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Stratigraphic and environmental correlations in the Fatra- and Norovica-Formation (Upper Triassic, Western Carpathians)

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4 text-figs.

Abstract

Two formations of several Upper Triassic developments in the Western Carpathians are compared: the Fatric restricted marine basin has been bounded by extensive shallows in the Hronic, where Norovica Fm. originated. Though both the formations have several common features (biogenic carbonate sediments arising in a hot climate with periodic violent storms under slow transgressive conditions etc.), they differ in some principal characteristics.

The informal and formal lithostratigraphical division and the most important biostratigraphical features are dealt more in detail.

1. Introduction

Both the Fatra- and Norovica-Formations, produced by shallow marine carbonate sedimentation, represent two of the principal development patterns of West Carpathian top Triassic sedimentary sequences (compare Fig. 1).

The development of the uppermost Triassic sediments in the Fatric has been previously named "Koessener Schichten", or simplier, but incorrectly "Rhaetian". Later, in 1974 it has been entitled by J. MICHALÍK as "Fatra-Schichten". Its type profile has been described by J. MICHALÍK in 1976 in the Dedošova dolina — valley in Vel'kā Fatra Mts. The same author formerly regarded the "Fatra-Member" and "Hybe-member" as two (partially synchronous) members of the so-called "Carpathian Koessen Formation". Later (in J. MICHALÍK et al., 1979 etc.) he has recognized that it is more reasonable to consider this Fatra-complex as an independent formation.

2. Lithostratigraphy

The average thickness of the Fatra-Fm. is nearly 30 meters (while in the nearshore it reaches hardly 16 meters, it exceeds 40—50 meters in the maximum subsidence zones). All the Fatra Fm. sequence consists of dark detrital (brecciated to organodetrital and broken shelly limestones), organogene (crinoidal, coralligenous, porifera-bearing, shelly bivalve and brachiopodal, gastropodal and foraminiferal limestones) and chemogeneous (micrital to oolite limestones and dolostones)

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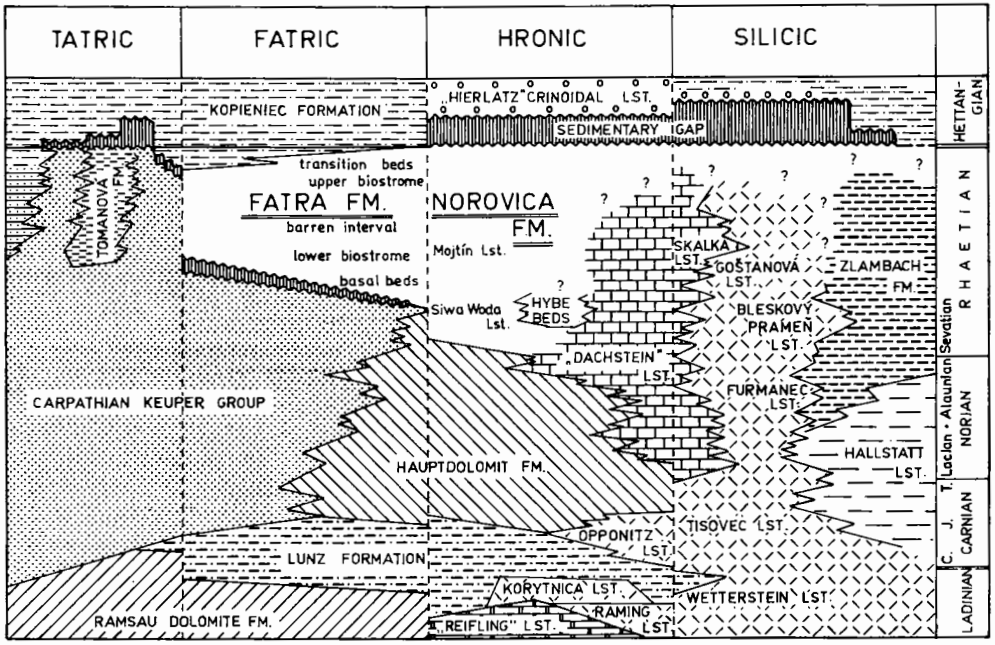

Fig. 1 : Schematic lithostratigraphic table of the West Carpathian Upper Triassic.

rocks with sporadic terrigeneous intercalations (marls, claystones and siltstones). The prevailing part of the detritus has been derived from skeletons of the organism, which have lived in a proper sedimentary basin.

