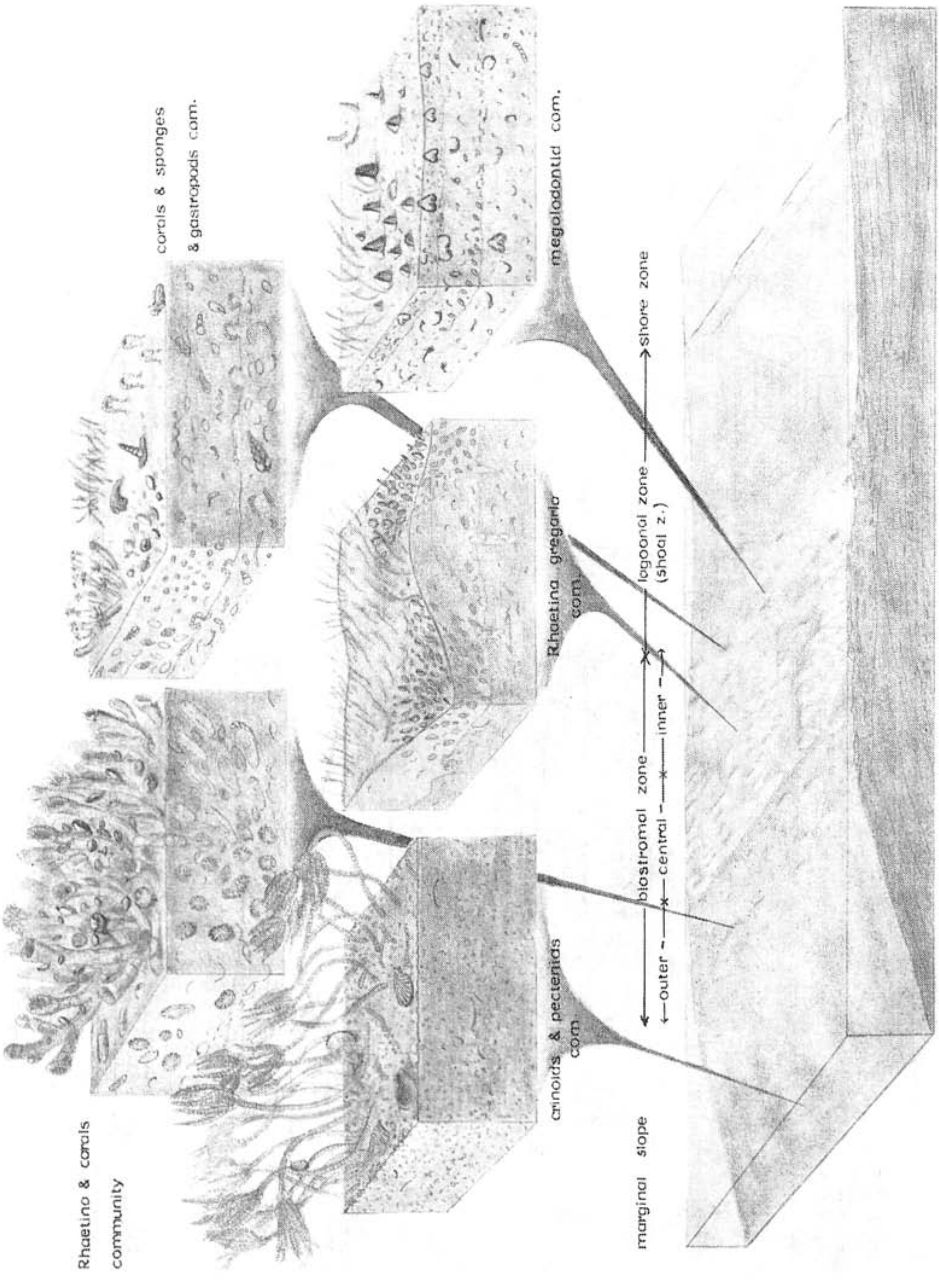
3. Based on the study of bivalve nekrocoenoses (K. M. Sultanov et al., (1975), however, it may be supposed that, at the absence of more distinct current transport, the conspicuousness of representation of valves of the species in necrocoenosis can be a reflection of its importance in the mother biocoenosis in spite of frequent misrepresentation by secondary factors (resistence against the influences of environment etc.).

4. Reconstructed was the rough composition of thirteen biocoenoses: seven of them are distinctly immature (opportunistic, immature communities according to the classification of J. Donahue – H. B. Rollins 1975), five transition immature-mature communities and one community can be possible (with doubts) to valuate as mature community.

5. On the basis of the preliminary trophic analysis it may be agreed the statement following from the works by K. R. Walker 1972 and J. C. Tipper (1975), that in the area of the solid to hard bottom (such as the biostrome zone) filtrating organismus are predominating. In direction towards the biostromal lagoon collectors acquire more importance, in places with finer bottom swallowers prevail.

