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The Norian-Rhaetian boundary in the light of micropaleontological data

Andrzej Gaździcki

Institute of Paleobiology of the Polish Academy of Sciences
Al. Żwirki i Wigury 93, 02-089 Warszawa, Poland

Heinz Kozur

State Museum of Meiningen
Schloß Elisabethenburg GDR-61 Meiningen

Rudolf Mock

Department of Geology and Paleontology of the Faculty of Natural Sciences
J. A. Comenius University Gottwaldovo nam. 19 86200 Bratislava

Project 4

Summary

The stratigraphic ranges of Late Triassic conodonts, holothurian sclerites, ostracodes, and foraminifers are studied in representative sections of the uppermost Triassic of the Western Carpathians and Eastern Alps. The zonal subdivisions based on the above mentioned microfossils could be correlated with the ammonoid zonation and the stratigraphic scheme proposed by Kozur (1973b).

The definition of the Norian-Rhaetian boundary with the base of the *Choristoceras haueri* zone agrees with the priority. This boundary is supported by distinct changes in animal and plant groups.

The typical Kössen Beds appear to be of Rhaetian age, contemporaneous with the Zlambach Beds, and only the lowermost parts of these two units represent (Zlambach Beds) or at some places represent (Kössen Beds) the uppermost Norian (upper Sevatian).

In the systematic part a new foraminifer species, *»Vidalina« carpathica* Gaździcki, n. sp. is described.

Contents

Introduction

The paper presents the results of studies on the stratigraphic sequences of conodonts, holothurian sclerites, ostracodes, and foraminifers from Upper Norian-Rhaetian sections of the Western Carpathians (Hybe, Bleskový prameň, Malý Mlynský vrch) and of the Eastern Alps (Fischerwiese, Kendelbachgraben, Weißloferbach) developed in different facies (cf. figs, 1, 2).

The Late Norian and Rhaetian conodont, ostracode, and holothurian sclerites assemblages comprise several short-living guide forms. Other fossils of steadily increasing importance for the stratigraphy, the foraminifers, were studied in thin sections. The foraminifers have yielded guide forms also in such parts of the sections where conodonts and holothurian sclerites are scarce or absent and ostracodes are hardly obtainable from the rocks. More than one hundred thin sections of samples from the above mentioned sections were available.

The zonations based on the above mentioned microfaunistic elements were correlated with the orthostratigraphic ammonoid zonation in accordance with the stratigraphic subdivision of the Norian and Rhaetian sensu Kozur (1973 b), concordant with the priority Gümbel's (1861) subdivision.

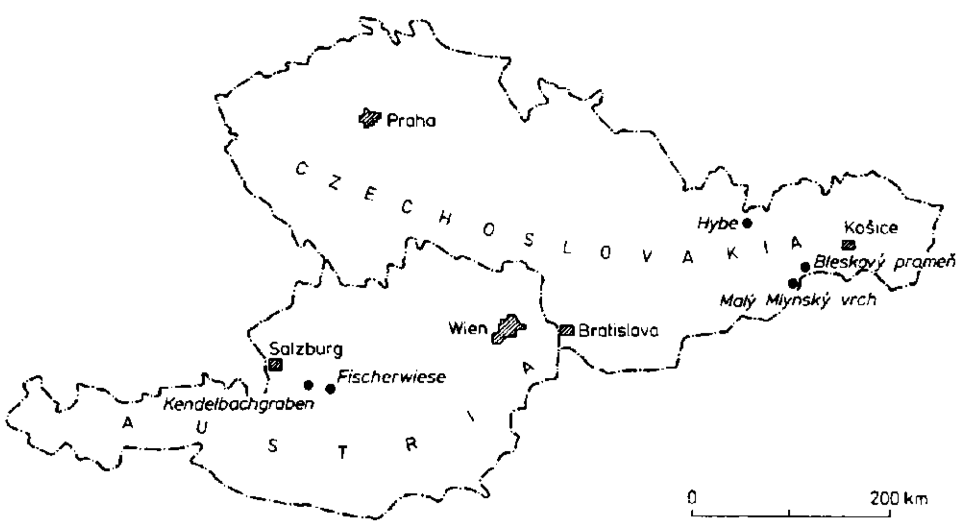


Fig. 1. Locality map of the investigated Upper Triassic sections in Czechoslovakia and Austria

Stratigraphical analysis of representative sections

Hybe (Low Tatra, Kössen Beds)

Hybe is the best known locality of Kössen Beds in the Slovak Carpathians, a classical locality on account of its rich fauna. It is situated south of the village of Hybe in the valley of the Biely Váh river, on the northern slopes of the Low Tatra (Koutek, 1927, fig. 1; Bystrický & Biely, 1966, fig. 8; Michalik, 1973, figs. 1, 2; Michalik in: Bystrický, 1973, figs. 13, 14). Its surroundings are built up of Upper Triassic of the Choč nappe ("Biely Váh Facies"), transgressively overlain by Paleogene sediments. The Upper Triassic is represented here by monotonous dolomites ("Hauptdolomit") of Carnian and Norian age, bedded light-grey "Dachstein Limestones", in places very variegated ones (Norian), and Kössen beds with rich Early Rhaetian fauna (fig. 2). The tectonical structure of the surroundings of the locality is highly complicated (cf. Michalík, 1973).

The highly fossiliferous beds were discovered by Stache (1867). Goetel (1917) described the rich assemblage of brachiopods, lamellibranchiates, corals, and echinoderms from this locality (about 40 species). This Rhaetian fauna is the typical Kössen fauna with *Rhaetina gregaria* (Suess), *R. pyriformis* (Suess) *Zeilleria norica* (Suess), *Oxycolpella oxycolpos* (Emmrich), *Rhaetavicula contorta* (Portlock), *Oxytoma inaequivalvis intermedia* (Emmrich), *Cassianella inaequiradiata* (Schafhäutl), *Modiolus schafhaeutli* (Štúr), *Retiophyllia clathrata* (Emmrich) etc. Andrusov (1934) found here the ammonite *Rhaetites rhaeticus* (Clark). Recently, the fauna of Kössen Beds from Hybe was studied by Kochanová (1967) and Michalik (1973, 1975).

Budurov & Pevný (1970) have reported from Hybe 4 fragments of the conodont *Gondolella navicula* Huckriede. This species ranges highest into the Sevatian, but not into the uppermost Sevatian. Unfortunately, it is not known from which place this sample was taken and thus this finding is open to discussion. It possibly originates from the "Dachstein Limestones". In the Kössen Beds in the layer XXXII in the profile by Michalík (1973, fig. 2) Ma-

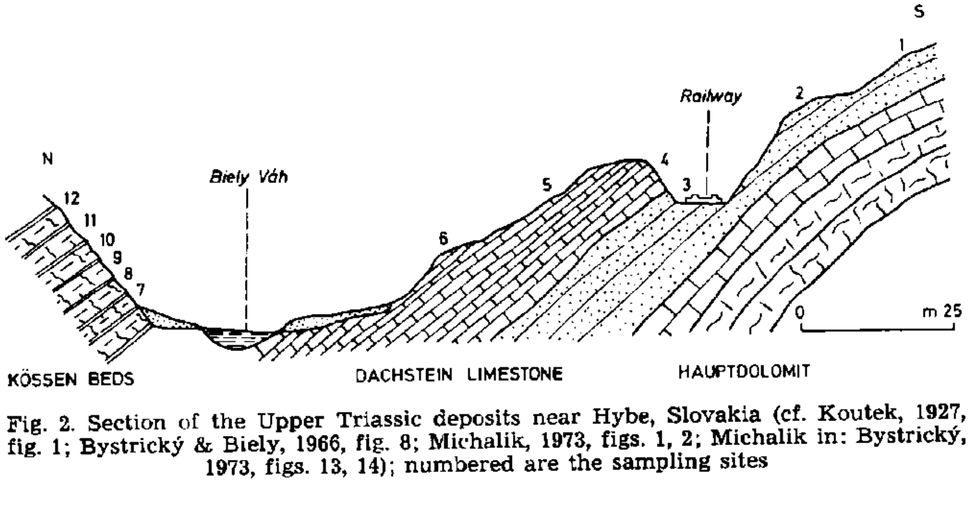


Fig. 2. Section of the Upper Triassic deposits near Hybe, Slovakia (cf. Koutek, 1927, fig. 1; Bystrický & Biely, 1966, fig. 8; Michalik, 1973, figs. 1, 2; Michalik in: Bystrický, 1973, figs. 13, 14); numbered are the sampling sites

jerska (1973) found conodonts originally determined as *Spathognathodus hernsteini* Mostler. These conodonts have later been described by Kozur & Mock (1974 b) as *Misikella posthernsteini* Kozur & Mock, the index species of the *posthernsteini* assemblage zone of the Rhaetian. Foraminifers of this sequence were studied by Salaj & Jendrejáková (1967) and Salaj; Biely & Bystrický (1967), and their stratigraphic importance was emphasized by Salaj (1969 a, b) and Gaździcki & Zawidzka (1973). In the years 1972—1975 the section was sampled by Gaździcki. About 40 thin sections made of these samples yielded numerous determinable foraminifers that made possible to discriminate faunal successions. The following foraminifers were found (location of samples see fig. 2):

Samples 1—3: *Semiinvoluta clari* Kristan, 1957, *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968), *Involutina* sp., and *Trocholina acuta* Oberhauser, 1964.

Age: Norian (Alaunian — Sevatian), *clari* & *oberhauseri* ass. zone.

Samples 4—7: *Trochammina alpina* Kristan-Tollmann, 1964, *Alpinophragmium* ? sp., *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, *Nodosaria ordinata* Trifonova, 1965, *Nodosaria* sp., *Miliolipora cuvillieri* Brönnimann & Zaninetti, 1972, *Semiinvoluta clari* Kristan, 1957, *Involutina communis* (Kristan, 1957), *Involutina tenuis* (Kristan, 1957), *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968), *Involutina* sp., *Trocholina permodiscoides* Oberhauser, 1964, and *Triasina oberhauseri* Koehn-Zaninetti & Brönnimann, 1968.

Age: Upper Norian (Sevatian), *clari* & *oberhauseri* ass. zone.

Samples 8—12: *Glomospira* sp., *Glomospirella friedli* Kristan-Tollmann, 1962, *Glomospirella pokornyi* (Salaj, 1967), *Glomospirella parallela* Kristan-Tollmann, 1964, *Glomospirella* sp., *Tolypammina* sp., *Trochammina alpina* Kristan-Tollmann, 1964, *Tetrataxis inflata* Kristan, 1957, *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, *Ophthalmidium* sp., *Miliolipora cuvillieri* Brönnimann & Zaninetti, 1972, *Planiinvoluta deflexa* Leischner, 1961, *Nodosaria ordinata* Trifonova, 1965, *Nodosaria* sp., *Lingulina* aff. *placklesensis* Kristan-Tollmann, 1970, *Diplotremina* sp., *Involutina communis* (Kristan, 1957), *Involutina tumida* (Kristan-Tollmann, 1964), *Involutina sinuosa sinuosa* Weynschenk, 1956, *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968), *Involutina* sp., *Trocholina permodiscoides* Oberhauser, 1964, and *Triasina oberhauseri* Koehn-Zaninetti & Brönnimann, 1968 — pl. 1, fig. 9.

Age: Lower Rhaetian, *pokornyi* & *friedli* ass. zone.

Bleskový prameň (Drnava, Slovak Karst)

This locality is about 1.5 km southeast of the village Drnava (Dernő), 12 km east of Rožňava (Slovak Karst) on the southern spur of the Drieňovec Hill (formerly Drienková hora, Somhegy) near the karst spring "Bleskový prameň" (Szörnyűkút, cf. Mello in: Bystrický, 1973, fig. 9). Rich thanatocoenosis, composed mainly of brachiopods, lamellibranchiates and cephalopods, can be found in some lenses of grey and blue-grey crinoidal to coquinoid limestones. The fauna is less frequent in the surrounding dark massive limestones that form the highest parts of the thick light "Furmanec Limestones" (Dachsteinriffkalk).

Stürzenbaum, 1879 (discoverer of the locality) considered these limestones rich in fossils to be Salzburg development of the Kössen Beds. He mentioned the species *Choristoceras marshi* Hauer and *"Terebratula" gregaria* Suess. The brachiopods from this locality were studied by Bittner, 1890, who considered most of the species to be typical of the Kössen Beds of the Alps. The cephalopods from Bleskový prameň were investigated by Mojsisovics, 1896. He put them to the Sevatian zone of *Pinacoceras metternichi* (the index species itself was not found here). Goetel, 1917 considered the limestones of this locality to be Dachstein Limestones and he regarded the fauna as Upper Rhaetian. Šuf, 1939 has demonstrated that cephalopods, brachiopods and other fossils occur together and not in a Norian and a Rhaetian horizon. Matějka & Andrusov, 1931, ascribing the higher stratigraphic value to the "Norian" cephalopods, considered the beds of Bleskový prameň to belong to the Sevatian. As to age, this locality was classified in the same manner also by Bystrický, 1964, who supplemented the fossil list by the Dasycladacean algae *Diplopora* cf. *phanerospora* Pia. This species is known from the Kössen Beds of the Alps (Ott, 1974, Flügel, 1975). Recently, brachiopods found here were restudied by Siblik, 1967. He described 21 species. On the whole this fauna is of Rhaetian character. The presence of the Norian *Halorella amphitoma* (Bronn) and the absence of *Rhaetina gregaria* (Suess) in this rich association are interesting. The cephalopods (15 species), lamellibranchiates (56 species) and gastropods (19 species) from Bleskový prameň were studied monographically by Kollárová-Andrusovová & Kochanová (1973). Complete lists of fossils and many informations about the locality are given in this monography. Budurov & Pevný (1970) mentioned 4 conodont species from the limestones of Bleskový prameň, among others *"Polygnathus" tethydis* Huckriede and *"Hindeodella" petraeviridis* Huckriede. These conodonts are illustrated on a photographic table. An erroneous determination can be therefore excluded. This conodont association cannot be younger than Middle Carnian, because such species as *Gladigondolella tethydis* (Huckriede) and *Metaprioniodus petraeviridis* (Huckriede) have never been found higher than Middle Carnian; most probably this association has a Ladinian age. Therefore these conodonts cannot originate from the limestones of Bleskový prameň as already pointed out by Mock (1971, 1975). For this reasons it is surprising that in the above mentioned monography on molluscan fauna of Bleskový prameň the authors ascribed primordial significance to the cephalopods and to the conodonts in their stratigraphic interpretation of the Bleskový prameň fauna as Sevatian and not as Rhaetian (p. 206: »die wichtigste Rolle spielten dabei die Cephalopoden und Conodonten«). Up to present no conodonts were found by the present authors from this locality inspite of the fact that relatively large rock samples were dissolved by acetic acid. Holothurian sclerites are scarce here, being mainly represented by *Theelia rosetta* Kristan-Tollmann. It should be also pointed out that some "decisive Norian" ammonoid species described by Mojsisovics (1896) — e. g. *Choristoceras (Peripleurites) boeckhi, Choristoceras (Peripleurites) stuerzenbaumi* and *Eopsiloceras clio* — have the following locus typicus and stratum typicum: Bleskový prameň, Drnava (Dernö), "Upper Norian" (in reality Rhaetian).