The lithological horizons occur in cycles beginning with clastic to organogene and oolitic limestones. Some of the preserved cycles are terminated with a marly or even dolomite horizon. Almost every new cycle begins with out-washing. This fact, combined with irregular space development of individual horizons leads to the origin of a very complicated and variable sequence, the thickness of the whole sedimentary column being reduced to a fraction of the possible value (compare Fig. 2).

Thus, the preserved Fatra-Formation sequence is a very incomplete record of the upper Triassic sedimentation. This is the reason why the profiles can only be correlated with each other with difficulty. To solve its stratigraphy is an especially intricate problem. As known, the lithofacial sequence has recently been divided (J. MICHALÍK et al., 1979, A. GAŹDZICKI et al., 1979) into several informal members (Fig. 2).

1. Basal beds are characterized by the shelly—limestone sequence with slight terrigeneous supply and with bivalve fauna (*Chlamys favrii tatrica*, *Ch. winkleri*, *Modiolus minutus*, *Neoschizodus* sp. etc.) and foraminifers (*Trochammina alpina*, *Agathammina* sp., *Nubecularia* sp., *Ophthalmidium* sp. etc., cf. J. MICHALÍK et al., 1979).

This development is typical of the so-called "Swabian facies" of E. SUESS and E. OPPEL, 1856.

2. The lower biostromatic member contains two or more sedimentary cycles. The basal horizon of each of them can be developed in the facies, similar to the

"basal beds". The bioclastic limestones above it, passing into coralligenous (with *Pinacophyllum* sp., *Stylophyllum gracile*, *Phacellostylophyllum medium*, *Ph. robustum* etc.), poriferal, algal, megalodon-bearing (*Conchodon infraliassicus*, *C. goeteli*, *Rhaetomegalodon tatricus* etc.), gastropodal, foraminiferal (*Agathammina austroalpina*, *Ammodiscus incertus*, *Tetrataxis inflata* etc.) and brachiopod-bearing limestones (*Rhaetina gregaria*) are most frequent. The definition of this member is close to the "Carpathian facies" of E. SUESS, 1868 with several "Lithodendronkalk" (= coral limestone) intercalations.

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

4. The upper biostrome member is very similar to the lower one; it also contains several sedimentary cycles. However, its corals, foraminifers, and other fauna are slightly different (cf. J. MICHALÍK et al., 1979).

5. The transition beds contain several uncommon lithological horizons: muddy limestones with nodular bedding planes and ostracodal fauna; distinct, often redeposited oolitic layers; bivalve shelly limestones with "mixed" Rhaetian and Hettangian bivalve fauna (*Cardinia* sp., *Chlamys valoniensis*, *C. dispar* together with *Rhaetavicula contorta* and *Placunopsis alpina*) and foraminifera *Ammodiscus multivolutus* and *Trocholina multispira*.

All the Fatra Formation lies transgressively on variegated Carpathian Keuper deposits, being covered by marine shales of Kopieniec Formation, Lower Jurassic in age.

The uppermost Triassic deposits of the Choč unit in the Hronic are very inclompletely preserved, as they have undergone considerable erosion. They consist mostly of reddish light grey to grey compact organogene and organodetrital limestones, resembling the Dachstein limestone in lithology. Range of their distribution is the northwestern part of Strážovské vrchy Mts., Malé Karpaty Mts. and Western Tatra Mts. This sequence is largely different from its time equivalent in the Tatric and Fatric units, displaying a continuous sedimentary transition from the underlying Hauptdolomit, while it is transgressively overlain by Lower Liassic crinoidal limestones. A. GAŻDZICKI and J. MICHALÍK 1980 suggested a new name — Norovica Formation for this lithostratigraphical unit. There are three members distinguishable in the Norovica Fm. according to the nature of the sedimentary sequence, microfacies and fauna (cf. Fig. 3).

The lowermost unit, distinguished by GAŻDZICKI and MICHALÍK 1980 is a somewhat problematic horizon of dark grey micritic limestones without fauna, in tectonic contact with overlying members.

The Siwa Woda Limestone Member includes grey, compact, sandy biopelsparite limestones with abundant Rhaetian conodonts (*Misikella posthernsteini*) and foraminifera (*Aulotortus friedli*). The type section of this unit is at the foot of Siwiańskie Turnie in the Chocholowska Valley. The member attains some 180 cm in thickness.

