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# ECOLOGY AND FACIAL RELATION OF SOME GROUPS OF TRIASSIC FORAMINIFERS AND OSTRACODS OF STRATIGRAPHIC IMPORTANCE

*(Pls. 3)*

Abstract: In the study of vertical distribution of some groups of foraminifers and ostracods important for stratigraphy in the West Carpathians in relation to other Tethyan regions their ecology and also considerable facial diversification are taken into account. From this study the knowledge of difference in their vertical distribution results, contributing to clearing up of the question from where one or another species or whole associations of foraminifers important for the stratigraphy migrated.

Резюме: При исследовании вертикального распространения некоторых групп фораминифер и остракодов имеющих важное значение для стратиграфии Западных Карпат по отношению к другим тетидным регионам учитывается их экология и также значительное фациальное разнообразие. Из этого исследования следует знание разницы вертикального распространения, которое способствовало объяснению вопроса, откуда мигрировали те или другие виды или целые ассоциации фораминифер важные для стратиграфии.

## *Introduction*

In the monographic work on Triassic foraminifers of the West Carpathians Salaj — Borza — Samuel (1983) studied and described 300 species from foraminifers and microorganisms of the group Incertae sedis belonging to 100 genera. It may be said that in all-world-scale they are Triassic taxa studied paleontologically in a most complex way so far. For each stage several types of foraminifer associations are described, the most important of which are designated as index fossils of individual zones and subzones.

Zonal subdivision of the Triassic is, however, based not on one group of foraminifers but on several groups. This is evident from facial diversity of the Triassic and so also from various ecological conditions suitable for one or another group of foraminifers or for various groups of microorganisms from the group of Incertae sedis, further of conodonts and ostracodes.

From the analysis of facial and ecological conditions, to which we paid attention, some regularities result. When taking them into regard with further more detailed microbiostratigraphic investigation of the West Carpathian Triassic time will be spared, when we shall take into consideration whether one or another group of microfossils can be present or absent in one or another facies.

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*Problem of the Permian — Triassic boundary*

In the West Carpathians one cannot express to the question of the Permian — Triassic boundary on the basis of foraminifers and even work out the stratigraphy of the lowermost Triassic members as its members are developed in facies unfavourable for foraminifers (Seis beds, Lužna formation, Werfen beds), which are prevailingly transgressive in relation to the substratum. Relation to the Permian cannot be solved faunistically here, similarly as in many other regions of the world where the Triassic is in German or Tethyan development. In spite of that in some regions of the world this possibility of faunistic solution of the Permian-Triassic relation exists regarding to gradual sedimentation between them in marine limestone facies, the microbiostratigraphy of the boundary beds is not established; the less is solved the problem, what types of foraminifer associations or what species are passing from the Permian to the Triassic.