The question of the age of the Bleskový prameň beds was repeatedly studied by Kozur & Mock. In their first publication (Kozur & Mock, 1972, 1974a) they determined the age of these beds as highest Sevatian (uppermost Sevatian sensu Tozer = uppermost *Rhabdoceras suessi* zone; Kozur, 1973b has divided this *Rhabdoceras suessi* zone in the Sevatian *Sagenites giebeli* and *Cochloceras suessi* zones and the Lower Rhaetian *Choristoceras haueri* zone). Kozur (1973b, pp. 17—18) put Bleskový prameň to the higher part of the zone with *Choristoceras haueri* (= uppermost *Rhabdoceras suessi* zone sensu Tozer, formerly uppermost Sevatian, now Lower Rhaetian) and he drew a parallel between this fauna and the middle Kössen Beds of its type locality in Austria. Such an age is also indicated by the brachiopods: *Zugmayerella koessenensis* (Zugmayer), *Rhaetina pyriformis* (Suess), and *Triadithyris gregariaeformis* (Zugmayer). These species occur at the type locality of the Kössen Beds in the upper part of the zone of *Choristoceras haueri*, immediately below the strata with *Choristoceras marshi* Hauer.* Kozur & Mock (1974c) pointed out that the fauna of Bleskový prameň is still Lower Rhaetian, but younger than the Lower Rhaetian (Lower Rhaetian sensu Kozur, 1973b, see above) of Hybe with *Rhaetites* cf. *rhaeticus* (Clarc), *Rhaetavicula contorta* (Portlock) and *Misikella posthernsteini* Kozur & Mock.

Foraminifers were previously reported from the Bleskový prameň area by Jendrejáková (1970). During the present studies foraminifers were found in the following samples:

Sample 166/1: »*Vidalina*« *martana* Farinacci, 1959, »*Vidalina*« *carinata* (Leischner, 1961), *Diplotremina* cf. *subangulata* Kristan-Tollmann, 1960, *Involutina* cf. *communis* (Kristan, 1957), and *Involutina tenuis* (Kristan, 1957).

Sample 166/2: *Glomospirella* sp., *Trochammina alpina* Kristan-Tollmann, 1964, *Tetrataxis* cf. *inflata* Kristan, 1957, »*Vidalina*« *martana* Farinacci, 1959 — pl. 1, figs. 2, 3, *Ophthalmidium* sp. — pl. 1, fig. 4, *Galeanella* cf. *tollmanni* (Kristan, 1957) — pl. 1, fig. 6, *Miliolipora* cf. *cuvillieri* Brönnimann & Zaninetti, 1972, *Diplotremina* ? sp., — pl. 1, fig. 7, *Variostoma* ? sp., *Involutina communis* (Kristan, 1957), and *Involutina* cf. *turgida* Kristan, 1957.

Sample 166/3-D_1: *Tolypammina* sp., *Ammobaculites* sp. — pl. 1, fig. 5, *Variostoma* ? sp., and *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968).

Sample 166/3-D_2: *Tolypammina* sp.

Sample 166/5-D_4: *Tolypammina* sp., *Trochammina* sp., »*Vidalina*« cf. *carinata* (Leischner, 1961) — pl. 1, fig. 1.

Sample Dr.: *Tolypammina* sp., *Trochammina alpina* Kristan-Tollmann, 1964, *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, *Planiinvoluta deflexa* Leischner, 1961, *Involutina communis* (Kristan, 1957), *Trocholina permodiscoides* Oberhauser, 1964, and *Triasina hantkeni* Majzon, 1954 — pl. 1, fig. 8.

The majority of the listed taxa are known from the Upper Norian to the Rhaetian. Attention should be paid to the foraminifer fauna of the sample

Footnote 1)

* Some of these brachiopods may occur also in the *Choristoceras marshi* zone. *Choristoceras marshi* seems to be rather a bad index species for the uppermost ammonoid zone of the Triassic, because this species should be expected to occur also in the *Choristoceras haueri* zone. Therefore the *haueri* and *marshi* zones should be rather separated by the disappearence of *Rhabdoceras suessi* and not by the first appearence of *Choristoceras marshi*. For this reason some correlations of brachiopod faunas with the ammonoid zonation of the Rhaetian are rather unclear.

no. 166/2 with *Galeanella* cf. *tollmanni* and *Involutina* cf. *turgida*, known from strata not older than Rhaetian or even Liassic of the Tethys (Kristan, 1957; Kristan-Tollmann, 1962, 1964; Brönnimann et al., 1973). Moreover, the sample Dr. yielded somewhat recrystallized specimens of *Triasina hantkeni* Majzon, indicative of the Rhaetian.

The occurrence of these forms in the Bleskový prameň succession indicates that these strata are younger than the Kössen Beds from Hybe, as it was previously suggested by Kozur (1973b) and Kozur & Mock (1973, 1974c).

Malý Mlynský vrch (Slovak Karst, Zlambach Beds)

The Malý Mlynský vrch hill (456,8 m) is the best locality of Zlambach Beds in the Slovak Karst (cf. Mock, 1973). This hill is situated appr. 1 km east of the village Silická Brezová, near to the Slovak-Hungarian boundary. Its surroundings are built up of Upper Triassic limestones of the Silica nappe. In the structure of the Malý Mlynský vrch hill we can find light massive limestones (so-called Tisovec Limestone), overlain by the typical pink and red Norian Hallstatt Limestones. The topmost beds of this locality consist of Upper Sevatian and Rhaetian Zlambach Beds. These Zlambach Beds have developed from the underlying Hallstatt Limestones quite gradually by accession of the clay component and by change in colour from pink through yellowbrown to grey. In its lower parts the Zlambach Beds are grey micritic limestones, followed by marls or marly slates, and finally by sandy shales. The thickness of the Zlambach Beds is here up to 10 m. The conodonts, holothurian sclerites, and foraminifers from this locality are listed by Mock (1973) and Kozur & Mock (1974a, b). The residues of the samples of Zlambach Beds with the Lower Rhaetian conodont fauna with *Misikella posthernsteini* Kozur & Mock and *Grodella delicatula* (Mosher) have yielded the following foraminifers (determined by Dr. A. Oravecz-Scheffer, Budapest): *Ammobaculites rhaeticus* Kristan-Tollmann, *A. alaskensis* Tappan, *Ammovertella polygyra* Kristan-Tollmann, *Glomospira gordialis* (Jones & Parker), *Haplophragmoides subglobosus* (Sars), *Hyperamminoides expansus elongatus* Kristan-Tollmann, and *Trochammina alpina* Kristan-Tollmann. The cephalopods that occur in relative abundance, have not yet been studied in detail. The genus *Choristoceras* is present.

During the present studies foraminifers were found in the following samples:

Sample MMV-1 — grey, slightly marly micrite from the lower part of the Zlambach Beds: *Trochammina alpina* Kristan-Tollmann, 1964 — pl. 4, fig. 10, *Agathammina* ? *iranica* Zaninetti et al., 1972 — pl. 4, figs. 8, 9, *Ophthalmidium* sp., and *Nodosaria* sp. — pl. 4, fig. 7.

Associated are the following conodonts and holothurian sclerites: *Misikella hernsteini* (Mostler), *Oncodella paucidentata* (Mostler), and *Theelia immisorbicula* Mostler, *T. kristanae* Mostler, *T. petasiformis* Kristan-Tollmann, *T. simoni* Kozur & Mock. The conodonts and holothurian sclerites indicate the upper part of the Upper Sevatian (*hernsteini* assemblage zone).

Sample MMV-2 — Hallstatt Limestone from a small quarry on the northern slope of the Malý Mlynský vrch: *Glomospira* sp. — pl. 4, fig. 15, *Glomospirella* ? sp. — pl. 4, fig. 14, *Tolypammina* sp., *Trochammina alpina* Kristan-Tollmann, 1964 — pl. 4, figs. 12, 13, *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, »*Vidalina*« sp., *Nodosaria ordinata* Trifonova, 1965, and *Nodosaria* sp.

Associated are the following conodonts and holothurian sclerites: *Metapolygnathus spatulatus* (Hayashi) + ramiform conodonts and *Biacumina acanthica* (Mostler), *Canisia symmetrica* (Mostler), *Frangerites complexus* (Kozur & Mock), *Praeeuphronides multiperforatus* Mostler, *Theelia immisorbicula* Mostler, *T. planorbicula* Mostler, *T. zawidzkae* Kozur and Mock. The conodonts and holothurian sclerites indicate a Lower to Middle Norian age (*spatulatus* zone).

Sample MMV-3 — grey marly limestone, directly overlying the beds with *Misikella hernsteini* (Mostler): *Glomospirella* sp., *Trochammina* ? sp., *Tetrataxis* sp., *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, *Ophthalmidium* cf. *triadicum* (Kristan, 1957) — pl. 4, fig. 6, *Ophthalmidium* sp., and *Nodosaria* sp.

This sample yielded also the conodont *Metapolygnathus slovakensis* Kozur (cf. Kozur, 1972a, p. 10) and the holothurian sclerites *Theelia rosetta* Kristan-Tollmann, *T. variabilis* Zankl, *T. heptalampra* (Bartenstein), and *Calclamna germanica* Frizzell & Exline.

Age: Lowermost Rhaetian or uppermost Sevatian.

Sample MMV-4 — grey marly limestone and marl: *Glomospira* cf. *perplexa* Franke, 1936, *Glomospira* sp., *Trochammina alpina* Kristan-Tollmann, 1964 — pl. 4, fig. 11, »*Vidalina*« *martana* Farinacci, 1959, »*Vidalina*« *carinata* (Leischner, 1961) — pl. 4, fig. 2, »*Vidalina*« *carpathica* Gaździcki, n. sp. — pl. 4, figs. 3—5, *Ophthalmidium* sp., *Planiinvoluta carinata* Leischner, 1961, *Nodosaria* sp., *Austrocolomia* sp., *Lenticulina* sp., *Diplotremina* sp., and *Turrispirillina* cf. *minima* Pantić, 1967.

No conodonts and holothurian sclerites occur in this sample. The foraminifers indicate an Upper Norian or Rhaetian age.

Sample MMV-6 — grey limy marl: *Glomospirella* cf. *pokornyi* (Salaj, 1967) — pl. 4, fig. 1, *Glomospirella* sp., *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964, *Ophthalmidium* sp., *Nodosaria* sp., *Austrocolomia* cf. *rhaetica* Oberhauser, 1967, and *Austrocolomia* sp.

No conodonts and holothurian sclerites occur in this sample. The foraminifers indicate the Lower Rhaetian *pokornyi* & *friedli* zone.

Fischerwiese (Salzkammergut, Zlambach Beds)

The Fischerwiese section is situated north of the village Ob. Lupitsch, appr. 6 km northwest of Bad Aussee, Salzkammergut (cf. Kristan-Tollmann, 1964, fig. 1). It is the type locality of the »coral facies« of the Zlambach Beds. These beds are denuded in the brook Korallenbach for a distance of more than 100 m. In its lower part there absolutely dominate soft, dark, clayey and marly schists, higher up there join in dm-thick beds of limestones that are calcarenites to rudites. These limestones are mainly built up of resedimented biogenetic detritus. They are massive, grey to greyviolet rocks resembling limestones from Bleskový prameň in the Slovak Karst. Still higher there are several beds filled up by corals and other fossil detritus. A great part of the fauna from this locality, mainly corals, derives from these places of the section. Other macrofossils — e.g. cephalopods, brachiopods, lamellibranchiates, bryozoans are less frequent (cf. Haas, 1909; Zapfe, 1967). Stratigraphic important faunal elements are *Choristoceras marshi* Hauer, *Stenarcestes polysphinctus* (Mojsisovics), *Racophyllites neojurensis* (Quenstedt), *Fissirhynchia fissicostata* (Suess), *Zugmayerella koessensis* (Zugmayer), *Trigonia zlambachiensis* Haas, *Oxytoma inaequivalve* (Sowerby), *Amblysiphonella steinmanni* (Haas), »*Thecosmilia*« *norica* Frech, *Montlivaltia norica* Frech, etc. Apart from the macrofossils there also rich microfaunas occur, see Kristan-Tollmann (1964) for foraminifers and Kollmann (1963), Bolz (1971, 1974) for ostracodes. The newest list of the fauna was completed by Wiedmann (1972).

By the finding of *Choristoceras marshi* Hauer (cf. Zapfe, 1967) the Rhaetian age of the Zlambach Beds from the Fischerwiese section was confirmed. Bolz (1971) has dated these rocks on the basis of the ostracode fauna as Upper Norian or Rhaetian.

The **sample** Ö-18 comes from the higher part of this locality, from a bed of solid grey rudite. Conodonts or holothurian sclerites have not been found in this sample. The following foraminifers could be determined in the sample Ö-18: *Glomospirella friedli* Kristan-Tollmann, 1962 — pl. 3, fig. 1, *Tolypammina* sp. — pl. 3, fig. 2, *Trochammina alpina* Kristan-Tollmann, 1964 — pl. 3, fig. 11, *Alpinophragmium perforatum* Flügel, 1967 — pl. 3, fig. 12, *Endothyra* sp. — pl. 3, figs. 5, 6, *Planiinvoluta deflexa* Leischner, 1961, *Ophthalmidium* sp. — pl. 3, fig. 3, *Galeanella* ? sp. — pl. 3, fig. 4, *Miliolipora* sp., »*Sigmoilina*« sp. — pl. 3, figs. 9, 10, *Diplotremina* cf. *subangulata* Kristan-Tollmann, 1960 — pl. 3, fig. 7, *Diplotremina* sp. — pl. 3, fig. 8, *Involutina communis* (Kristan, 1957), *Involutina* sp., and *Trocholina permodiscoides* Oberhauser, 1964.