6. The majority of communities from the Fatra formation are apparently allopatric. This fact is comprehensible regarding to the circumstance that the underlier of this sequence are abiogenic deposits of the Carpathian Keuper and

Fig. 10. Scheme of communities of the biostromatic complex of the Fatra formation. Original.


Rhaetina & corals community
corals & sponges & gastropods com.
megalodontid com.
Rhaetina gregaria com.
crinoids & pectenids com.
marginal slope
biostromal zone
outer
central
inner
lagoonal zone (shoal z.)
shore zone

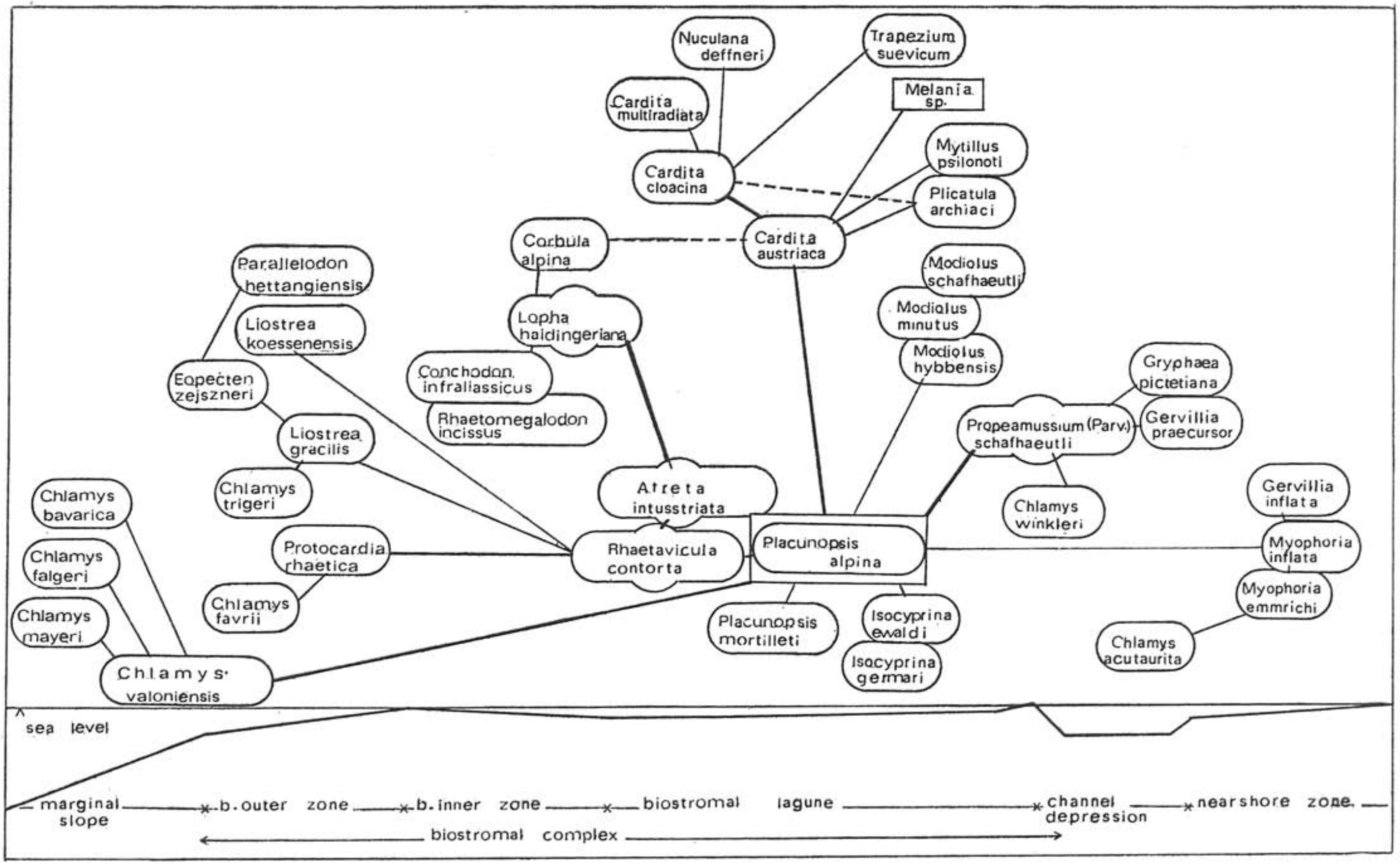


Fig. 11. Schematic representation of relations of bivalve species of the Fatra formation. Original according to data of M. Kochanová.