*Group of foraminifers of the family Nodosariidae* EHRENBERG, 1838

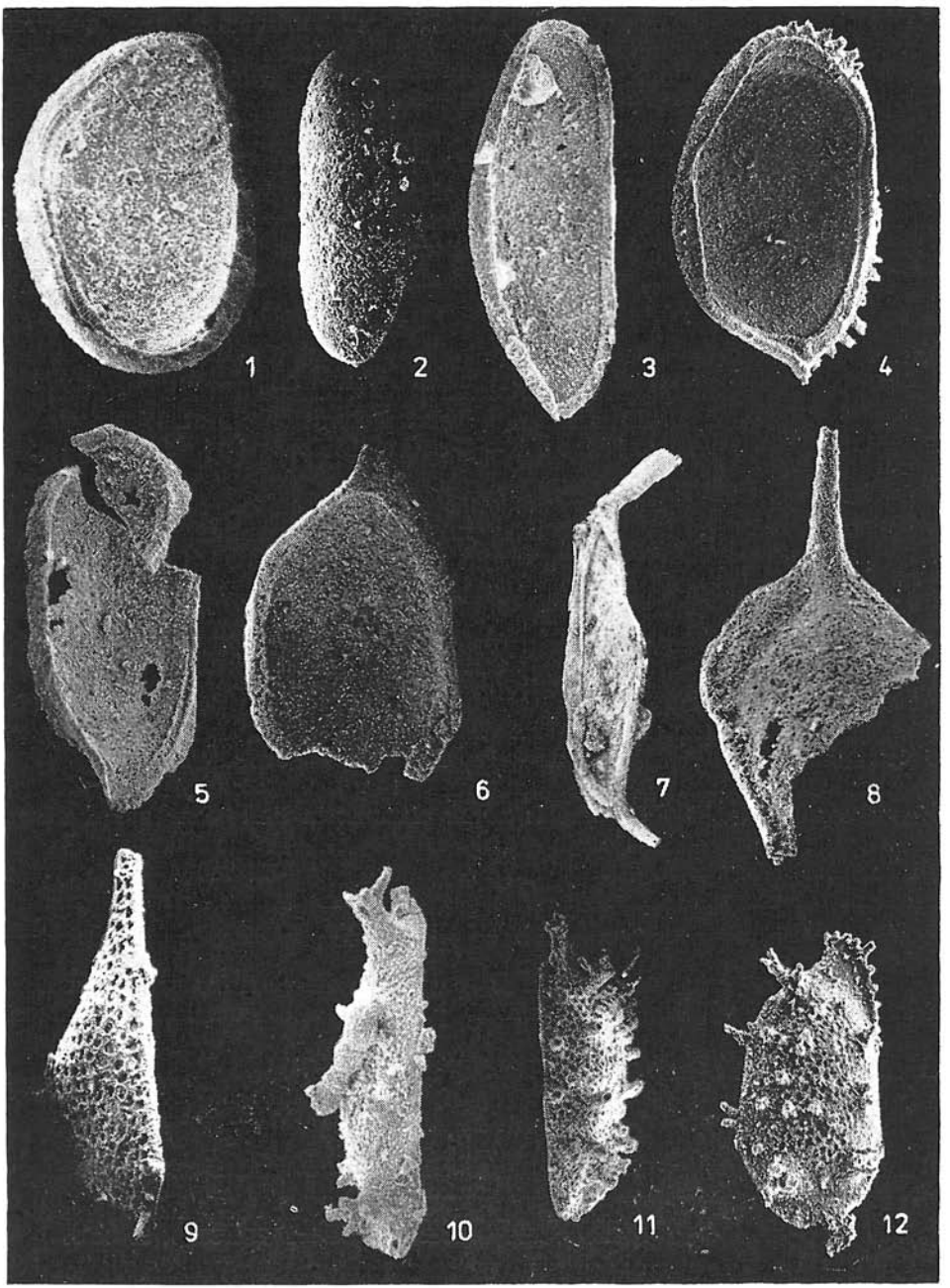
Many representatives of some genera of the family *Nodosariidae* EHRENBERG, 1838, which were living in the Permian, were also passing into the Triassic (see Salaj — Borza — Samuel, 1983). There are types of species mainly bound to deeper marly and limestone facies. They are known from washings of the Lunz, Kössen and Zlambach beds on the one hand and from limestones or washings (in diluted 3 — 5 % acetic acid), mainly from the facies of the Reifling or Pseudoreifling, Schreyeralm and Hallstatt limestones on the other hand. In their study it is possible to be restricted to determination of species but without nearer solution of phylogenetic relations between them.

It results from the above mentioned that representatives of the family *Nodosariidae* EHRENBERG, 1838 are not present im the basal transgressive lithofacies or in Lower Triassic neritic facies, further they are missing in the Gutenstein limestones prevailingly deposited in hypersaline environment. They are scarcely found in the facies of the Steinalm, Tisovec, Furmanec, Dešťanky limestones but are missing in the facies of the Wetterstein, Opponitz limestones and naturally in various dolomites (Ramsau, Reifling, Wetterstein and Hauptdolomit).