Age: Lower Rhaetian *pokornyi* & *friedli* zone.

Kendelbachgraben (Osterhorn Group, Kössen Beds)

It is the famous, historical profile of Suess & Mojsisovics (1869). There arises here a thick sequence of Upper Triassic and Lower Jurassic outcropped along a distance of more than 600 m. This locality is situated southwest of Wolfgangsee in the side valley of Zinkenbachtal (cf. Mosher, fig. 10 and Morbey, 1975, figs. 1—3). The profile starts with a sequence of grey, accentuatedly bedded Plattenkalk with megalodonts (cf. Morbey, 1975, fig. 2). The highest part of the Plattenkalk yielded the **sample** Ö-41 with the following foraminifers: *Glomospirella friedli* Kristan-Tollmann, 1962, *Glomospirella* sp. — pl. 2, fig. 8, *Trochammina alpina* Kristan-Tollmann, 1964, *Alpinophragmium perforatum* Flügel, 1967 — pl. 2, fig. 3, *Agathammina austroalpina* Kristan-Tollmann & Tollmann, 1964 — pl. 2, fig. 4, *Nodosaria ordinata* Trifonova — pl. 2, fig. 6, *Frondicularia woodwardi* Hochwin, 1895, *Involutina communis* (Kristan, 1957) — pl. 2, figs. 10—12, *Involutina* cf. *tumida* (Kristan-Tollmann, 1964), *Involutina minuta* Koehn-Zaninetti, 1969, *Involutina sinuosa oberhauseri* (Salaj, 1967), *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968), *Involutina* sp., and *Trocholina permodiscoides* Oberhauser, 1964 — pl. 2, fig. 13.

Age: Lower Rhaetian *pokornyi* & *friedli* zone.

Immediately above the beds with the sample Ö-41 the "classical Rhaetian" starts with thick Kössen Beds in the "Swabian development": thick and thin-bedded limestones, coquinoid limestones, calcareous shales, marls and clayey shales. There is a rich Lower Rhaetian fauna with *Rhaetavicula contorta* (Portlock) and other bivalves, higher up also with the brachiopod *Rhaetina gregaria* (Suess). Above these beds the "Hauptlithodendronkalk" with *Thecosmilia* follows interbedded with layers of grey limestones with megalodonts. Still higher up are grey limestones with *Rhaetina pyriformis* (Suess), *Oxycolpella oxycolpos* (Emmrich), *Zeilleria norica* (Suess), etc. The highest part of the Rhaetian — the so-called Salzburg facies of Suess — itself distinguishes by the predominance of dark clayey and marly shales over the limestones. Many pyritized specimens of *Choristoceras marshi* Hauer occur in the black soft shales. Then there follows another short section (covered by detritus) with several beds of dark limestone separated from one another by intercalations of shales. Without a sharp lithological break there follow dark limestones of the Liassic with *Psiloceras*. From the higher part of the Rhaetian with *Choristoceras marshi* Hauer, Mosher (1968) described the conodonts *Cypridodella delicatula* Mosher and *Neospathodus lanceolatus* Mosher. Foraminifers, conodonts, and holothurian sclerites were found at the present studies in samples collected in the uppermost part of the section, developed in the Salzburg facies. These microfaunas were found in limestones that occur directly below and above the soft shales with *Choristoceras marshi*. Directly below the soft shales with *Choristoceras marshi* is a horizon of dark limestones, about 80 cm thick, that is divided into 5 layers ranging from 10—20 cm in thickness. The samples of these limestones have yielded the following faunas:

Sample Ö-34 — Basal dark limestone layer from the left bank of the brook, 15 cm thick, with *Clamys* cf. *bavarica*: *Trochammina alpina* Kristan-Tollmann, 1964 — pl. 2, fig. 1, *Trochammina* ? sp. — pl. 2, fig. 2, *Cornuspira* sp., *Nodosaria* sp. — pl. 2, fig. 7, *Austrocolomia* cf. *rhaetica* Oberhauser, 1967, *Austrocolomia* sp., and *Diplotremina* sp.

No conodont and holothurian sclerites.

Sample Ö-35 — Third limestone layer, 10 cm thick: *Nodosaria* sp. and *Lenticulina* sp.

Beside of these stratigraphical unimportant foraminifers this sample have yielded stratigraphically significant fauna of conodonts and holothurian sclerites: *Grodella delicatula* (Mosher), *Misikella posthernsteini* Kozur & Mock, *Neohindeodella dropla* (Spasov & Ganev), *Parvigondolella* n. sp.* and *Calclamna germanica* Frizzell & Exline, *Fissobractites subsymmetricus* Kristan-Tollmann, *Theelia heptalampra* (Bartenstein), *T. rosetta* Kristan-Tollmann, *T. variabilis* Zankl.

Footnote 2)

* This species has developed from *Parvigondolella lata* Kozur & Mock. It shows very strong homeomorphy to the genus *Misikella*, but *Misikella* has never denticles behind the main denticle. Moreover, the new species is in all cases accompanied by the same ramiform elements as *Parvigondolella*, whereas *Misikella* is apparently a single element species. This new species of *Parvigondolella* and a new species of *Misikella* can be served as local guide forms in subzonal rank for the Rhaetian of the Alps to define subzones within the *posthernsteini* assemblage zone. But unfortunately these species are very rare and until now only present in the Alps, whereas *Misikella posthernsteini* has a great distribution from New Guinea through the Himalayas to Poland, Slowakia and the Alps. Therefore only *Misikella posthernsteini* is a suitable guide form for the Rhaetian in an useful conodont zonation.

The conodonts and holothurian sclerites indicate a (Lower) Rhaetian age (*posthernsteini* assemblage zone).

Sample Ö-36 — Uppermost dark limestone layer, 22 cm thick, directly below the soft shales with *Choristoceras marshi*: *Trochammina alpina* Kristan-Tollmann, 1964, *Ophthalmidium* sp. — pl. 2, fig. 9, *Nodosaria* sp., and *Frondicularia woodwardi* Howchin, 1895.

No conodonts and holothurian sclerites.

From the dark limestones immediately above the soft shales with *Choristoceras marshi* only one sample (Ö-38) was investigated. This upper Rhaetian sample has only yielded foraminifers.

Sample Ö-38 — lowermost dark limestone bed, 20—30 cm thick, directly resting on the soft shales with *Choristoceras marshi*: *Glomospira* sp., *Glomospirella* cf. *friedli* Kristan-Tollmann, 1962, *Trochammina alpina* Kristan-Tollmann, 1964, *Nodosaria* sp., *Lingulina* cf. *placklesensis* Kristan-Tollmann, 1970 — pl. 2, fig. 5, and *Diplotremina* sp.

Age: According to the underlying soft shales with *Choristoceras marshi* the age must be Upper Rhaetian.

The problem of the Norian-Rhaetian boundary

The Rhaetian stage was introduced by Guembel (1859, 1861). In the German Basin (Franconia) he has put all beds between the top of the red and variegated marls of the Middle Keuper and the basis of the *Schlotheimia angulata* zone of the Liassic to his Rhaetian stage (for the first time already 1856, see Kozur, 1973 b). In the Alpine region he has defined the Rhaetian stage with the Kössen Beds and the zone of *Rhaetavicula contorta* (Guembel, 1859, 1861). Whereas the upper boundary of Guembel's Rhaetian stage lies in the German Basin within the Liassic (at the basis or in some cases within the *Schlotheimia angulata* zone) the Lower boundary of the Rhaetian was exactly and universally defined both in the German Basin and in the Alpine region with the basis of the *Rhaetavicula contorta* zone.* Therefor a clear priority exists for the lower boundary of the Rhaetian stage. Mojsisovics (in: Mojsisovics, Waagen & Diener, 1895) accepted this priority as he introduced the Sevatian substage of his Juvavian (now Norian) stage. According to Mojsisovics, the Sevatian substage includes the (lower) *Pinacoceras metternichi* and the (upper) "*Sirenites*" *argonautae* zones. The age of the *Argosirenites argonautae* zone was misinterpreted by Mojsisovics. This zone is an equivalent of the middle and upper *Himavatites columbianus* zone sensu Tozer (= *Himavatites columbianus* zone in a more restricted scope by Kozur, 1973 a) and belongs according to Kozur (1973 a) to the Lower Seva-

Footnote 3)

* The forerunner of *Rhaetavicula contorta* is unknown (the same is true at many zonal index forms of the Triassic ammonoid zonation, e. g. *Rhabdoceras suessi*). Therefore, *Rhaetavicula contorta* may begin at some places considerably earlier than the beginning of the Rhaetian. But the *Rhaetavicula contorta* zone is defined in the Rhaetian Kössen Beds and in beds of roughly the same age in the German Basin and in the typical Kössen Beds (e. g. in their type locality) the *Rhaetavicula contorta* zone is at least a Rhaetian assemblage zone that is younger than the Sevatian *Pinacoceras metternichi* and *Argosirenites argonautae* zone (Sevatian in its original definition).

tian. Therefore the upper boundary of the Sevatian substage must be defined by the upper boundary of the *Pinacoceras metternichi* zone according to the priority. Kozur (1973 b) could prove that the uppermost range of *Pinacoceras metternichi* (horizon with *P. metternichi* and *Cochloceras suessi* = *Cochloceras suessi* zone according to Kozur, 1973 b) is older than the first appearence of *Choristoceras* within the Zlambach facies and the contemporaneous first appearence of *Rhaetavicula contorta* in the Swabian facies of the Kössen Beds. Therefore, according to the priority, the lower boundary of the Rhaetian stage lies immediately above the uppermost Sevatian substage of the Norian stage and there is no overlap between the Norian and Rhaetian stages as originally defined by Guembel and Mojsisovics. Only the Lower Rhaetian Zlambach Beds with *Choristoceras haueri* (together with true Upper Sevatian Zlambach Beds with *Cochloceras* and without *Choristoceras*) were erroneously regarded as the lower subzone of the Sevatian *Pinacoceras metternichi* zone by Mojsisovics. The index species *Pinacoceras metternichi* was never found in the *Choristoceras haueri* subzone and Kozur (1973 b) pointed out that the *Choristoceras haueri* (sub)zone is younger than the highest occurrence of *Pinacoceras metternichi*. Tozer (1967) has rejected the *Pinacoceras metternichi* zone and replaced it by the *Rhabdoceras suessi* zone. He has supposed that both zones are contemporaneous. Krystyn (1973, 1974) and some other European geologists have followed him. Recently *Rhabdoceras suessi* was found in the Middle part of the Rhaetian Kössen Beds and in those parts of Zlambach marls that were conventionally assigned to the Rhaetian. For this reason Urlichs (1972), Fabricius (1974), Krystyn (1974), and Tozer (1974) included this part of the typical Rhaetian Kössen Beds (about 80 % of these beds) in the Sevatian substage or they rejected the whole Rhaetian stage as a facies type of the Upper Norian. This is against the priority and disagrees with the faunal succession. Wiedmann (1972, 1974) has also supposed that the Rhaetian and Upper Norian are time-equivalents, but because the Rhaetian stage has clearly the priority he included the Upper Norian in the Rhaetian stage. Because *Rhabdoceras suessi* is absent in the lower half and in the highest parts of the Kössen Beds he has divided his Rhaetian in the *Phyllytoceras zlambachense*, the *Rhabdoceras suessi*, and the *Choristoceras marshi* zones. Tozer (1974) and Krystyn (1974) have rejected the *Phyllytoceras zlambachense* zone and supposed that this zone and the *Rhabdoceras suessi* zone are contemporaneous. Krystyn (1974), Tozer (1974) and Wiedmann (1972, 1974) agree that the Kössen Beds (the typical Rhaetian according to the intentions of Guembel) include the entire Sevatian. Krystyn (1974) even believes that the lowermost Kössen Beds belong probably to the Middle Norian!

Regarding not only the ammonoid faunas from scattered incomplete and often tectonically disturbed sections in the Alps but also the successions and the evolution of the conodonts, holothurian sclerites and other microfossils in continuous profiles Kozur (1973 b) has arrived to a quite different opinion. Within the continuous sections of Canada (published by Tozer, 1967) 3 horizons with different ammonoid faunas can be noticed within the *Rhabdoceras suessi* zone (see Tozer, 1967; Kozur, 1973 b) that can be recognized also in the Alpin-Mediterranean Triassic. The lowermost horizon was regarded by Tozer (1967) as lower subzone of the *Rhabdoceras suessi* zone. From this horizon To-z e r (1967) listed *Rhabdoceras suessi* together with *Halorites, Sagenites, "Arcestes", Placites,* and *Rhacophyllites.* This fauna can be correlated with the fauna of the *Sagenites giebeli* zone that contains beside of *Rhabdoceras suessi* the stratigraphically important genera *Halorites, Sagenites, Helictites,* and *Steinmannites,* but not *Cochloceras* and *Metasibirites.* M o j s i s o v i c s placed erroneously his *Sagenites giebeli* zone in the Lower Juvavian (= Lower Norian) stage, because this fauna was collected from a fissure filling in older sediments. By the aid of ammonoids, but also according to the conodont association (most of the *Metapolygnathus bidentatus* zone) the *Sagenites giebeli* zone can be worldwide recognized. Therefore this zone is a useful standard zone within the Sevatian stage. The second ammonoid horizon within the *Rhabdoceras suessi* zone is characterized by the appearence of the ammonoid genera *Cochloceras* (including *Paracochloceras* as subgenus) and *Metasibirites.* These genera are associated with *Rhabdoceras suessi.* Most characteristic is the worldwide occurrence of *Cochloceras (Paracochloceras)* suessi in this horizone (*Cochloceras suessi* zone* by K o z u r , 1973 b that replaces the *Cladiscites ruber* zone by M o j s i s o v i c s , see K o z u r , 1973 b). The *Cochloceras suessi* zone corresponds to the greatest part of Tozer's upper subzone of the *Rhabdoceras suessi* zone. This upper subzone is characterized according to T o z e r (1967) by the following ammonoids: *Choristoceras suttonensis, Rhabdoceras suessi, Cochloceras (Paracochloceras) suessi, Cycloceltites* cf. *C. arduini, Metasibirites* sp., *"Arcestes"* sp., *"Cladiscites"* sp., *Megaphyllites* cf. *M. insectus, Placites* sp., and *Rhacophyllites* sp. This fauna of the upper subzone of the *Rhabdoceras suessi* zone is a mixed fauna that derives from different places. *Choristoceras suttonensis* occurs only in one section in the uppermost *Rhabdoceras suessi* zone and T o z e r (1967, p. 78) has written: "The Sutton Formation... contains an unusual fauna of the *suessi* zone which includes the genus *Choristoceras* as well as *Rhabdoceras.*" Beside of *Rhabdoceras suessi* and *Choristoceras suttonensis* this fauna includes *Megaphyllites* cf. *insectus* and *Cycloceltites* cf. *arduini* unknown in deeper parts of the upper *Rhabdoceras suessi* zone of Canada, but not the typical association with *Cochloceras (Paracochloceras)* and *Metasibirites.* Only this uppermost *Rhabdoceras suessi* zone sensu T o z e r , 1967 (= *Choristoceras haueri* zone according to K o z u r , 1973b) can be recognized in the Lower Rhaetian part of the Zlambach marls and of the Kössen Beds. For this fauna the concurrent occurrence of *Rhabdoceras* and *Choristoceras (Choristoceras)* as well as the species *Megaphyllites insectus* Mojsisovics, *M. robustus* Wiedmann, *Cycloceltites arduini* (Mojsisovics), *Rhaetites rhaeticus* (Clark), and *Phyllytoceras zlambachense* Wiedmann are most characteristic. This "unusual fauna of the *Rhabdoceras suessi* zone" (T o z e r , 1967) is the "usual" ammonoid fauna of the lower and middle part of the type Rhaetian and it belongs according to the priority to the Rhaetian stage. According to W i e d m a n n (1974) there