The Mojtín Limestone Member is the basic subunit of the Norovica Formation. It comprises reddish light- to dark-grey micritic, oolitic to organodetrital limestones with abundant brachiopods, bivalves, corals and rich and diverse foraminiferal involutinid associations, dominated by *Triasina hantkeni*. The name

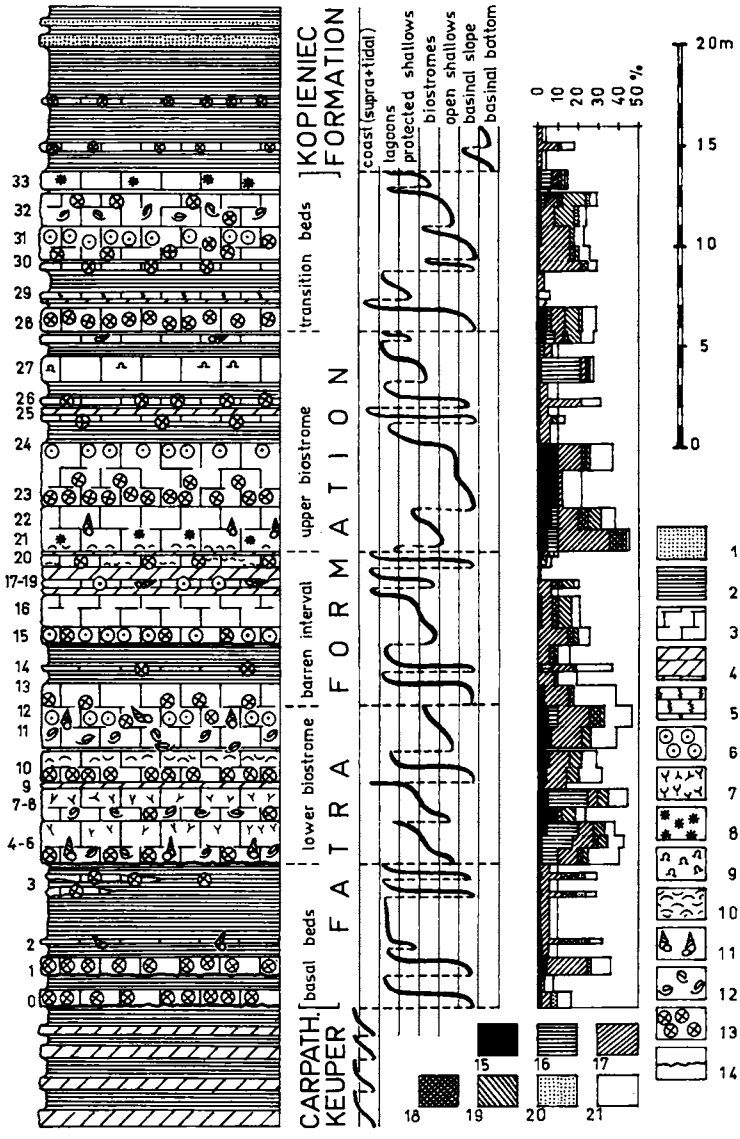

Fig. 2.: Lithostratigraphy of the Fatra Formation based on the Híreška section. First column: lithology; second one: sedimentary environments and their changes; third column: percentage share of organisms. Explanations 1 — 14: lithology: 1-sandstones, 2-shales, 3-fine detritic limestones, 4-dolomites, 5-marly ("lateritic") limestone, 6-oolitic limestone, 7-algae, 8-corals, 9-porifers, 10-bivalves, 11-gastropods, 12-brachiopods, 13-crinoids, 14-erosional surfaces. 15—21: groups of organisms (3. column): 15-forams, 16-reef builders, 17-bivalves, 18-gastropods, 19-brachiopods, 20-ostracods, 21-crinoids.