If we take into consideration from data in literature that representatives of

Plate 1

Fig. 1. *Healdia anisica* KOZUR × 40
Fig. 2. *Bairdiacypris anisica* KOZUR × 55
Fig. 3. *Bairdia finalyi* MÉHES × 60
Fig. 4. *Bairdiolites compactus* KRISTAN — TOLLMANN × 50
Figs. 5, 6. *Triebelina muelleri* KOZUR × 60
Fig. 7. *Acanthoscapha bogschi interrupta* KOZUR × 70
Fig. 8. *Acanthoscapha bogschi interrupta* KOZUR × 50
Fig. 9. *Triebelina (Mirabairdia)* n. sp. × 70
Fig. 10. *Triebelina (Mirabairdia) spinosa* KOZUR × 60
Fig. 11. *Triebelina (Mirabairdia) spinosa* KOZUR × 50
Fig. 12. *Ceratobairdia longispinosa* KOZUR × 60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the family *Nodosariidae* are present in the Lower Triassic and Anisian, for instance in Turkey (Zaninetti, 1976), Bulgaria (Trifonova, 1978), where also facies corresponding to conditions of deeper environment are developed, we tend to the opinion (Salaj, 1979) of their migration from east to west or from south to north. The migration was gradual, so as favourable ecological conditions were created for them. In the West Carpathians they appear as early as the Pelsonian, but are not present everywhere. In the Tatricum (Vysoké Tatry, Veľká Fatra and Malá Fatra Mts.) and Fatricum (Malé Karpaty, Veľká Fatra, Nízke Tatry Mts.) foraminifers of the family *Nodosariidae*, although scarcely, are represented practically as late as the Rhaetian of shallow-water character (Tomanova and Fatra formations) where together with them, but relatively scarcely, involute foraminifers of the family *Archaediscidae* CUSHMAN, 1928 are found.

The shallow-water character of the mentioned Rhaetian formations overlying the Carpathian Keuper is doubtless. These formations were even deposited for a short time also in hypersaline environment as confirmed by the *Glomospirella — Glomospira* horizon with distinctly dwarfed forms of the mentioned genera (Michalík — Jendrejáková — Borza, 1979; Salaj, 1979; Salaj — Borza — Samuel, 1983).

It is evident from the above mentioned that the faunistic crisis known from the Permian — Triassic boundary persisted in the Tatricum and Fatricum practically to the Rhaetian, naturally, moreover, distinctly influenced by tectonic processes corresponding to the Labinian phase (Havrila, 1983).