Footnote 4)

* Unfortunately also from *Cochloceras suessi* the forerunner is unknown and the rather restricted occurrence of *Cochloceras suessi* may be facies-controlled. Therefore in the present stage of our knowledge no clear separation between the *Sagenites giebeli* and the *Cochloceras suessi* zones is possible. But the conodonts and other microfossils (e. g. holothurian sclerites) indicate a clearly higher position of the *Cochloceras suessi* horizon than at least most of the *Sagenites giebeli* zone.

is moreover also an overlap in the stratigraphic range of *Rhabdoceras suessi* and *Choristoceras marshi*. The lower boundary of the Rhaetian lies above the uppermost Norian *Pinacoceras metternichi* zone, but within the upper *Rhabdoceras suessi* zone that is not contemporaneous with the *Pinacoceras metternichi* zone. By the aid of conodonts (see chapter: Stratigraphic value of microfossils at the Norian-Rhaetian boundary) it could be proved that the first appearence of *Choristoceras* and the disappearence of *Cochloceras, Metasibirites, Pinacoceras* and other important fossils of the uppermost Rhaetian coincide with the first appearence of *Rhaetavicula contorta* in the Kössen Beds in its type locality and therefore with the lower boundary of the Rhaetian stage according to the priority (Guembel, 1859, 1861). At this basis of the Rhaetian stage many changes both in the macro- and in the microfaunas occur (see Kozur, 1973b). At the ammonoids such very frequent and worldwide distributed genera as *Cochloceras* and *Metasibirites* and a lot of species of other genera disappear and *Choristoceras (Choristoceras)* appears. At the pelecypods a distinct change can be observed characterized e.g. by the disappearence of the worldwide distributed and very frequent Upper Norian genus *Monotis*, by the appearence of the genus *Rhaetomegalodon* and the dissappearence of many species of *Neomegalodon*, by the appearence of *Rhaetavicula contorta** and some other forms. At the gastropods many Paleozoic elements disappear before the appearence of many new forms at the base of the Jurassic system. A great change can be also observed at this level in the echinoderms (echinoids, holothurian sclerites). At the brachiopods many Norian elements disappear and many Rhaetian elements appear at the lower boundary of the Rhaetian stage or somewhat higher. In the terrestrial, fresh water, and brackish water deposits many amphibians and reptiles as well as many ostracodes and charophytes disappear and some important new groups appear (see Kozur, 1974). Very interesting is also the first appearence of mammals at this level. The changes in the microfaunas at the Norian-Rhaetian boundary will be discussed in the chapter: Stratigraphic value of microfossils at the Norian-Rhaetian boundary.

Some remarks are necessary to the problem of mixed Norian-Rhaetian faunas with Norian ammonoids and Rhaetian brachiopods and other Rhaetian fossils. This is only a virtual problem. From the plenty of Upper Norian ammonoid species lesser than 10 % (e.g. *Rhabdoceras suessi*) straddles the Norian-Rhaetian boundary, fewer than at most other stage boundaries. Some ammonoids traditionally regarded as Upper Norian elements have moreover their stratum typicum in Rhaetian beds, e.g. *Choristoceras (Peripleurites) boeckhi, Choristoceras (Peripleurites) stuerzenbaumi, Choristoceras (Choristoceras) haueri*. All these species were hitherto unknown from the type Rhaetian Kössen Beds. Therefore all these species were erroneously interpreted as Upper Norian guide forms with an uppermost stratigraphical range up to the uppermost Norian, but not higher. On the other hand, in the type Rhaetian Kössen Beds many typical Rhaetian brachiopods and pelecypods occur, but ammonoids

Footnote 5)

* The first appearence of *Rhaetavicula contorta* may be facies controlled (see footnote 3).

are rare or lacking. If we find the above mentioned ammonoids and the contemporaneous brachiopods and pelecypods in suitable facies together in the same layer, than seemingly Norian guide forms (in reality Norian holdovers of Lower Rhaetian age or Lower Rhaetian guide forms erroneously interpreted as Upper Norian ones) and Rhaetian brachiopods or pelecypods occur together. As mentioned above the Rhaetian ammonoid fauna does not consist almost exclusively of Upper Norian holdovers. Many seeming Norian holdovers or even Upper Norian guide forms are in reality Lower Rhaetian guide forms. For instance, the "Late Norian" species of *Choristoceras (Choristoceras)* have their type locality in Lower Rhaetian Zlambach marls. These species do not occur together with *Cochloceras* as it could seem from the faunal list for the Zlambach marls given by Mojsisovics (1893). This faunal list contains the ammonoids of Zlambach marls from different localities and of different ages (uppermost Norian and Rhaetian).

Stratigraphic value of microfossils at the Norian-Rhaetian boundary

The studies on conodonts, holothurian sclerites, ostracodes, and foraminifers were carried out on over 2000 samples of Upper Norian and Rhaetian rocks from sections in the West Carpathians, Hungary, Austria, and the German Basin as well as on some scattered samples from various localities in Europe and Asia. These microfaunal groups comprise several important short-living guide fossils of the Upper Norian and Rhaetian that belong to well-known evolutionary lines. The results of these studies were published by Salaj, Biely & Bystrický (1967), Salaj (1969a, b, 1974, 1977), Bunza & Kozur (1971), Kozur (1971, 1972a, b, c, 1973a, b, c, d, 1974a, b, 1975), Kozur & Mock (1972, 1973, 1974a, b, c), Kozur & Mostler (1972a, b, c), Kozur & Oravecz (1972), Gaździcki & Zawidzka (1973), Gaździcki (1974a, b, 1975), Gaździcki & Iwanow (1976). The most important results of all these studies are briefly summarized below.

Conodonts (see Plate 5)

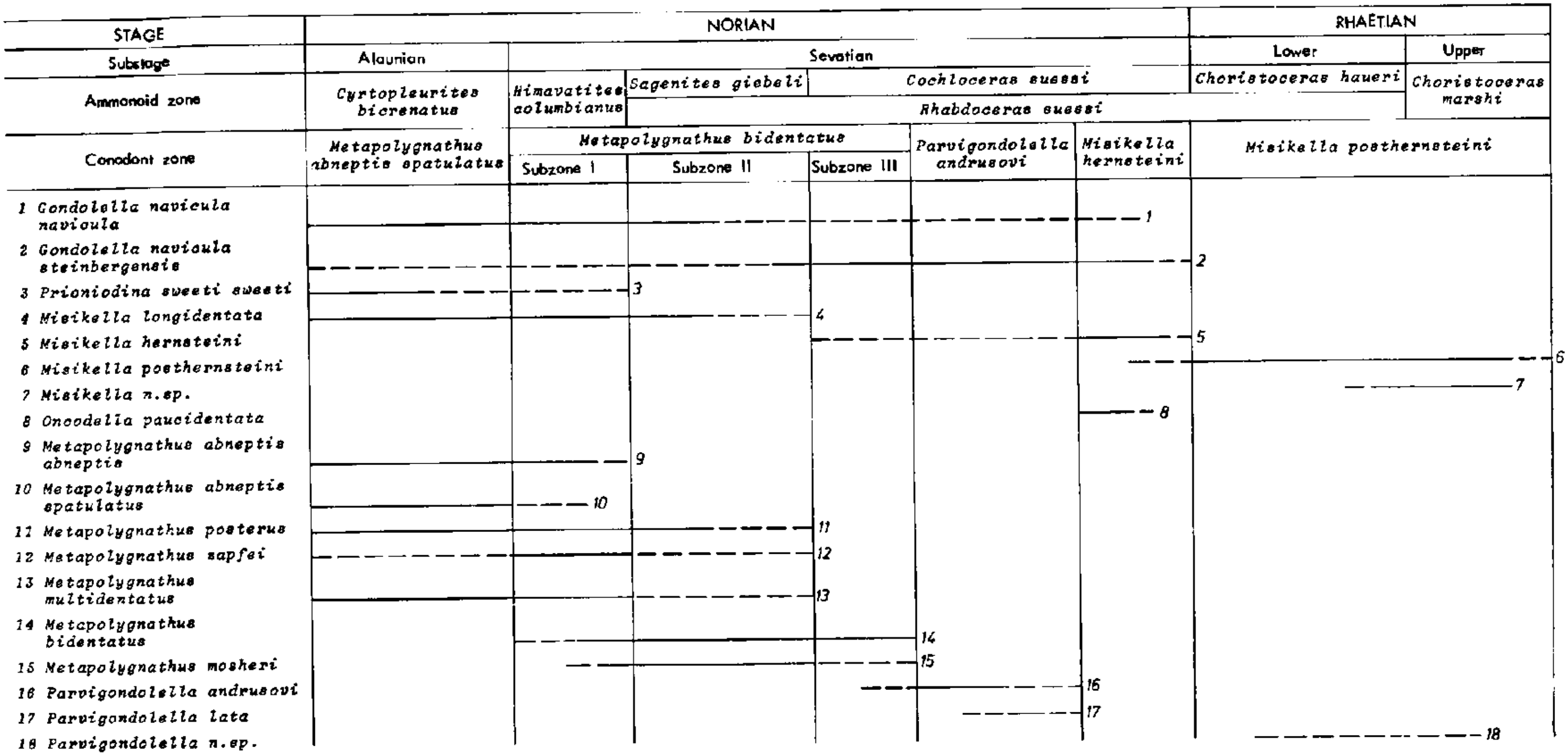
The major part of Sevatian substage (Upper Norian) belongs to the *Metapolygnathus bidentatus* zone that may be subdivided in some subzones. The *Himavatites columbianus* zone (in the restricted scope sensu Kozur, 1973a) and the *Sagenites giebeli* zone belong to this conodont zone. The *Cochloceras suessi* horizon or zone comprises the uppermost part of the *Metapolygnathus bidentatus* zone as well as the *Parvigondolella andrusovi* and *Misikella hernsteini* zones. The guide forms of the Rhaetian stage are *Misikella posthernsteini* and new, but unfortunately very rare and geographically restricted species of *Parvigondolella* and *Misikella* that are undescribed until now. *Misikella posthernsteini* has its first appearence in the uppermost Sevatian, where a complete transitional series to the strongly predominant *Misikella hernsteini* can be observed. The latter species died out at the Norian-Rhaetian boundary. The evolutionary transition between *Metapolygnathus bidentatus* and *Parvigondolella andrusovi* can be also observed in many sections (e.g. Steinbergkogel, Hernstein — both Austria — and Bohúňovo — Slovakian Karst). The existence of evolutionary transition lines both from *Metapolygnathus bidentatus* to *Parvi-*

gondolella andrusovi and from *Misikella hernsteini* to *Misikella posthernsteini* prove that the entire Rhaetian proper (with highly developed species of *Parvigondolella*, more advanced than *P. andrusovi*, and with *Misikella posthernsteini* and a further highly developed species of *Misikella*) is younger than the Sevatian. The absence of *Metapolygnathus bidentatus, Parvigondolella andrusovi,* and *Misikella hernsteini* in the whole Rhaetian is therefore not caused by unsuitable facies, but by the fact that the type Rhaetian Kössen Beds* and other Rhaetian beds are younger than the *Metapolygnathus bidentatus* zone (that comprise the major part of the Sevatian) and even younger than the *Parvigondolella andrusovi* and *Misikella hernsteini* zones of the uppermost Sevatian. Important for the definition of the Norian-Rhaetian boundary is the Steinbergkogel section (Austria). The uppermost parts of this section displays the evolutionary transition from *Misikella hernsteini* to *Misikella posthernsteini.* Here it may be clearly proved that *Misikella hernsteini* is the forerunner of *Misikella posthernsteini* and that the distribution of these two species is not controlled by the facies. In a kind letter to one of us (Kozur) Prof. Mostler, Innsbruck, has given very interesting new data on the distribution of conodonts in the uppermost Norian and Rhaetian stages. He has also found the evolutionary transition from *Misikella hernsteini* to *Misikella posthernsteini* in several sections. Moreover he has sent a table showing the distribution of conodonts in the type section of the Kössen Beds (Weissloferbach, Austria). From this profil we had only two samples with *Misikella posthernsteini* from the middle Kössen Beds. Mostler could prove that in Weissloferbach *Rhaetavicula contorta* and *Misikella posthernsteini* appear almost contemporaneously in the higher part of the lower Swabian facies and that the range of *Misikella posthernsteini* extends up to the top of the *Choristoceras marshi* zone. The conodont datings show that the Kössen Beds from their type locality are younger than the uppermost Sevatian *Misikella hernsteini* zone. Therefore the view of Krystyn (1974), Tozer (1974), and Wiedmann (1974) that the lower and middle Kössen Beds are contemporaneous with the entire Sevatian (Tozer, 1974, Wiedmann, 1974) or even with the Sevatian and parts of the Middle Norian (Krystyn, 1974) must be rejected. A new species of *Misikella* described by Mostler (in press) is locally important for the conodont zonation within the Rhaetian Kössen Beds. This species occurs in the *Choristoceras marshi* zone (except of the upper third of this zone) and in the uppermost part of the *Choristoceras haueri* zone and it is a very distinctive guide form for this time interval. The range of this species seems to be roughly the same as of *Triasina hantkeni* and of *Choristoceras marshi* (cf. Gaździcki, 1974, 1975, Wiedmann, 1974, and table 1—2). The conodonts are also very important for dating the Zlambach Beds. The Roßmoos section (Austria) is the most important here.