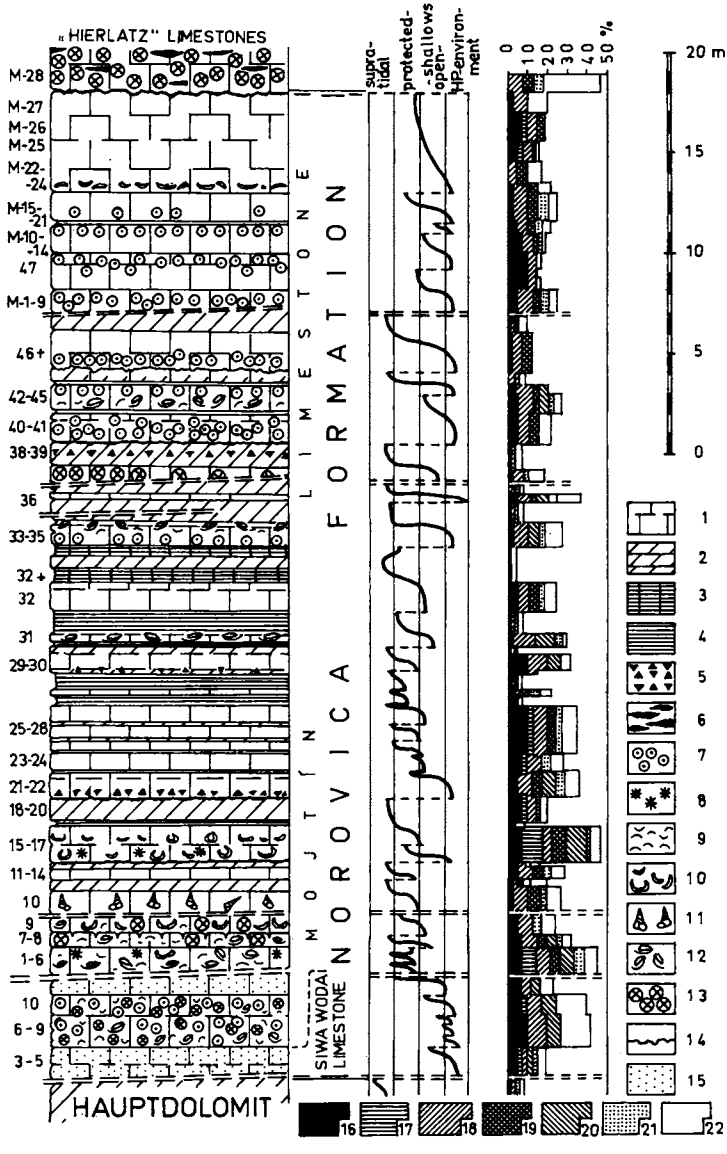

Fig. 3.: Lithostratigraphy of the Norovica Formation based on the Tŕstie section. First column: lithology; second column: sedimentary environment changes; third column: percentage share or organic skeleton fragments in sediment. Explanations 1—15: lithology: 1-micritic and fine detrital limestones, 2-dolomite, 3-marlstone, 4-shales, 5-breccia, 6-cherts, 7-oolitic limestone, 8-corals, 9-bivalves, 10-megalodon limestone, 11-gastropods, 12-brachiopods, 13-crinoids, 14-erosional surfaces, 15-limestone with fine detrital quartz. 16—22: groups of organisms (for 3. column): 16-forams, 17-reef builders, 18-bivalves, 19-gastropods, 20-brachiopods, 21-ostracods, 22-crinoids.

of the member is derived from the Mojtínska valley in the Strážovské vrchy Mts. The upper boundary of the member coincides with the upper boundary of the whole Norovica Fm. This member attains up to 50 m thickness and occurs in all the geological sections investigated in the West Tatra and Strážovské vrchy Mts.

3. Biostratigraphy

The study of the Rhaetian biostratigraphy in the Western Carpathians is extremely difficult. *Rhaetavicula contorta*, originally defined as the Rhaetian index-species, has a too wide stratigraphical range. The ammonite *Choristoceras marshi* has not been found in the Western Carpathians as yet. A parastratigraphical correlation (as suggested by S. J. MORBEY 1975) has been made in the Tomanová Fm. in the Fatric (see E. PLANDEROVÁ in J. MICHALÍK et al., 1976) and in one section of Fatric in the West Tatra Mts. (see E. PLANDEROVÁ in A. GAŹDZICKI et al., 1979). The first palynostratigraphical data from the Carpathian Keuper Group indicated a Rhaetian age for its uppermost part (lower part of *Choristoceras marshi* Zone?). On the basis of all the data obtained from the Fatra Fm. we can estimate its age to be probably younger than the lower part of *C. marshi* Zone, and older than the base of the Liassic (Hettangian).