### *Group of foraminifers of the family Fischerinidae* MILLET, *1898*

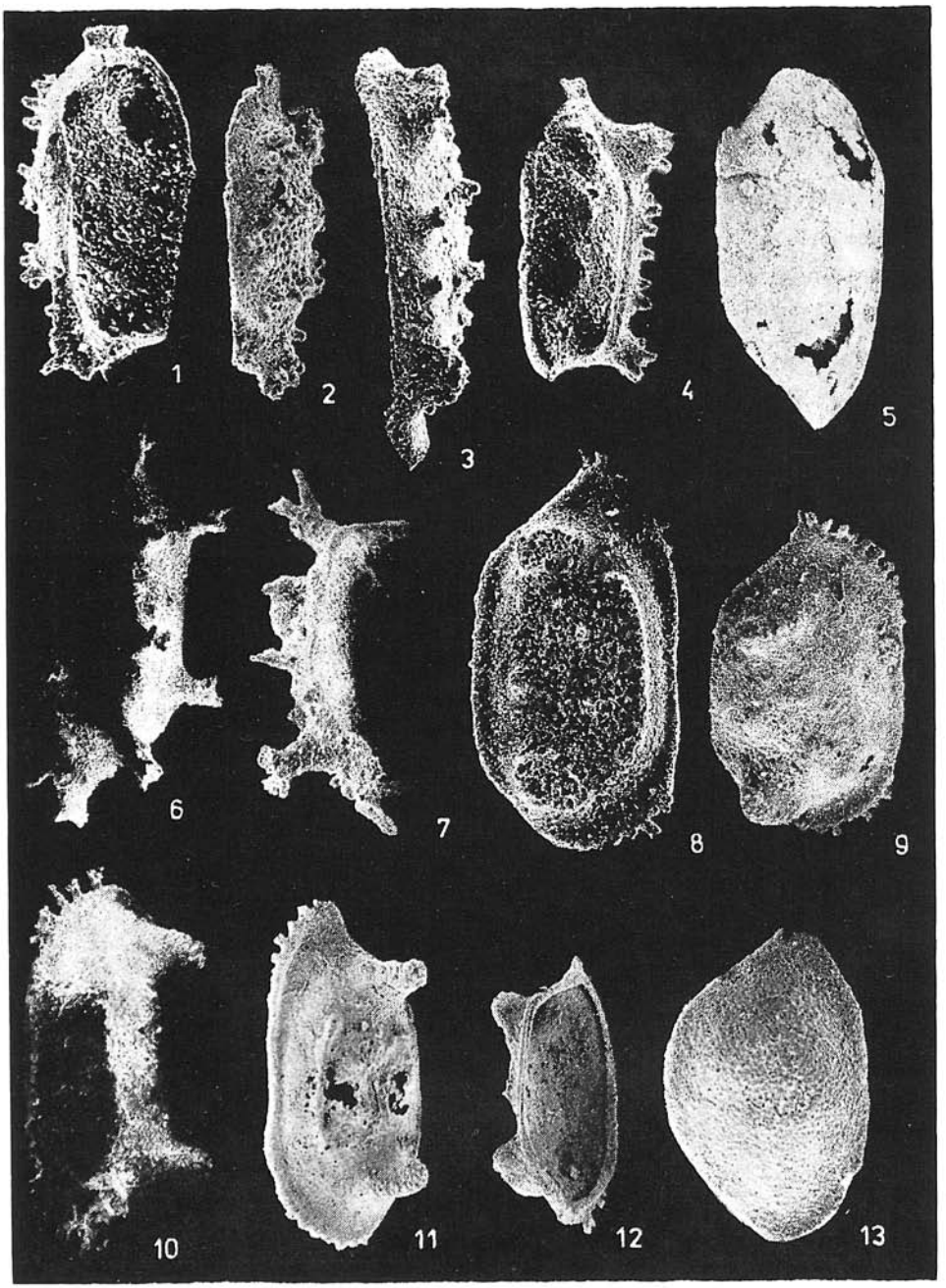
A further important group of foraminifers of the family *Fischerinidae* MILLET, 1898 is characteristic for the shallow-neritic Campilian beds, lagoonar Gutenstein limestones and shallow-water Carnian Tisovec limestones.

The neritic Campilian beds are characterized by *Meandrospira cheni* (HO) and *Meandrospira pusilla* (HO). The lagoonar Gutenstein limestones are characterized by the species *Meandrospira insolita* (HO) on the one hand and by the species *Meandrospira deformata* SALAJ (in Salaj — Biely — Bystrický, 1967) on the other hand, testifying to a distinct hypersaline environment, in which a part of the Gutenstein limestones deposited (Mišík, 1972; Salaj — Polák, 1978).

The Steinalm platform, prevailingly dasycladacean limestones are characterized by the association of foraminifers with *Meandrospira insolita* (HO) on