Footnote 6)

* In the Adnet region the Kössen Beds contain according to Mostler *Metapolygnathus bidentatus* and *Misikella hernsteini* in its lower parts. Therefore the Kössen Beds of this region begins earlier (in the same level as the Upper Sevatian part of the Zlambach Beds) than in the type region of the Kössen Beds. The occurrence of *Metapolygnathus bidentatus* and *Misikella hernsteini* (= uppermost part of the *M. bidentatus* zone = Upper Sevatian) in the lower Kössen Beds of the Adnet region proves that the absence of these species in the Kössen Beds of the type locality cannot be facies controlled.

Table 1. Distribution of conodont guide-species in the Upper Norian and Rhaetian of the Alpine-Mediterranean Triassic



——— frequent occurrence - - - - rare occurrence

The distances in the table 1 are not time-related! For instance, the *Sagenites giebeli* zone comprises a considerably greater part of the Sevatian than the *Cochloceras suessi* zone.

This section displays the uppermost Sevatian (grey limestone bank) and the lowermost Rhaetian (in the facies of the Zlambach marls). Bolz (1974) listed the following ammonoids from the grey limestone bank: *Arcestes giganto-galeatus, A. intuslabiatus, Cladiscites tornatus, Cochloceras* sp., *Megaphyllites insectus, Metasibirites* sp., *Paracladiscites multilobatus, Pinacoceras metter-nichi, Placites oxyphyllus, Rhacophyllites neojurensis,* and *Stenarcestes* cf. *subumbilicatus*. This fauna is typical of the *Cochloceras suessi* zone. The samples of the lower part of the section have yielded many conodonts indicative of the upper *bidentatus* zone. The occurrence of the *hernsteini* zone seems to be indi-cated by the concurrent occurrence of *Misikella hernsteini* and *M. posthernsteini* (transitional forms to *M. hernsteini*) in the uppermost grey limestone bank. Because only very few conodonts are known from this level, a somewhat older age is also possible, but the *hernsteini* zone is certainly present in the grey limestone bank. The overlying Zlambach marls yielded single individuals of *Misikella posthernsteini* only. Unfortunately conodonts are absent in the samples immediately above the top of the grey limestone bank. Bolz (1974) has listed the following ammonoids from the Zlambach Beds above the grey limestone bank: *Arcestes* ? sp., *Megaphyllites robustus, Phyllytoceras zlam-bachense*. This fauna is typical for the *Phyllytoceras zlambachense* zone ac-cording to Wiedmann (1974) that was correlated by Wiedmann (1972) with the Swabian facies of the lower Kössen Beds. The conodont datings probably confirm this correlation. Bolz (1974) assigned the grey limestone bank and the Zlambach marls of Roßmoos to the Upper Norian. According to the ammonoid and probably also the conodont datings at least a part of the Zlambach marls of Roßmoos, occurring above the grey limestone bank, belong to the Lower Rhaetian. This section is important as it shows that also very high levels within the *Pinacoceras metternichi* zone as well as within the more restricted *Cochloceras suessi* zone (such level is represented by the grey limestone bank) are older than the Rhaetian *Misikella posthernsteini* zone. The upper range of *Pinacoceras metternichi* and the genera *Cochloceras* and *Meta-sibirites* coincide with the upper range of *Misikella hernsteini*, whereas the upper range of *Rhabdoceras suessi* is very much higher within the Lower Rhaetian *Misikella posthernsteini* zone. By the aid of conodonts it can be proved therefore that the upper ranges of the *Pinacoceras metternichi* and *Rhabdoceras suessi* zones do not coincide. Sometimes the Zlambach Beds also represent the uppermost Norian. We had only one sample of a transition facies between grey Hallstatt Limestone and Zlambach marls with *Cochloceras* (material form old collections, designated as "Zlambach marl", from unknown locality). This sample has yielded conodonts from the *Misikella hernsteini* assemblage zone (*Misikella hernsteini* and *Misikella posthernsteini*) and thus it represents the uppermost Sevatian. So the stratigraphic range of the Zlambach Beds seems to be the same as that of the Kössen Beds. Kozur & Mock (1973) have demonstrated that the onset of more clastic sedimentation widely spread in the Rhaetian has followed short-lasting tectonical movements in the latest Sevatian and Rhaetian time (contemporaneous in the Alps, Slovakia, and in the German Basin). According to this view it may be expected that the sedi-mentation of both the Zlambach Beds and the Kössen Beds begins in many cases at the basis of the Rhaetian, but in some places already earlier, in the uppermost Sevatian, or later, within the lowermost Rhaetian. Unfortunately, up to present, no conodonts were found in the lowermost Kössen Beds.

Holothurian sclerites

As pointed out by Kozur & Mock (1974a) the Sevatian and Rhaetian can be divided into several holothurian assemblage zones:

(1) Association with *Theelia zawidzkae, Theelia praeseniradiata,* primitive *Theelia stellifera,* and *Fissobractites subsymmetricus.* Age: Lower Sevatian; *Himavatites columbianus* zone; lower *Metapolygnathus bidentatus* zone.

(2) Association with *Theelia stellifera* and *Fissobractites subsymetricus* without *Theelia zawidzkae.* Age: Lower Sevatian; *Sagenites giebeli* zone; middle *Metapolygnathus bidentatus* zone.

(3) Association with highly developed *Theelia stellifera, Theelia norica, Theelia seniradiata, Theelia stellifera bistellata, Praeeuphronides robustus, Acanthotheelia kuepperi, Fissobractites subsymmetricus,* and first primitive *Theelia heptalampra.* Age: Upper Sevatian; lower *Cochloceras suessi* zone; upper *Metapolygnathus bidentatus* zone.

(4) Association with *Theelia kristanae* together with the same species as in association (3). Age: Upper Sevatian; *Cochloceras suessi* zone; *Parvigondolella andrusovi* assemblage zone.

(5) Association with *Theelia kristanae* and *Acanthocaudina exlinae.* Age: Uppermost Sevatian; upper *Cochloceras suessi* zone; *Misikella hernsteini* assemblage zone.

(6) Association with *Theelia rosetta, Theelia variabilis, Theelia heptalampra,* and *Fissobractites subsymmetricus.* Age: Rhaetian; *Misikella posthernsteini* assemblage zone.

At the Norian-Rhaetian boundary there is found one of the greatest breaks in the development of the holothurian sclerites. From over 150 species of holothurian sclerites occurring in the Upper Norian only *Fissobractites subsymmetricus, Calclamna germanica, Staurocumites bartensteini, Theelia heptalampra, Priscopedatus triassicus, Theelia rosetta, Theelia variabilis, Uncinulinoides spicata,* and probably *Achistrum triassicum* passed into the Rhaetian. The first 4 species enter also the Liassic. Except for these long-ranging species there are known up to now only 4 other species of typical Rhaetian aspect. The holothurian sclerites that occur in fairly different marine facies are one of the best markers for the Norian-Rhaetian boundary.

Ostracodes

In the German Basin at the Norian-Rhaetian boundary there is a sharp break in the ostracode fauna (Kozur, 1975). The same is true in Hungary, where in the Rhaetian many ostracodes of Jurassic aspect have appeared and coexisted with some ostracodes of Triassic aspect (Kozur & Oravecz, 1972). According to Bolz (1974) in the Alps the Upper Norian and the Lower Rhaetian ostracode fauna is quite equal. But as pointed out above, the "Upper Norian" Zlambach marls of Roßmoos with *Phyllytoceras zlambachense* and *Megaphyllites robustus* are Lower Rhaetian and overlie the grey limestone bank of uppermost Norian. Also all other localities discussed by Bolz (1974) — Fischerwiese, Grünbachgraben, Höllgraben and at least parts of the Mühlgraben section that was not sampled by us — are of Lower Rhaetian age. As it can be expected from this fact, the ostracode faunas of all these localities are very similar and differ only slightly because of facial reasons. A new (still undescribed) Upper Norian ostracode fauna gathered by Kozur differs from the Rhaetian ones also after the elimination of facial differences. In the Rhaetian ostracode fauna primitive members of typical Meso-Cenozoic families appear for the first time (e.g. first Trachyleberididae: *Boogaardella*, first Cytheruridae: *Parariscus*). Many genera that appear for the first time in the Rhaetian have clearly Jurassic aspects, e.g. *Klieana, Boogaardella, Stykella, Aparchitocythere, Parariscus* (Kozur, 1973c). Many species and genera, above all holdovers from the Paleozoic or near related forms, disappear near the Norian-Rhaetian boundary and within the Rhaetian.

Foraminifers

In some sediments where conodonts and holothurian sclerites are rare or absent and the ostracodes cannot be separated from the rocks the foraminifers have yielded most important guide forms. Among the foraminifers the representatives of the family Involutidae Bütschli, 1880 have special stratigraphic and paleogeographic importance (Gaździcki, 1974a, Fig. 11; 1974b, tab. 1; see also Salaj, 1969 a, b; 1974; 1977). Three foraminifer zones can be recognized from the Middle Norian up to the uppermost Rhaetian (tab. 2; see also Gaździcki, 1974a, 1974b; Salaj, 1974, 1977). These 3 zones are the *Semiinvoluta clari & Triasina oberhauseri* assemblage zone (Alaunian-Sevatian), the *Glomospirella pokornyi & Glomospirella friedli* assemblage zone (Lower Rhaetian) and the *Triasina hantkeni* range zone (? higher Lower Rhaetian, Upper Rhaetian).

The *Glomospirella pokornyi & Glomospirella friedli* assemblage zone could be proved in the samples MMV-6 (Zlambach Beds of Malý Mlynský vrch), 166/2 (fossiliferous limestone of Bleskový prameň), Ö-18 (Zlambach Beds of Fischerwiese), Ö-41 (uppermost "Plattenkalk" immediately below the Kössen Beds, Kendelbachgraben), Ö-38 (upper Kössen Beds, Kendelbachgraben). and in the samples 8—12 from the Kössen Beds of Hybe. Most interesting is the comparison between the faunas of the samples 166/2 (Bleskový prameň) and the samples 8—12 from Hybe. Both faunas belong to the Lower Rhaetian *Glomospirella pokornyi & Glomospirella friedli* zone, but the occurrence of *Galeanella* cf. *tollmanni* and *Involutina* cf. *turgida* indicates that the sample 166/2 from Bleskoý prameň (until now regarded as Upper Norian) is younger than the Lower Rhaetian of Hybe as earlier pointed out by Kozur (1973b) and Kozur & Mock (1973, 1974c). Interesting is also the age from the sample Ö-18 from the Fischerwiese. The foraminifer fauna indicates an Early Rhaetian age as it do the ostracode fauna from this locality. Because the Late Rhaetian *Choristoceras marshi* was also described from this locality, the beds with *Choristoceras marshi* either represent only the uppermost part of the section or *Choristoceras marshi* occurs also in the Lower Rhaetian (as it was inferred by Wiedmann, 1974). The same age as for the Bleskový prameň limestone

Table 2. Upper Norian-Rhaetian foraminifer zonation in the Alpine-Mediterranean Triassic

STAGE			NORIAN	RHAETIAN	
Substage			Sevatian	Lower	Upper
Zone			*clari* & *oberhauseri*	*pokornyi* & *friedli*	*hantkeni*
Foraminifers	guide forms	*Glomospirella pokornyi*		—	
		Glomospirella friedli		—	—
		Semiinvoluta clari	—	—	
		Triasina oberhauseri	—	—	
		Triasina hantkeni		? —	—
	other forms	*Glomospirella parallela*		—	—
		Trochammina alpina	—	—	—
		Alpinophragmium perforatum		—	—
		Tetrataxis inflata		—	—
		Agathammina? iranica	—	—	
		"Vidalina" martana	—	—	—
		"Vidalina" carinata	—	—	—
		"Vidalina" carpathica	—	—	
		Galeanella tollmanni		—	—
		Miliolipora cuvillieri	—	—	—
		Planiinvoluta deflexa		—	—
		"Sigmoilina" sp.	—	—	
		Nodosaria ordinata	—	—	—
		Turrispirillina minima	—	—	
		Involutina communis	—	—	—
		Involutina tenuis	—	—	—
		Involutina tumida	—	—	—
		Involutina sinuosa sinuosa	—	—	—
		Involutina sinuosa oberhauseri	—	—	
		Involutina gaschei	—	—	—
		Involutina minuta		—	
		Trocholina acuta	—	—	—
		Trocholina permodiscoides	—	—	—

For stratigraphic ranges of taxa, definition of the zones and additional comments see Salaj, 1969 a, b, 1974 and Gaździcki, 1974 a, b

? questionable occurrence

is indicated, but an Upper Rhaetian age cannot be ruled out (see remarks to sample Ö-38). The fauna of the sample Ö-38 is somewhat puzzling. This sample derives from the rocks directly overlying the marls with *Choristoceras marshi*. Therefore the fauna of the Upper Rhaetian *Triasina hantkeni* zone rather than the Lower Rhaetian fauna of the *Glomospirella pokornyi* & *Glomospirella friedli* assemblage zone should be expected in this sample. Because *Glomospirella friedli* markedly enters the *Triasina hantkeni* range zone, it is possible that the sample Ö-38 represents the *Triasina hantkeni* range zone (Upper Rhaetian), but the index form is absent because of facial reasons. The fauna of the sample Ö-41 from the uppermost part of the "Plattenkalk" immediately below the Kössen Beds of Kendelbachgraben is also very important. The sample Ö-41 taken just below the base of the Kössen Beds should be of Middle Norian age, if the correlations of the lower and middle Kössen Beds with the entire Sevatian (Tozer, 1974; Wiedmann, 1974) or even with the entire Sevatian and a part of the Middle Norian (Krystyn, 1974) are correct. The rich fauna of the *Glomospirella pokornyi* & *Glomospirella friedli* assemblage zone in the sample Ö-41 demonstrates that the uppermost "Plattenkalk" of Kendelbachgraben is most probably of Early Rhaetian age or at least not older than latest Sevatian. This dating confirms the view of Kozur (1973b) that most of the Kössen Beds are of Rhaetian age and younger than the uppermost Sevatian as it can be proved also by conodonts and holothurian sclerites (see above).