Slightly better results have been obtained by studying the Norovica Fm. stratigraphy. The Siwa Woda Limestone yielded an extremely rich collection of the latest Rhaetian conodonts *Misikella posthernsteini* and *M.* sp. The abundant occurrences of *Triasina hantkeni* in the Mojtín Lst. allow this member to be assigned to the "upper" Rhaetian, comparable with the Fatra Formation.

4. Sedimentary conditions

Both the formations mentioned bear marks of warm and dry subtropical climate with occasional storm periods. As to present knowledge the Fatra Fm. is believed to be deposited in a partially isolated sea basin with normal to slightly raised salinity. The average depth in the shallows was 0—15 meters (as indicated by the oolite distribution studies by MICHALÍK 1978), the coral biostromes grew in depths between 2 and 50 meters, the oxygen deficit level ran probably about 100 m below sea level. A broad lowland of a flat arid basin with terrigeneous sedimentation separated this sea basin from the continental interior. A different tectonical activity and different subsidence of the sea bottom segments have been caused by synsedimentary transversal faults. The highly unstable Fatra Fm. environment favoured the opportunistic bottom dwellers: this is the reason why most of the Fatra Fm. communities belonged to the immature communities category.

On the other hand, the lithostratigraphical sequence of the Norovica F. represents a narrower range of environments and bears no marks of such great oscillations. The majority of lithofacies belong both to the protected- and open shallows environments. The faunal list is much more complete, although not as rich as the one of the Hybe Beds. This fact fits very well with the assumption of increasing faunal diversity from the isolated basins to the open sea passage (ROLLINS and DONAHUE, 1975). Several organisms illustrate this tendency very well by their distribution: for example brachiopods (MICHALÍK, 1977, 1979), worms (MICHALÍK and ZIEGLER, 1980), bivalves, foraminifera (MICHALÍK, 1980) etc. These features have also been discussed by MICHALÍK and JENDREJÁKOVÁ, 1978.