Plate 2

Figs 1, 3. *Triebelina (Mirabairdia) pernodosa illyrica* KOZUR × 70
Figs. 2, 4. *Triebelina (Mirabairdia) pernodosa illyrica* KOZUR × 60
Fig. 5. *Spinocypris* cf. *vulgaris* KOZUR × 50
Figs 6, 7. *Triebelina (Mirabairdia) pernodosa gemerina* KOZUR × 50, × 65
Fig. 8. *Triebelina (Triebelina) martinssoni* KOZUR × 50
Figs. 9, 10. *Bairdiolites compactus* KRISTAN–TOLLMANN × 50, × 70
Figs 9, 10. *Bairdiolites compactus* KRISTAN–TOLLMANN × 45, × 40
Fig. 13. *Triebelina kristane praecurssor* KOZUR × 50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the one hand and with *Meandrospira dinarica* KOCHANSKY–DEVIDÉ and PANTIĆ, *Meandrospiranella samueli* SALAJ (in Salaj – Biely – Bystrický, 1967 and with *Meandrospiranella irregularis* SALAJ (in Salaj — Biely – Bystrický, 1967) on the other hand.

The representatives of the mentioned species of the genus *Meandrospira* and *Meandrospiranella* are relatively abundant still in the lower part of the Schreyeralm limestones rich in *Dasycladacea*, mainly corresponding to the Lower Illyrian. Their upper part poor in *Dasycladacea* (mainly the Slovak Karst) was deposited already rather under pelagic conditions *(Ammonoidea)* and is very poor in representatives of *Fischerinidae* MILLET, 1898.

It is remarkable that the representatives of the individual genera of this family, with the exception of the species *Agathammina austroalpina* KRISTAN–TOLLMANN et TOLLMANN, are not represented in the facies of Weterstein limestones or dolomites (Ladinian-Lower Carnian). It is evident that this facies was not favourable for development of representatives of the family *Fischerinidae* MILLET, 1898, similarly as for representatives of the family *Nodosariidae* EHRENBERG, 1838. We encounter them again in the Carnian platform Tisovec limestones rich in *Dacycladacea (Meandrospirella carnica* ORAVECZNE–SCHEFFER, *Meandrospirella planispira* ORAVECZNÉ–SCHEFFER, *Bispiranella ovata* SAMUEL SALAJ and BORZA, *Bispiranella subcarinata* SAMUEL, SALAJ and BORZA) as well as in the Furmanec and Dachstein limestones representatives of the genus *Planiinvoluta* LEISCHNER, 1961 are found from the family *Fischerinidae* MILLET, 1898.

*Group of foraminifers of the family Ammodiscidae* REUSS, *1862 and some ostracods*

To highly adaptive forms adapted to live in lagoonar (not in hypersaline) environment, in neritic – detrital and platform-limestone, *Dasycladacea* – and partly coral-rich environment belong representatives of some genera of the family *Ammodiscidae* REUSS, 1862. They are mainly species of the genera *Pilammina* PANTIĆ, 1965 and *Pilamminella* SALAJ, 1978.