The *Triasina hantkeni* range zone was only indicated in the sample Dr. from the Bleskový prameň locality. This is very interesting, because the ammonoid fauna of this locality was hitherto erroneously assigned to the Sevatian (Upper Norian) substage. It may be that *Triasina hantkeni* already occurs in the upper part of Lower Rhaetian, so that perhaps the range of this species comprises both the upper part of the Lower Rhaetian and the Upper Rhaetian. But on the other hand parts of the Bleskový prameň limestone may be already Upper Rhaetian and the never confirmed record of *Choristoceras marshi* (Stürzenbaum, 1879) may be correct. Also the fauna from the sample Dr. proves that the strata from the Bleskový prameň locality are of Rhaetian age and younger than the Lower Rhaetian of Hybe.

Some remarks to the papers of Hohenegger & Piller (1975) and Bystrický (1975)

Hohenegger & Piller (1975) have assigned *Glomospirella friedli* Kristan-Tollmann, 1962, *G. parallela* Kristan-Tollmann, 1964, and *G. expansa* Kristan-Tollmann, 1964 to the genus *Involutina*. This may be correct, but it is beyond the matter of this paper to discuss this problem. *Involutina gaschei* (Koehn-Zaninetti & Brönnimann, 1968) is certainly not an younger synonym of *Glomospirella friedli* Kristan-Tollmann, 1962, because the stratigraphic range of these two species is quite different, so that the differences between these two species are not facies-controlled as supposed by Hohenegger & Piller (1975), but true species differences.

The stratigraphic importance of Late Triassic foraminifers was recently questioned by Bystrický (1975), which is in contradiction with the data available. It should be noted that the marked stratigraphic value of the foraminifers and especially of the representatives of the families Ammodiscidae and Involutinidae from the uppermost Triassic is connected with their rapid evolution. A fairly good knowledge of internal structure, phylogenetic relations, ecology, and paleogeography of the foraminifers is highly advantageous here (see Gaździcki, 1974a, b; Salaj, 1974, 1977; Zaninetti, 1976). Moreover, the succession of foraminifer faunas was reconstructed on the basis of highly complete sections of the Upper Triassic from the Alpine region. Therefore, foraminifer datings are fairly reliable. Bystrický (1975) has questioned the stratigraphic value of foraminifers for the zonation of the Upper Triassic with the reference to the foraminifer succession in the Hybe profil. However, this section is tectonically disturbed and the succession of layers is still the matter of controversy (see Goetel, 1917; Michalík, 1973; Bystrický, 1975).

According to Bystrický (1975) also the conodonts have no value for stratigraphic subdivisions in the uppermost Norian and Rhaetian. In this connection Bystrický (1975) reconstructed "contradictions" in conodont datings comparing older and newer papers and views of conodont workers. In this respect the remarks of Bystrický (1975) are pure polemic and therefore not worthy to discuss. Bystrický (1975) has not noticed that not the conodont datings, but the stratigraphic schemes were changed and that the former *Spathognathodus hernsteini* Mostler was revised and subdivided by Kozur & Mock (1974a, b) into *Misikella hernsteini* (Mostler) and *M. posthernsteini* Kozur & Mock. Thus, the "contradictions" in the conodont datings reconstructed by Bystrický (1975) are in reality the result of the scientific progress in the Upper Triassic stratigraphy and conodont taxonomy. The same is true for the great number of such "contradictions" in the papers of Bystrický (compare e.g. the papers of Bystrický 1972, 1973 and appendix to the latter paper with regard to the stratigraphy of the Upper Triassic of Silická Brezová).

Some remarks are necessary to special views in the paper of Bystrický (1975) that contradict the above mentioned stratigraphic results from our micropaleontological studies at the Norian-Rhaetian boundary.

(1) The so-called "conodontenfreier Bereich" (cf. Huckriede, 1958; Kozur, 1971; Kozur & Mock, 1972) was not considered as an equivalent of a biozone by these authors as assumed by Bystrický (1975). Meanwhile *Misikella posthernsteini* and some other conodonts were found in this stratigraphic level and the *posthernsteini* assemblage zone was established for this stratigraphic level and the *post-hernsteini* fauna by Kozur & Mock (1974c).

(2) According to Bystrický (1975) there are no considerable changes in the conodont, ostracode, holothurian, brachiopod, and ammonoid faunas at the Norian-Rhaetian boundary (with references to Urlichs, 1972; Mosher, 1968; Sweet u.a., 1971; Pearson, 1970, Dagis, 1974, and Kozur, 1972c). Urlichs (1972) has investigated only Rhaetian ostracode faunas of the Kössen Beds at Weißloferbach, the type locality of the Rhaetian Kössen Beds. He assigned the lower and middle part of this section to the Upper Norian (because of the occurrence of *Rhabdoceras suessi*). In our view, discussed above, the whole section of the Kössen Beds at Weißloferbach is Rhaetian

(perhaps with exception of the lowermost beds, where no conodonts and ostracodes were found and *Rhaetavicula contorta* is still absent). The "Norian" part (sensu Urlichs) of the Kössen Beds from Weißloferbach contains *Misikella posthernsteini*, and new highly developed species of *Misikella* and *Parvigondolella*, the typical Rhaetian conodont fauna. The conodont association of the *Misikella posthernsteini* assemblage zone together with *Rhabdoceras suessi*, *Choristoceras ammonitiforme*, typical Rhaetian brachiopods, and pelecypods (e.g. *Rhaetavicula contorta*) indicate a Lower Rhaetian age (*Choristoceras haueri* zone) for this part of the section. Therefore Urlichs (1972) has not compared Upper Norian and Rhaetian ostracodes, but Lower Rhaetian ostracodes with Upper Rhaetian ones. The Lower and Upper Rhaetian ostracode faunas are, of course, very similar, but clearly different from the true Upper Norian ostracode faunas. Kozur (1972c) has also still assigned the uppermost *Rhabdoceras suessi* zone to the Upper Norian sensu Tozer (1967). The "Upper Norian" ostracodes by Kozur (1972c) were found in the uppermost *Rhabdoceras suessi* zone. According to Kozur (1973b) this part of the *Rhabdoceras suessi* zone is contemporaneous with the Lower Rhaetian *Choristoceras haueri* zone. Therefore the "Upper Norian" ostracodes by Kozur (1972c) have the same Lower Rhaetian age as the "Upper Norian" ostracodes described by Urlichs (1972). It is clear that these ostracode faunas are very similar to other Rhaetian ostracode fauna, but there are great differences to the true Upper Norian ostracode faunas (see chapter: Stratigraphic value of microfossils at the Norian-Rhaetian boundary).

The view of Bystrický (1975) that the very rich Upper Norian holothurian fauna had passed into the Rhaetian is nowhere confirmed (neither in published nor in unpublished material — in the contrary in all published papers the great differences between the Norian and Rhaetian holothurian faunas were emphasized) and unsubstantiated.

The differences between the Upper Norian and Rhaetian ammonoid faunas are considerable (see chapter: The problem of the Norian-Rhaetian boundary), in spite of the fact that some species straddles the Norian-Rhaetian boundary (e.g. *Rhabdoceras suessi*).

In contrary to the references by Bystrický (1975) already the papers of Mosher (1968) and Sweet et al. (1971) show very clearly the great break in the conodont faunas between the Norian and Rhaetian. Mosher (1968, fig. 12) listed 22 conodont species in the Sevatian (not all range up to the Norian-Rhaetian boundary), but only 4 in the Lower Rhaetian. This break is in reality still greater, because "*Neospathodus lanceolatus*" comprises two species, the Upper Norian *Misikella hernsteini* and the uppermost Norian to Rhaetian *Misikella posthernsteini*. Moreover, there are some highly developed hitherto undescribed species of *Misikella* and *Parvigondolella* in the Rhaetian that are unknown in the Norian.

Dagis (1974, tab. 3) showed that at the Norian-Rhaetian boundary 32 brachiopod genera died out and 3 genera have their first appearence at the base of the Rhaetian (the latter number may by considerably higher, if the Norian-Rhaetian boundary will be revised in all areas). Moreover, Dagis (1974, p. 272) pointed out that in all sections of northwestern Caucasus a sharp, not facies-controlled change in the brachiopod fauna occurs above the beds with

Monotis caucasica and Norian brachiopods. Above these Upper Norian beds a rich brachiopod fauna occurs that is very similar to the brachiopod fauna of the Kössen Beds and to the fauna of Drnava (Bleskový prameň). The ammonoid fauna of this region was regarded as Upper Norian, but it consists of Norian holdovers that are frequent in the Lower Rhaetian (e.g. *Megaphyllites insectus, Rhacophyllites debilis, Placites polydactylus*). Thus, in contrary to the view of Bystrický (1975), Dagis (1974) has shown considerable changes in the brachiopod fauna at the Norian-Rhaetian boundary. Pearson (1970) accepted the "Plattenkalk"-Kössen Beds boundary as Norian-Rhaetian boundary, but he assumed that *Rhabdoceras suessi* has the same upper range as the genus *Cochloceras* and that *Rhabdoceras suessi* is older than the Kössen Beds or it ranges only up to the lowermost brachiopod horizon of the Kössen Beds (below the first appearence of *Rhaetavicula contorta*). The newest results (Ulrichs, 1972) have shown however that *Rhabdoceras suessi* occurs together with *Rhaetavicula contorta* and it is absent only in the upper third of the Kössen Beds. Therefore Pearson (1970) assigned the uppermost *Rhabdoceras suessi* zone to the Norian, but the lower and middle Kössen Beds with *Rhaetavicula contorta* and Rhaetian brachiopods (contemporaneous to the uppermost *Rhabdoceras suessi* zone) to the Rhaetian. For this reason many Rhaetian guide forms of the brachiopods were regarded as Upper Norian by Pearson (1970), if the beds were placed in the uppermost *Rhabdoceras suessi* zone by ammonoids (e.g. Bleskový prameň, post-*Monotis* beds of northwestern Caucasus).

(3) Bystrický (1975, p. 183) has erroneously equated the post-*hernsteini* fauna of Kozur & Mock (1972) with the *posthernsteini* assemblage zone (Kozur & Mock (1974c). The post-*hernsteini* fauna is the conodont fauna immediately above the *Misikella hernsteini* assemblage zone. The *Misikella posthernsteini* assemblage zone comprises both the post-*hernsteini* fauna and the formerly recognized "conodontenfreien Bereich" of the uppermost Triassic, in which now conodonts were found (above all *Misikella posthernsteini*). Therefore it is not correct, if Bystrický (1975) pointed out that the "conodontenfreier Bereich" of the uppermost Triassic follows above the *Misikella posthernsteini* assemblage zone. In reality Jurassic beds follow above the *Misikella posthernsteini* assemblage zone.

(4) Bystrický (1975, p. 184) pointed out that in the *posthernsteini* assemblage zone of Malý Mlynský vrch *Gondolella navicula, Metapolygnathus bidentatus, Misikella hernsteini*, and *Oncodella paucidentata* occur together with *Misikella posthernsteini* in the same beds at the same locality. This is quite incorrect. In Malý Mlynský vrch are some outcrops with conodonts of the *spatulatus* assemblage zone, the upper *bidentatus* range zone, the *hernsteini* assemblage zone, and the *posthernsteini* assemblage zone. *Metapolygnathus bidentatus, Misikella hernsteini, Oncodella paucidentata*, and *Gondolella navicula* were not reported from the *Misikella posthernsteini* assemblage zone, but from the underlying zones. In the *Misikella posthernsteini* zone only the index species was found. In one sample taken from the beds between the *Misikella hernsteini* and *Misikella posthernsteini* assemblage zones *Metapolygnathus slovakensis, Grodella delicatula*, and *Prioniodina* (*Cypridodella*) *muelleri* were found, but never the species mentioned by Bystrický.

(5) Bystrický (1975, p. 187) pointed out that the relation of the horizon with *Misikella hernsteini* and the horizon with *Misikella posthernsteini* at the locality Hybe, "so important for the stratigraphy", is unclear. He has not noticed that the former *M. hernsteini* of Hybe is in reality *M. posthernsteini* as pointed out by Kozur & Mock (1974c). Therefore in Hybe do not exist a fauna with *"Spathognathodus" hernsteini* and *Misikella posthernsteini* as Bystrický assumed, but only a fauna with *Misikella posthernsteini*. In this respect it is very interesting that Bystrický has repeatedly pointed out that the position of *"Spathognathodus" hernsteini* in the Hybe section is clear, but the stratigraphic position of *M. posthernsteini* is unclear. This seems to be only polemic, because it should be quite clear that the known stratigraphic level of *"Spathognathodus" hernsteini* from Hybe does not change with taxonomic revision of this species. Therefore it is surprising, if Bystrický (1975, p. 190) wrote: "Without precise data on the occurrence of the fauna, which are unconditionally necessary in stratigraphy, consequently also the indication of the occurrence of *Misikella posthernsteini* Kozur & Mock is not more valuable than the rejected presence of the species ? *Gondolella navicula* Huckriede".

Description of the new species

? Family **Fischerinidae Millett, 1898**

? Subfamily **Cyclogyrinae** Loeblich & Tappan, 1961

? Genus *Vidalina* Schlumberger, 1900

"Vidalina" carpathica Gaździcki, sp. n.

Pl. 4, figs. 3—5

Holotype: The specimen presented in pl. 4, fig. 4.

Type horizon: Zlambach Beds (Upper Norian-Rhaetian).

Type locality: Malý Mlynský vrch (Slovak Karst), Czechoslovakia.

Derivation of the name: carpathica — after the Carpathians.

Diagnosis: Test discoidal, somewhat flattened, with distinct central swell and always with keel. Wall calcareous, imperforate. Coiling planispiral, involute, probably nonseptate; 3—4 whorls in the spire. The last whorl separated from central part by deep constrictons.

Material: 10 well-preserved individuals.

Association: With *Glomospira* cf. *perplexa*, *Glomospirella* sp., *Trochammina alpina*, *Agathammina austroalpina*, *"Vidalina" carinata*, *Nodosaria ordinata*, *Austrocolomia* sp., and *Diplotremina* sp.

Description: Test calcareous, imperforate, elongate, consisting of relatively large, spherical proloculus and tubular second chamber with well-marked keel. Whorls 3—4 in number; coiling planispiral, involute, bilaterally symmetrical. Axial section displaying the central part (proloculus and first 2—3 whorls) with characteristic central swell, separated from the last whorl by marked constrictions (pl. 4, fig. 4—5). Deuteroloculus circular in outline (pl. 4, fig 5). Sharp keel especially well-developed along the last whorl (pl. 4, fig. 3—5).

Dimensions of the test: diameter: 280—320 μm, thickness: 60 μm, diameter of the proloculus: about 30 μm.