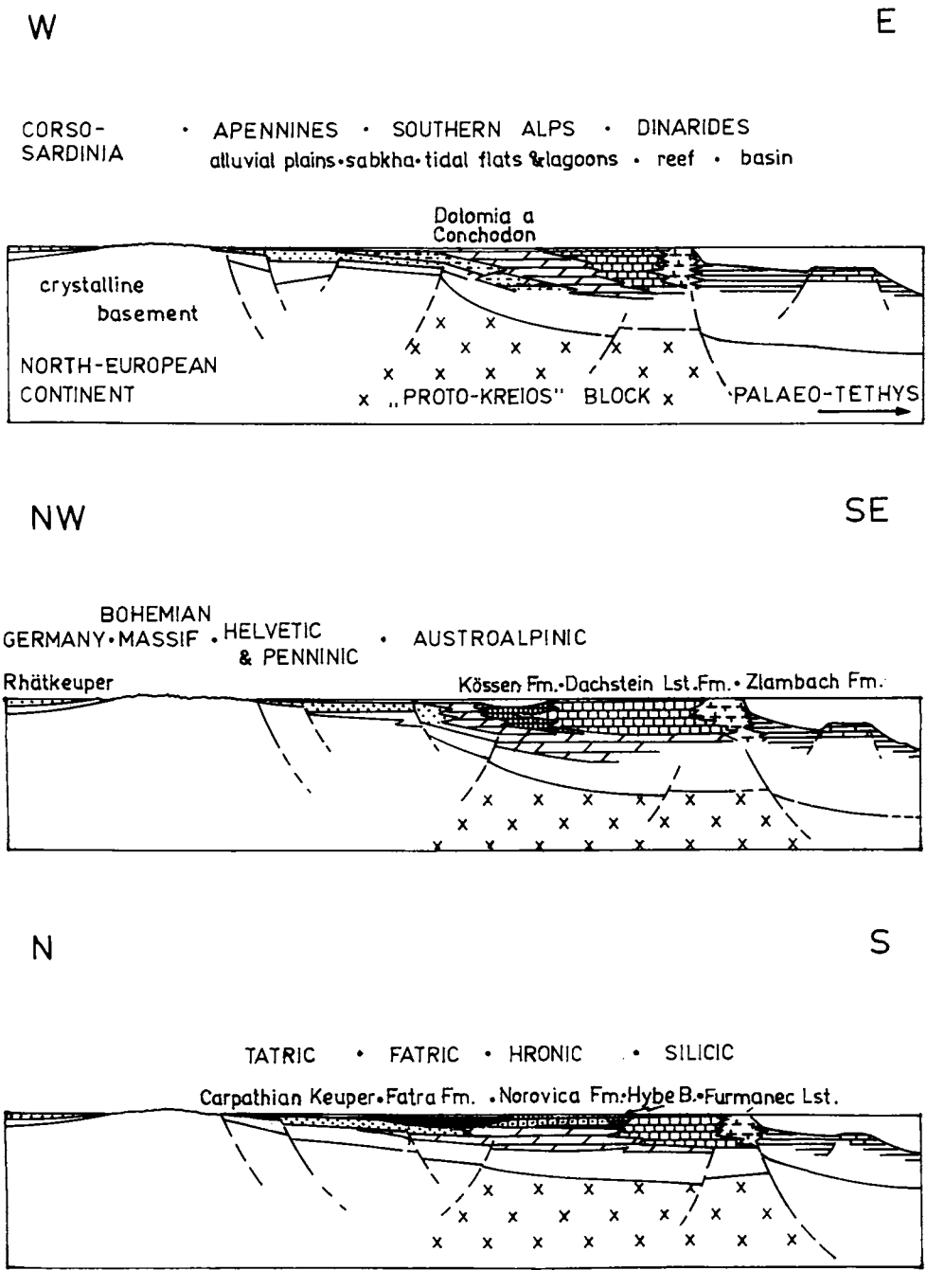

Fig. 4: Schematic paleogeographic profiles through the Late Triassic deposits of the northwestern Tethyan shelf area. Upper: central Mediterranean area (according to Laubscher and Bernoulli 1977, modified); in the middle: Alpine area; lower profile: West Carpathian area. Idealized, not to scale, vertical dimension exaggerated.

5. Comparisons

The position of the above mentioned formations in the uppermost Triassic palinspastic section is interpreted schematically in the Fig. 4. The majority of the West Carpathian Triassic formations seem to be clearly reduced when compared with equivalent Alpine sedimentary units, even more than expressed on the scheme.

The Fatra Fm. basin lay close to the boundary zone between the realm of North-European continental terrigeneous influence ("Germanic Triassic") and a stable belt of permanent shallow reef-lagoonal facies, which could indicate the existence of an "ancestor" of TOLLMANN's (1978) Jurassic-Cretaceous "Kreios" block. The Fatra Fm. basin had probably a more external position than the isochronous Alpine Koessen Fm. basin. The relic-like occurrence of the Hybe Beds in the Hronic could have had some connection with eastern extensions of the latter area. However, the recognition of their detailed litho- and biostratigraphy needs further investigations. The Fatra Fm. was deposited in a shallow isolated sea embayment with small subsidence and with rich, but little-diversified marine benthic fauna. Skeletal fragments of benthic animals form about 31% of the whole sediment volume. As can be seen from the following table, the reef builders (algae, porifera and corals) are the third dominating group of the fauna beside the bivalves and crinoids.

Fatra Formation (Híreška section)

bivalves	32 %
crinoids	22 %
reef builders	14 %
forams	13 %
brachiopods	8 %
gastropods	7 %
ostracods	3,5%
other groups	1,5%

Norovica Fm. (Tŕstie section)

forams	23 %
bivalves	22,5%
crinoids	22 %
gastropods	10,5%
ostracods	10 %
brachiopods	7 %
reef builders	2,5%
other groups	2,5%

The Norovica Fm., on the other hand, is a shallow threshold-like development, related to the Dachstein Lst. development. The former formation is typified by its reduced thickness, frequent oscillations, expressed in dolomite intercalations, abundance of oolitic limestone layers and further attributes. Organic fragments form about 26% of all the sediment volume. Apart from bivalves and crinoids the foraminifera are dominant, but gastropoda and ostracoda are also important components of the fauna.

Thus, the top Triassic development of the Western Carpathian area has some pecularities when compared with more westerly segments of the northern Tethyan shelf. They were probably caused by transversal fault tectonics, small subsidence rate and slightly different tectonic history, connected with a position of the West Carpathian segment in the late Triassic tectonic situation. All these pecularities are well recorded in sedimentary columns of both the Fatra- and Norovica Formations.