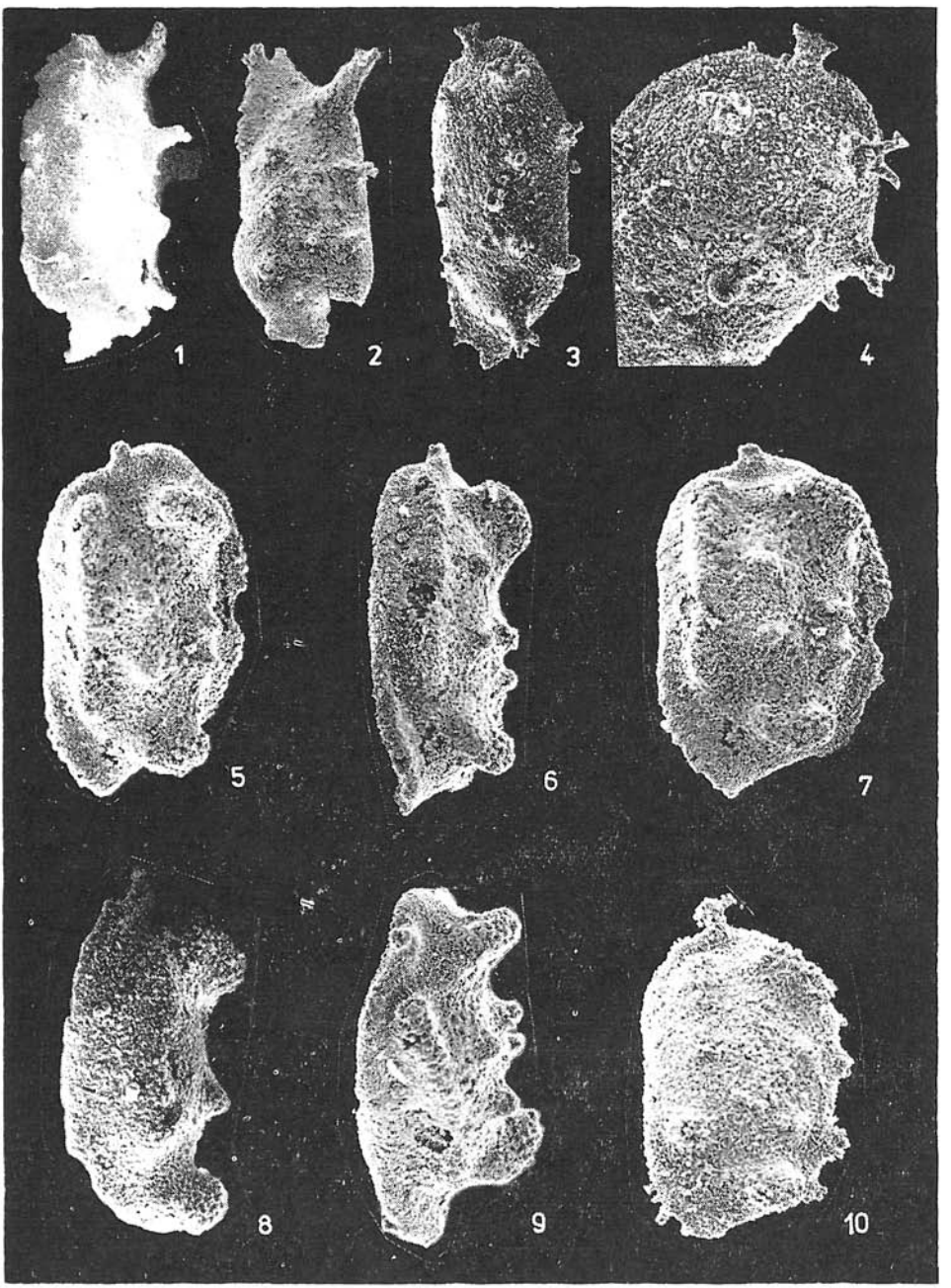
In the Lower Triassic Campilian beds of the West Carpathians it is *Pilamminella* cf. *triphonensis* (BAUD, ZANINETTI and BROENNIMANN), known from the Taurides where also *Pilamminella elbursorum* (BROENNIMANN, ZANINETTI, BOZORGNIA and HUBER) is found.

In the Anisian Steinalm and the lower part of the Schreyeralm limestones *Pilammina densa* PANTIĆ, *Pilamminella grandis* (SALAJ, in Salaj – Biely

Plate 3

Figs 1, 2, 3, 4. *Ceratobairdia longispinosa* KOZUR × 50, × 40, × 60, × 100
Figs 5, 6, 7. *Nodobairdia sinense* KRISTAN–TOLLMANN × 50
Figs. 8, 9. *Nodobairdia sinense* KRISTAN–TOLLMANN × 75, × 60
Fig. 10. *Mirabairdia medionodosa* KRISTIAN–TOLLMANN × 80

All specimens figured in plates 1–3 are from the Lower Illyrian Reifleing limestones, locality Gombasek serpentines (see Salaj – Borza – Samuel, 1983; Fig. 10, p. 33).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— Bystrický, 1967) and *Pilamminella semiplana* (KOCHANSKY–DEVIDÉ and PANTIĆ) are found.