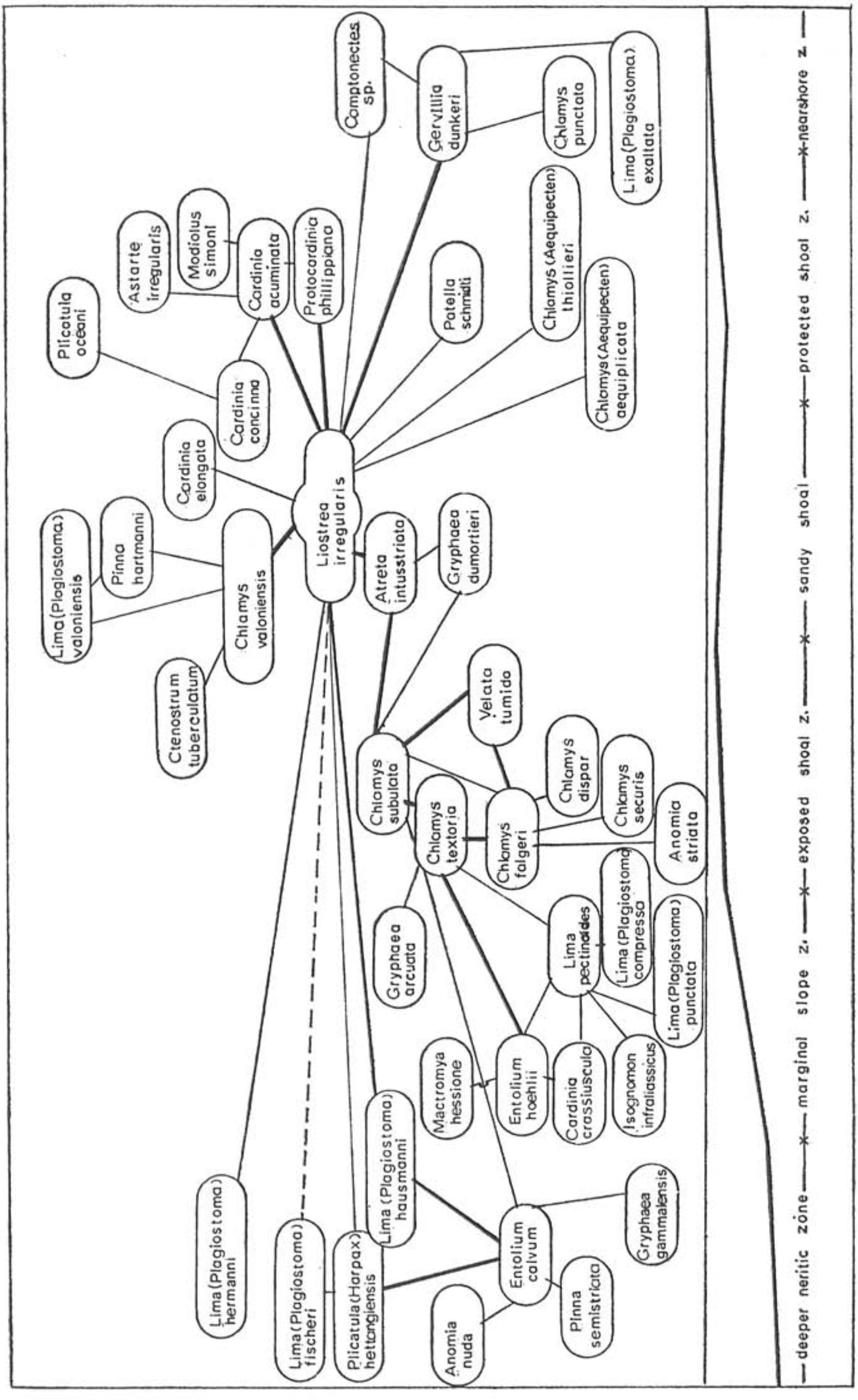


Fig. 12. Schematic representation of relations of bivalve species of the Gresten formation of the Fatric. Original according to data of M. Kochanová.

in the environment proper of the Fatra formation sedimentation basin living cenditions were very variable and consequently there was not enough time for development of sufficiently stable, well-developed domestic communities with strictly limited ecological functions of their members.

The development of communities was always interrupted by catastrophic events, caused by sea-floor oscillations: old communities were destroyed and the space was inhabited again by populations of eurytopical species. While the conditions set in were lasting, these populations gradually changed into specific communities: usually they were, however, destroyed sooner (by drying up, higher salinity, wash-out or change of depth) than they could have specified.

7. In sequences of the Hronic and Gemeric indications of phyletic relations maybe noticed in organic assemblages, as also a larger diversity and stability (localities Hybe, Goštanová etc.). This fact fully agrees with the model of H. B. Rollins – J. Donahue (1975), in which the increase of these properties of communities in partly separated basins, towards the seaway is supposed (p. 261).

Translated by J. PEVNÝ

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Review by J. BYSTRICKÝ Manuscript received June 15, 1976