6. References

GAŹDZICKI, A., MICHALÍK J., PLANDEROVÁ E., SÝKORA M., 1979: An Upper Triassic — Lower Jurassic sequence in the Krížna-nappe (West Tatra Mts., West Carpathians, Czechoslovakia). Záp. Karp., Geol. (Bratislava), 5., p. 119—148.

GAŹDZICKI A., MICHALÍK J., 1980: Uppermost Triassic sequences of the Choč-nappe (Hronic) in the West Carpathians of Slovakia and Poland. Acta geol. Polon. (Warszawa), 30, 1., p. 61—76.

LAUBSCHER H. P., BERNOUILLI D., 1977: Mediterranean and Tethys. In: The ocean basins and margins. Plenum Publ. Co., N. York—Toronto—Washington, vol. 4 A., p. 1—28.

MICHALÍK J., 1974: Zur Paläogeographie der Rhätischen Stufe des westlichen Teiles der Krížna-Decke in den Westkarpaten. Geol. zb. Geol. Carp. (Bratislava), 25, 2., p. 257—285.

MICHALÍK J., 1976: Characteristic profile through the Fatra member of the highest Triassic, Krížna nappe in the closure of Dedošova valley (Gaderská dolina, Vel'ká Fatra). (In Slovak, Engl. res.) Kmetiánum (Martin), 4., p. 125—143.

MICHALÍK J., PLANDEROVÁ E., SÝKORA M., 1976: To the stratigraphic and paleogeographic position of the Tomanová Formation in the uppermost Triassic of the West Carpathians. Geol. zborn. Geol. Carpath. (Bratislava), 27, 2., p. 299—318.

MICHALÍK J., 1977: Paläogeographische Untersuchungen der Fatra-Schichten des nördlichen Teiles des Fatrikums in den Westkarpaten. Geol. zborn. Geol. Carpath. (Bratislava), 28, 1., p. 71—94.

MICHALÍK J., 1978: To the paleogeographic, paleotectonic and paleoclimatic development of the West Carpathian area in the uppermost Triassic. In: Paleogeografický vývoj Západných Karpát. Bratislava, GÚDŠ, p. 189—211.

MICHALÍK J., JENDREJÁKOVÁ O., 1978: Organism communities and biofacies of the Fatra Fmt. (Uppermost Triassic, Fatric) in the West Carpathians. Geol. zborn. Geol. Carpath. (Bratislava), 29, 1., p. 113—137.

MICHALÍK J., 1979: Paleobiogeography of the Fatra Formation of the uppermost Triassic of the West Carpathians. Paleont. konf. 77, kat. paleont. UK (Praha), 1978., p. 25—39.

MICHALÍK J., JENDREJÁKOVÁ O., BORZA K., 1979: Some new Foraminifera species of the Fatra Formation (uppermost Triassic) in the West Carpathians. Geol. zborn. Geol. Carpath. (Bratislava), 30, 1., p. 45—60.

MICHALÍK J., 1980: A paleoenvironmental and paleoecological analysis of the West Carpathian part of the northern Tethyan nearshore region in the latest Triassic time. Riv. Ital. Paleont. (Milano), 85, 3—4., p. 1047—1064.

MICHALÍK J., ZIEGLER V., 1980: Late Triassic serpulids (Annelida, Polychaetia) in the West Carpathians. Geol. zborn. Geol. Carpath. (Bratislava), 31, 4., p. 627—640.

MORBEY S. J., 1975: The palynostratigraphy of the Rhaetian stage, Upper Triassic in the Kendelbachgraben, Austria. Palaeontogr. (Stuttgart), B 152, 1—3., p, 1—75.

ROLLINS H. B., DONAHUE J., 1975: Towards a theoretical basis of paleoecology: concepts of community dynamics. Lethaia (Oslo), 8., p. 255—270.
OPPEL A., SUESS E., 1856: Über die muthmasslichen Aequivalente der Koessener Schichten in Schwaben. Sitzungsb. Ak. Wiss. Wien, Math.-Nat. Cl. 21, p. 335—549.
SUESS E. & MOJSISOVICS E., 1868: Studien über Trias- und Jura-Bildungen in den östlichen Alpen II: Gebirgsgruppe des Osterhorns. Jahrb. geol. Reichsanst. (Wien), 18., p. 1—167.
TOLLMANN A., 1978: Plattentektonische Fragen in den Ostalpen und der plattentektonische Mechanismus des mediterranen Orogens. Mitt. österr. geol. Ges. (Wien), 1976, 69., p. 291—351.