Remarks: The new species "*Vidalina*" *carpathica* Gaździcki, sp. n. differs from all other Late Triassic and Liassic "*Vidalina*" in the last whorl separated from the central part with deep constrictions, especially well-displayed by axial sections (pl. 4, figs. 4—5). The small number of individuals precluded an accurate identification of the forms "A" and "B". The size of the proloculus and the number of the whorls appear almost identical in all the forms available; it is assumed that they all represent the form "B". It is highly probable that these individuals could loose their last whorl at the deep constrictions. The remaining central part appears to be very similar to the form "A" of the species "*Vidalina*" *carinata* (Leischner) = *Neoangulodiscus carinatus* (Leischner) = *Involutina carinata* Leischner (cf. pl. 1, fig. 1 herein, and Leischner, 1961, pl. 2, figs. 15 a—d) recorded from the Norian-Rhaetian and primarily from the Lower Liassic of the Tethyan areas (Leischner, 1961; Kristan-Tollmann, 1962; Brönnimann, Poisson & Zaninetti, 1970).

Occurrence: Known from the type locality only.

Conclusions

The entire Kössen Beds of their type locality (perhaps with exception of the lowermost part where *Rhaetavicula contorta* and conodonts are absent) are Rhaetian in age and younger than the Sevatian substage of the Upper-Norian stage.

The Zlambach Beds are contemporaneous with the Kössen Beds and begin at some places within the uppermost Sevatian (? upper *Metapolygnathus bidentatus* zone, *Misikella hernsteini* assemblage zone in the conodont zonation; *Cochloceras suessi* zone in the ammonoid zonation by Kozur, 1973 b).

The major part of the *Rhabdoceras suessi* zone is older than the Kössen Beds. *Rhabdoceras suessi* straddles the Norian-Rhaetian boundary and occurs also in the lower and middle parts of the Rhaetian, here together with the genus *Choristoceras*.

The *Rhabdoceras suessi* zone is inconvenient as standard zone. The upper range of the index species *R. suessi* exceeds the upper range of *Pinacoceras metternichi*, the index species of the *metternichi* zone, and therefore it straddles the Norian-Rhaetian boundary. Therefore the *Rhabdoceras suessi* zone should be rejected and replaced by the *Sagenites giebeli* zone (corresponding to the lower subzone of the *Rhabdoceras suessi* zone by Tozer, 1967), the *Cochloceras suessi* zone (Upper Sevatian corresponding to great parts of Tozer's upper subzone of *Rhabdoceras suessi* zone), and the *Choristoceras haueri* zone (Lower Rhaetian corresponding to the uppermost part of the *Rhabdoceras suessi* zone by Tozer, 1967).

The Norian-Rhaetian boundary between the *Cochloceras suessi* and *Choristoceras haueri* zones agrees with the priority and is characterized by an important faunal change both in the macro- and micro-faunas.

The dating of the *Glomospirella pokornyi* & *Glomospirella friedli* assemblage zone as Lower Rhaetian (Gaździcki, 1974) is confirmed. Also by the aid of foraminifers could be proved that the »Sevatian« of Bleskový prameň is younger than the Lower Rhaetian of Hybe as it was previously suggested by Kozur & Mock (1973, 1974 c).

The uppermost "Plattenkalk" of Kendelgraben belongs to the *Glomospirella pokornyi* & *Glomospirella friedly* assemblage zone and therefore it probably represents the basal Rhaetian, being certainly not older than uppermost Sevatian. This disagrees with the views of Krystyn (1974), Tozer (1974), and Wiedmann (1974) that the Kössen Beds include the entire Sevatian or even parts of the Middle Norian (Krystyn, 1974) and confirms the view of Kozur (1973 b) that the typical Kössen Beds (not the lower Kössen Beds of the Adnet region) are younger than the uppermost Sevatian. Only the lowermost parts of the typical Kössen Beds (without *Rhaetavicula contorta* and conodonts) may locally represent the uppermost Sevatian.

Plate 1

Samples from Bleskový prameň (fig. 1—8) and Hybe (fig. 9), Czechoslovakia

1 »*Vidalina*« cf. *carinata* (Leischner); sample 166/5-D_4, × 300.
2—3 »*Vidalina*« *martana* Farinacci; 166/2, × 150.
4 *Ophthalmidium* sp.; 166/2, × 70.
5 *Ammobaculites* sp.; 166/3-D_1, × 60.
6 *Galeanella* cf. *tollmanni* (Kristan); 166/2, × 100.
7 *Diplotremina* ? sp.; 166/2, × 100.
8 *Triasina hantkeni* Majzon; Dr., × 60.
9 *Triasina oberhauseri* Koehn-Zaninetti & Brönnimann; sample Hybe 12, × 130.

All photos taken by Dr. A. Gaździcki

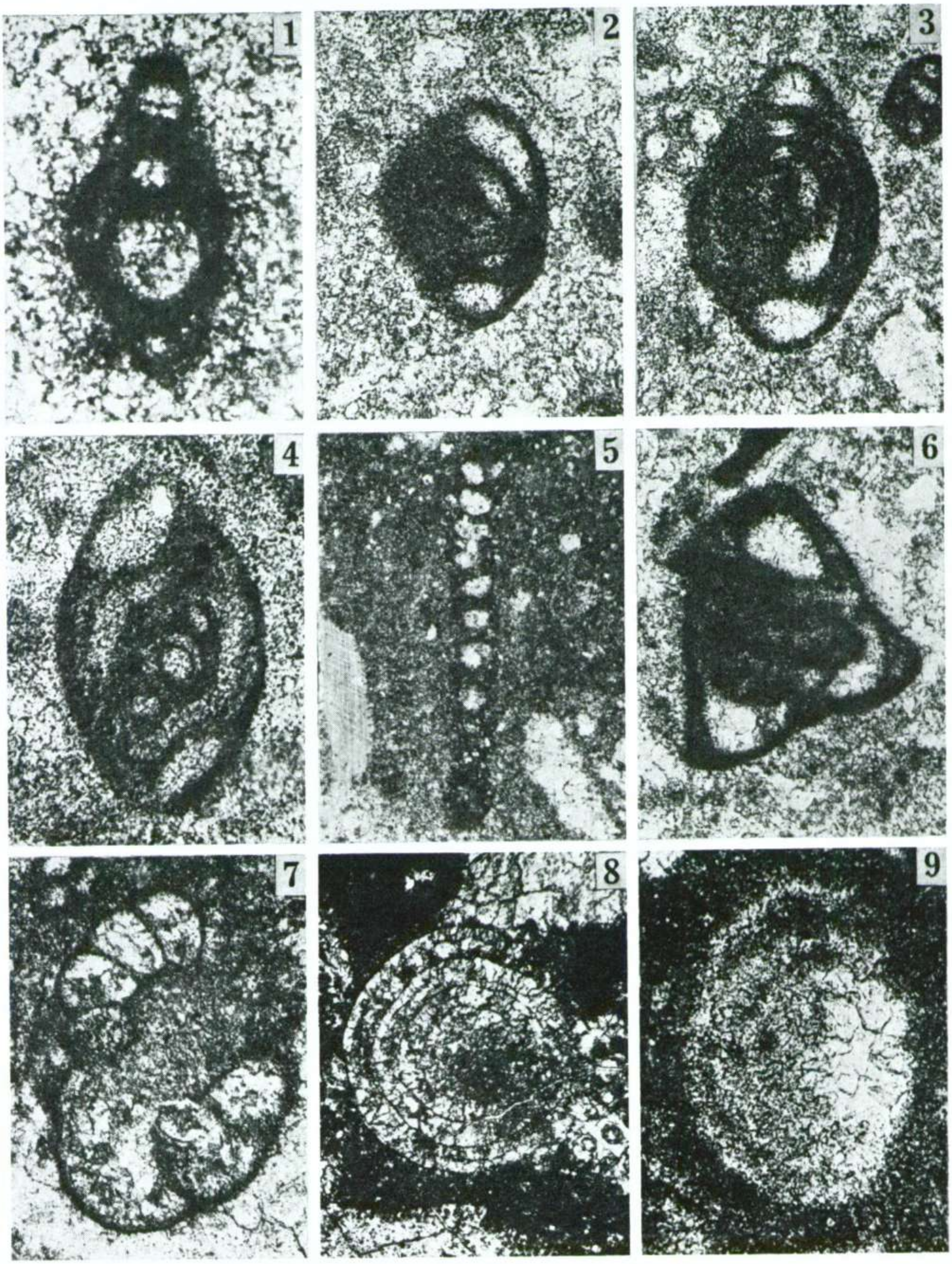

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Plate 2

Samples from Kendelbachgraben, Austria

1 *Trochammina alpina* Kristan-Tollmann; Ö-34, × 250.
2 *Trochammina* ? sp.; Ö-34, × 250.
3 *Alpinophragmium perforatum* Flügel; Ö-41, × 40.
4 *Agathammina austroalpina* Kristan-Tollmann & Tollmann; Ö-41, × 100.
5 *Lingulina cf. placklesensis* Kristan-Tollmann; Ö-38, × 150.
6 *Nodosaria ordinata* Trifonova; Ö-41, × 150.
7 *Nodosaria* sp.; Ö-34, × 250.
8 *Glomospirella* sp.; Ö-41, × 150.
9 *Ophthalmidium* sp.; Ö-36, × 250.
10—12 *Involutina communis* Kristan; Ö-41, *10, 12* — × 90, *11* — × 70.
13 *Trocholina permodiscoides* Oberhauser; Ö-41, × 90.

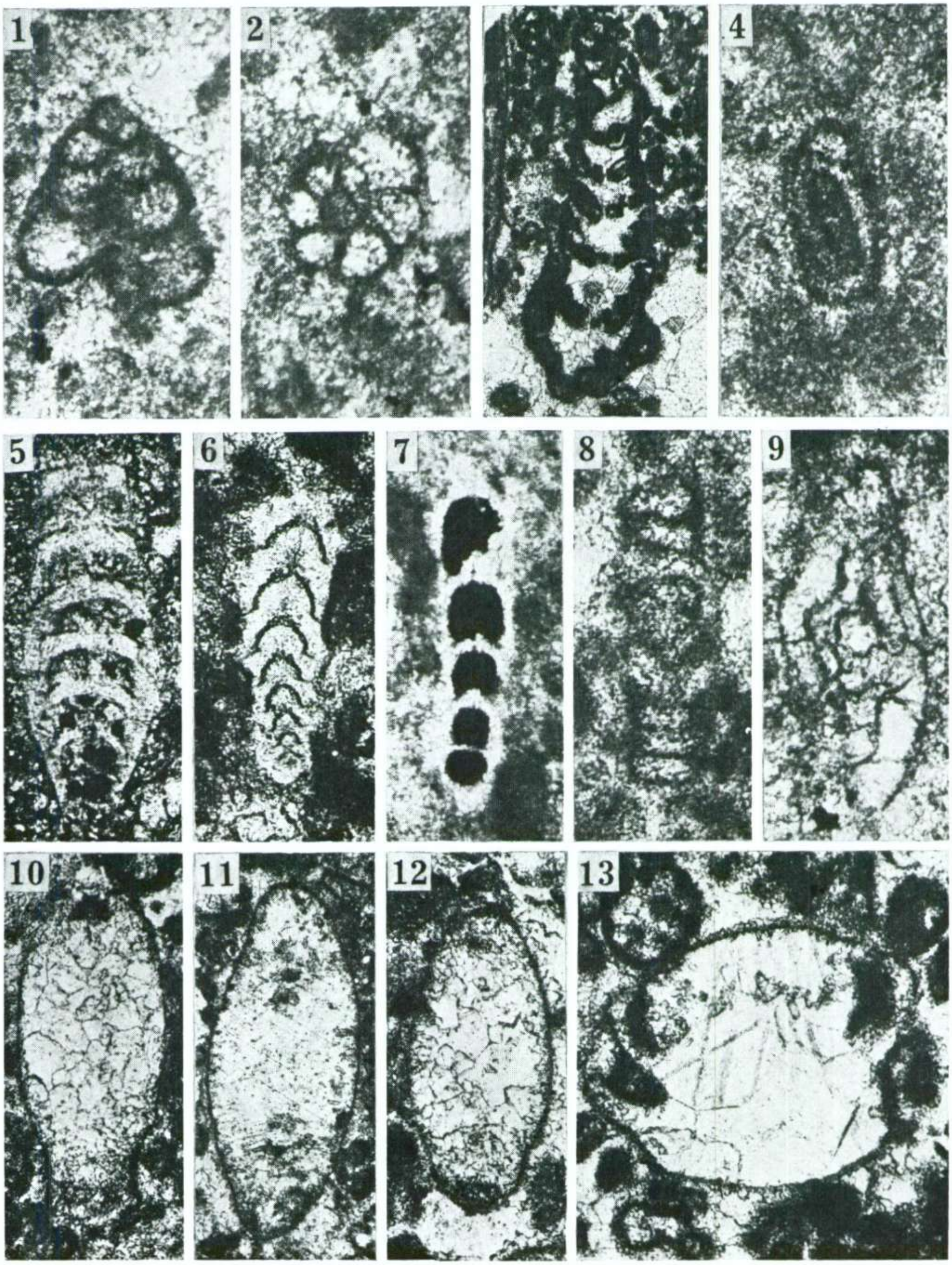
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Plate 3

All specimens from sample Ö-18 (Fischerwiese, Austria)

1 *Glomospirella friedli* Kristan-Tollmann, × 130.
2 *Tolypammina* sp., × 60.
3 *Ophthalmidium* sp., × 150.
4 *Galeanella* ? sp., × 150.
5—6 *Endothyra* sp., × 60.
7 *Diplotremina* cf. *subangulata* Kristan-Tollmann, × 60.
8 *Diplotremina* sp., × 60.
9—10 »*Sigmoilina*« sp., × 150.
11 *Trochammina alpina* Kristan-Tollmann, × 150.
12 *Alpinophragmium perforatum* Flügel, × 40.