A facies dubious for their development is the facies of the Gutenstein limestones. It is very probable that they are not found in this facies at all. Therefore also the find of Borza (1970) of the species *Pilammina densa* Pantić from the Gutenstein limestones (cf. Salaj – Borza — Samuel, 1983) seems to be problematic. It is, however, proved in Turkey (Zaninetti – Dager, 1978) that the species *Pilammina densa* PANTIĆ is also found in the facies of pelagic limestones with *Ammonoidea* already from the Anisian base. If it is confirmed with further investigation in the West Carpathians that *Pilammina densa* PANTIĆ is found here from the Middle Anisian, so it will be confirmed quite unambiguously that its migration was taking place from the east.

In the facies of the Wetterstein and Tisovec limestones the species *Pilamminella gemerica* (SALAJ) is found and in the Tisovec limestones, moreover, *Pilamminella kuthani* (SALAJ, in Salaj – Biely – Bystrický, 1967) is present.

Finally it is necessary to mention the species *Pilamminella begani* (SALAJ) and *Pilamminella falsofriedli* SALAJ, BORZA and SAMUEL, which are found in the Dachstein lagoonar limestones.

As to the upper boundary of extension of the species *Pilammina densa* PANTIĆ, *Pilamminella grandis* (SALAJ, in Salaj – Biely – Bystrický, 1967), *Pilamminella semiplana* (KOCHANSKY–DEVIDÉ and PANTIĆ), equally as representatives of *Fischerinidae* – species of the genera *Meandrospira* and *Meandrospiranella*, it is generally proved in the West Carpathians (Salaj – Biely – Bystrický, 1967), Alps, Dinarides, Taurides (Zaninetti, 1976) and in the Balkans (Trifonova, 1978) that these species are not passing through the Illyrian — Fassanian boundary. In the West Carpathians, so far as these species are bound to the platform algal Steinalm limestones, they also can reach the Illyrian — Fassanian boundary. In the majority of cases, as we know from literature (Bystrický, 1964, 1983), in the Upper Illyrian mainly the Schreyeralm or Reifling limestones are developed, so in these facies the mentioned representatives of the individual genera are practically not found. Instead of them deeper – water genera are present, represented by the species: *Turritellella mesotriassica* KOEHN–ZANINETTI, *Nodobacularia cylindriformis* SALAJ, BORZA and SAMUEL, *Nodobacularia vujisići* UROŠEVIĆ and GAŽDZICKI, *Agathammina judicariensis* PREMOLI–SILVA, *Ophthalmidium tricki* (LANGER) and *Ophthalmidium exiguum* KOEHN–ZANINETTI.

The presence of abundantly represented nodosarian foraminifers (SALAJ, 1978) and sculptured ostracodes (Pl. 1–3) incidentally provided with tubular protrusions (device for attachment to algae) in the lower part of the Reifling limestones from the Gombasek serpentines (Salaj – Borza – Samuel, 1983) would testify to sedimentation at the depth of 200–300 m, maximum to 700 m (maximum depth of the photic zone).

The ostracode association is represented mainly by the species: *Healdia anisica* KOZUR, *Bairdiolites compactus* KRISTAN–TOLLMANN, *Triebelina (Triebelina) martinsoni* KOZUR, *Bairdiacypris anisica* KOZUR, *Bairdia finalyi* MEHES, *Praemacrocypris mocki* KOZUR, *Ceratobairdia longispinosa* KOZUR, *Trie-*

*belina (Mirabairdia) pernodosa gemerina* KOZUR, *Triebelina (Mirabairdia) spinosa* KOZUR, *Triebelina (Mirabairdia) pernodosa illyrica KOZUR, Acanthoscapha bogschi interupta* KOZUR and others.