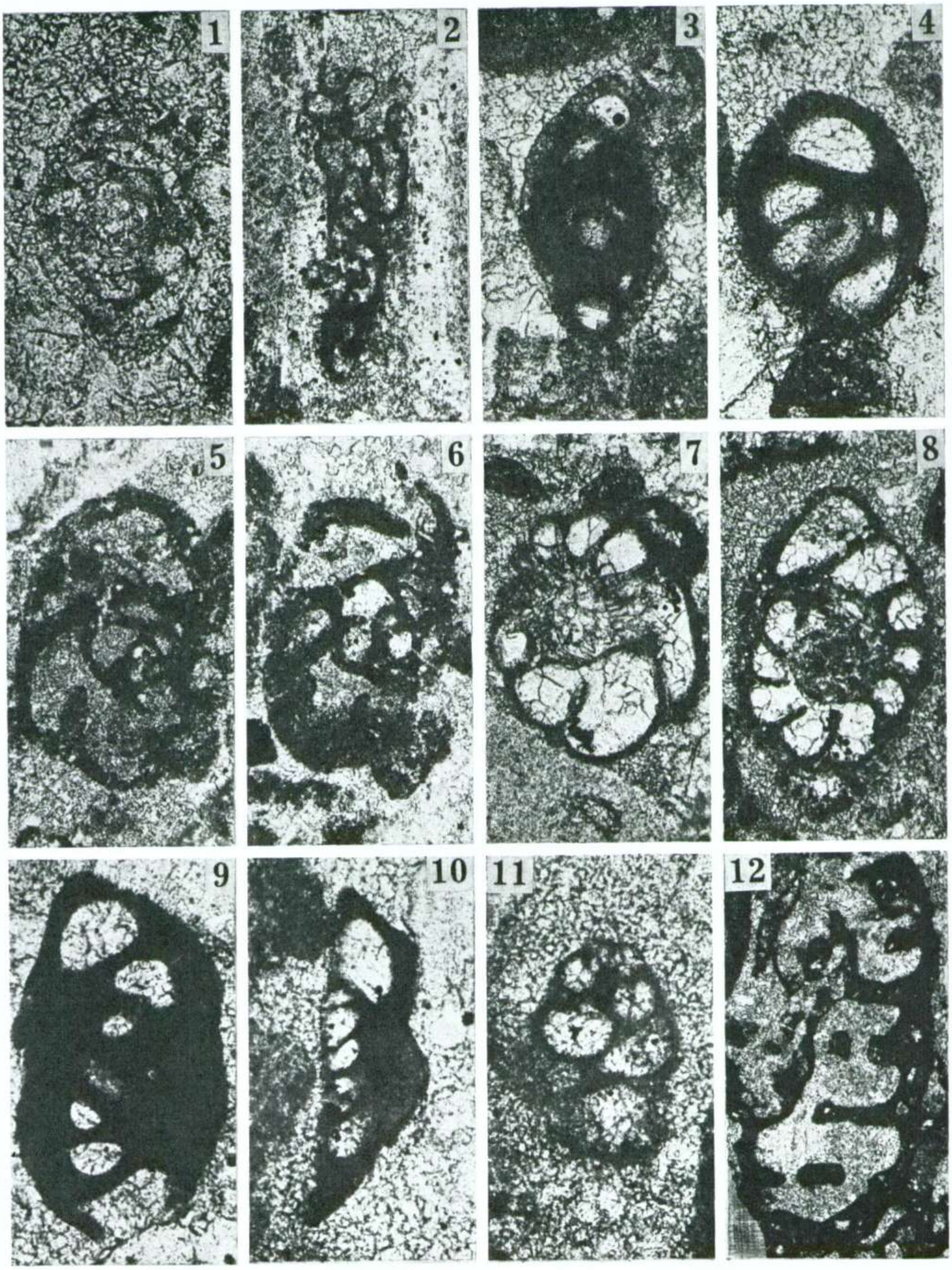
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Plate 4

All samples from Malý Mlynský vrch (Slovakian Karst)

1 *Glomospirella* cf. *pokornyi* (Salaj), MMV-6, × 200.
2 »*Vidalina*« *carinata* (Leischner); MMV-4, × 150.
3—5 »*Vidalina*« *carpathica* Gaździcki sp. n. (fig. 4: holotype); MMV-4, × 150.
6 *Ophthalmidium* cf. *triadicum* (Kristan); MMV-3, × 200.
7 *Nodosaria* sp.; MMV-1, × 200.
8—9 *Agathammina* ? *iranica* Zaninetti, Brönnimann, Bozorgnia & Huber; MMV-1, × 300.
10—13 *Trochammina alpina* Kristan-Tollmann: *10* — MMV-1, × 250, *11* — MMV-4, × 250; *12, 13* — MMV-2, × 200.
14 *Glomospirella* ? sp.; MMV-2, × 300.
15 *Glomospira* sp.; MMV-2, × 200.

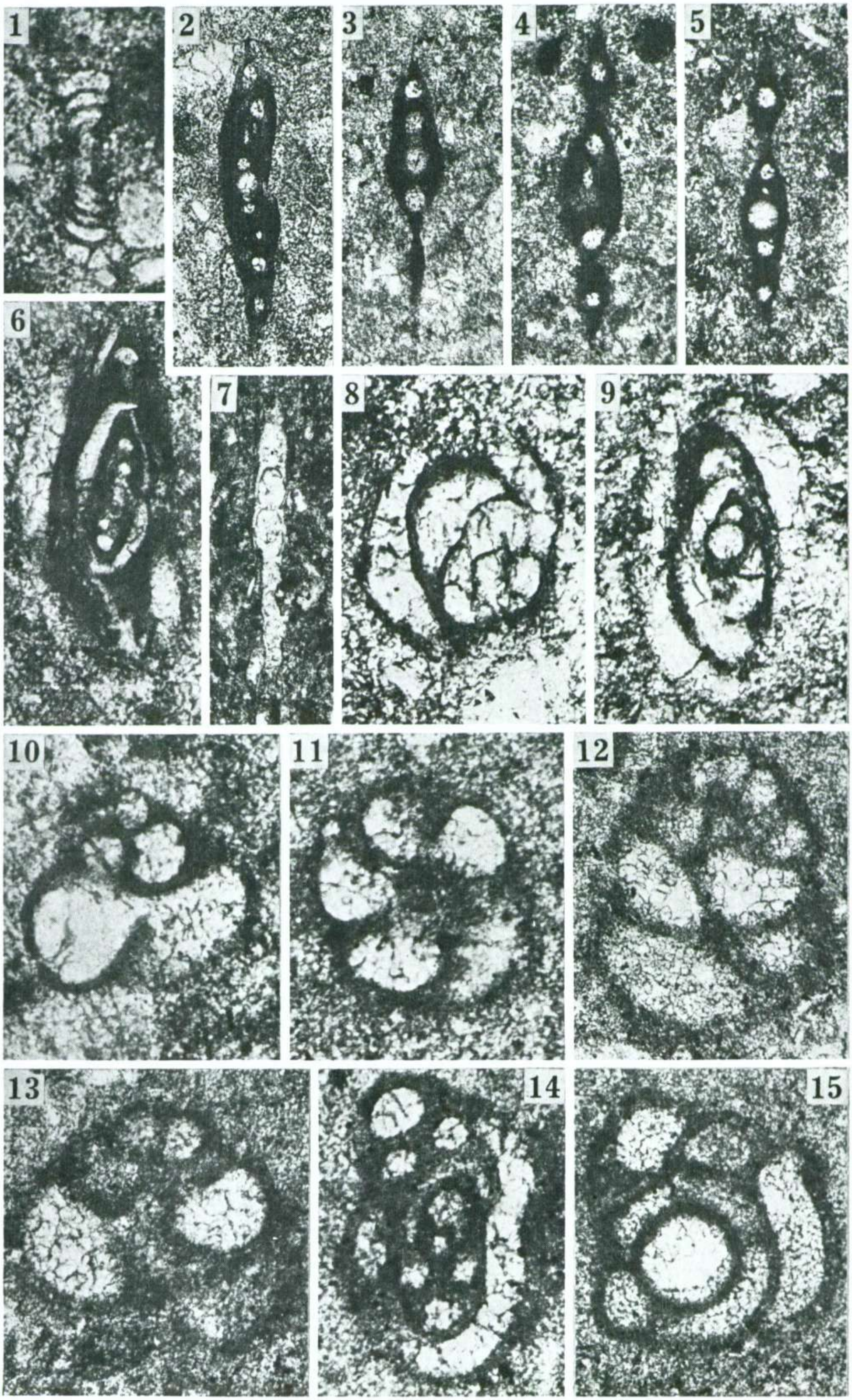
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Plate 5

1, 2 ***Misikella posthernsteini*** Kozur & Mock, fig. *1*: posterior view; fig. *2*: lateral view; Lower Rhaetian (*pokornyi & friedli* foraminifer zone, ***Misikella posthernsteini*** conodont zone), Choč nappe, Chochołowska Valley at the foot of Siwiańskie Turnie (western part of the Tatra Mts., Poland). 200 ×.

3—7 ***Misikella hernsteini*** (Mostler), figs. *3 a, 4—6*: lateral view; figs. *3 b, 7*: upper view; all from the uppermost Sevatian of Hernstein, Austria (Bed C 1 according to Mostler, Oberhauser & Plöchinger, 1967), ***Misikella hernsteini*** conodont assemblage zone. 83 ×.

8, 9 ***Parvigondolella andrusovi*** Kozur & Mock, lateral view, Upper Sevatian, ***Parvigondolella andrusovi*** conodont assemblage zone; fig. *8*: Bohúňovo (Silica nappe, Slovakian Karst), 100 ×; fig. *9*: Silická Brezová (Silica nappe, Slovakian Karst), 60 ×.

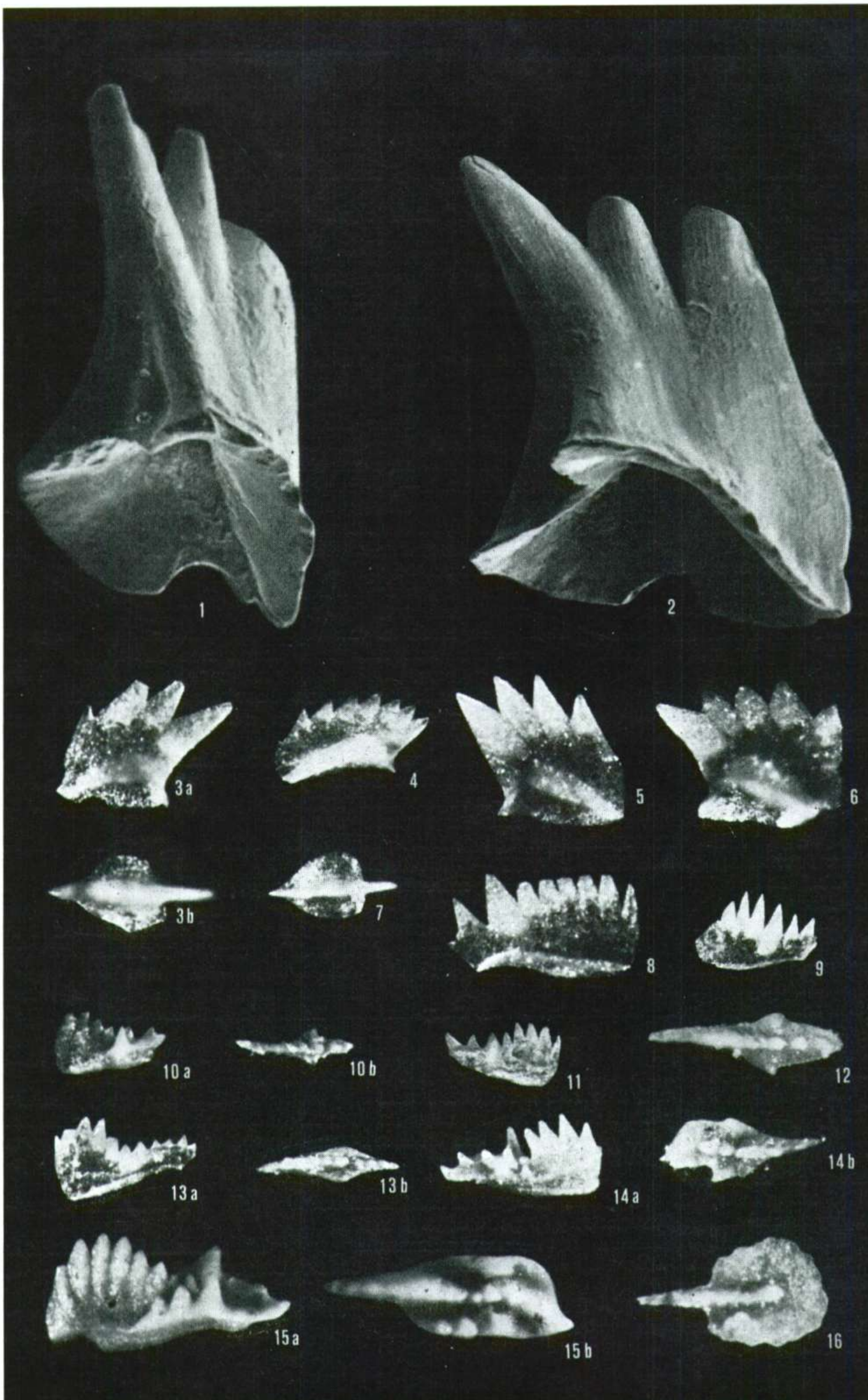
10—12 ***Metapolygnathus bidentatus*** (Mosher); figs. *10 a, 11*: lateral view; figs. *10 b, 12*: upper view; all from the upper ***Metapolygnathus bidentatus*** conodont zone (Middle Sevatian) of Silická Brezová (Silica nappe, Slovakian Karst); fig. *10*: platform quite reduced, only lateral denticles are present, sample S 1, 60 ×; figs. *11, 12*: platform still well developed, sample S 19, 100 ×.

13 ***Metapolygnathus mosheri*** (Kozur & Mostler), *a*) lateral view, *b*) upper view; upper ***Metapolygnathus bidentatus*** conodont zone (Middle Sevatian), Silická Brezová (Silica nappe, Slovakian Karst), sample S 17, 60 ×.

14 ***Metapolygnathus posterus*** (Kozur & Mostler), *a*) lateral view, *b*) upper view, middle ***Metapolygnathus bidentatus*** zone (Lower Sevatian), Silická Brezová (Silica nappe, Slovakian nappe, Slovakian Karst), sample S 30, 60 ×.

15 ***Metapolygnathus zapfei*** Kozur, *a*) lateral view, *b*) upper view, Sommeraukogel (Austria), »Hangendrotkalk«, lower ***Metapolygnathus bidentatus*** conodont zone (Lower Sevatian), 60 ×.

16 ***Metapolygnathus abneptis spatulatus*** (Hayashi), upper view of an aberrant specimen, near to the holotype of this subspecies, lower ***Metapolygnathus bidentatus*** conodont zone (Lower Sevatian), Silická Brezová (Silica nappe, Slovakian Karst), sample S 16, 60 ×.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