The mentioned depth should not be greater because in a relatively short section of time shallow-water Lower Ladinian reef limestones begin to occur. This transition to shallowing was gradual as confirmed by finding of a facies transitional between the basin and reef facies (M e l l o, 1977) with *Plexoramea cerebriformis* M e l l o, *Ladinella porata* OTT, *Tubiphytes obscurus* MASLOV, *Thaumatoporella parvovesiculifera* (RAIN.), *Baccinella floriformis* PANTIĆ and *Baccinella ordinata* PANTIĆ. From the foraminifers *Endothyranella wirtzi* (KOEHN – ZANINETTI) is represented.

It is, however, necessary, to mention that in places also crinoidal limestones are found the Schreyeralm and Reifling limestones and so far these are not allodapic, i. e. turbidite, so in most cases we are also finding representatives of the family *Fischerinidae* MILLET, 1898 in then, i–e. representatives of the genera *Meandrospira* LOEBLICH and TAPPAN, 1964 and *Meandrospiranella* SALAJ, 1967, emend. SALAJ, 1969, equally the species *Pilammina densa* PANTIĆ, *Pilamminella grandis* (SALAJ) and *Pilamminella semiplana* (KOCHANSKY –DEVIDÉ and PANTIĆ) are present. It should be noted that scarcely the first representatives of involute foraminifers of the family *Archaediscidae* CUSHMAN, 1928 are found with them, represented by the species *Permodiscus pragsoides* OBERHAUSER.

*Group of foraminifers of the family Archaediscidae* CUSHMAN, 1928

In the West Carpathians representatives of this family are found from the Upper Illyrian to the Rhaetian or Liassic. They are represented in the lower part of the Wetterstein limestones where together with *Pilamminella gemerica* (SALAJ) are found sporadically *Permodiscus pragsoides* OBERHAUSER, *Permodiscus planidiscoides* OBERHAUSER, *Aulotortus oscillens* (OBERHAUSER), *Angulodiscus tumidus* KRISTAN. Their explosive development begins practically in the Upper Ladinian in the facies of the Wetterstein limestones and they are abundant up to the Rhaetian. They are found in the Silicicum and Hronicum practically in all facies besides the facies of the Hallstatt and Opponitz limestones. In these facies from involute foraminifers, however, thin-walled and small specimens of the species *Semiinvoluta clari* KRISTAN can be represented sporadically. Further on, representatives of the trochospirally coiled genera *Lamelliconus* PILLER, 1978, *Auloconus* PILLER, 1978 and *Trochonella* KRISTAN, 1957, which besides sporadical occurrences in the Reifling limestones *(Lamelliconus)* are found in the Lunz, Zlambach, Kössen and Hybe beds. The involute, distinctly thin-walled foraminifers, although scarcely, are represented in the Hauptdolomit (Nízke Tatry, Hybe, cf. S a l a j – B o r z a – S a m u e l, 1983) in intrabiopelmicrite layers deposited under calm lagoonar conditions of the subtidal to intertidal (with low energy). With them are frequent thalassinid anomuran *(Crustacea – Decapoda)* coprolites *Parafavreina thoronetensis* BROENNIMANN, CARON and ZANINETTI and thin-walled small ostracodes. These are also found in the Opponitz limestones, however, foraminifers practically have established in them.

*Group of foraminifers of the families Nubeculariidae* JONES, 1875; *Miliolidae* EHRENBERG, *1839 and Milioliporidae* BROENNIMANN and ZANINETTI (in Zaninetti — Bozorgnia — Dashti — Moshtaghian, 1971)

This is practically one of the most represented group of foraminifers in the West Carpathians Salaj — Borza — Samuel (1983) describe them practically from all carbonate facies. Many of them have a narrow stratigraphic range and thus are important for stratigraphy, other ones have a wider stratigraphic range, regarding to high adaptability to ecological conditions. In every case, it will be necessary in future to pay more attention to this group, mainly from the viewpoint of their vertical distribution in relation to facies. Not less important will be the question of their taxonomy for solutation of their systematic position.

For this reason it will be necessary to pay more attention to the method of washing so that we should obtain least damaged specimens from various types of limestones.

Translated by J. Pevný

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