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THE MIDDLE AND UPPER TRIASSIC OF THE STRATENSKÁ HORNATINA MTS. AND ITS RELATION TO THE TRIASSIC OF THE SLOVAK KARST SILICA NAPPE (THE WEST CARPATHIAN MTS., SLOVAKIA)

(Figs. 3)

A b s t r a c t: The Stratenská hornatina Mts. Triassic ("the North Gemeride Mesozoic") has been revised lithostratigraphically as well as biostratigraphically. The Middle Triassic is represented mainly by deposits of the shallow water platform (Gutenstein beds, Steinalm limestone, Wetterstein limestone — dolomite). Basinal deposits are limited to the Upper Illyrian (Schreyeralm, Reifling limestones). The Upper Triassic is represented by facies of the shallow water platform (Tisovec, Furmanec, Dachstein limestones), basinal deposits are limited to the Julian substage (Trachyceras, Reingraben, Mürztal beds) and mainly to the Norian stage. Lateral equivalents of the Furmanec limestone are the Aflenz and Dešťanky limestones (a new informal lithostratigraphic unit).

According to distribution of individual Middle and Upper Triassic facies, the Stratenská hornatina Mts. Triassic can be taken for an equivalent of the Hallstatt facies area, where the shallow water platform was followed by the "Aflenz channel" from the North and by the "Hallstatt channel" from the South, the northernmost part of the latter being represented by the southernmost part of the Slovak Karst Silica nappe Triassic. Thus, the Stratenská hornatina Mts. Triassic is not the eastern part of the Muránska plošina pl. Triassic, as it has been traditionally believed until recently.

Р е з ю м е: Триас Стратенского погорья („северный гемеридный мезозой") был литостратиграфически и биостратиграфически ревизован. Средний триас представлен особенно осадками мелководной платформы (гутенштайнские пласты, штайналмский известняк, веттерштайнский известняк — доломит). Котловинные осадки ограничены лишь на верхний илир (шраералмский известняк, райфлингский известняк). Верхний триас представлен фациями мелководной платформы (тисовецкий, фурманецкий и дахштайнский известняки), котловинные осадки ограничены на юльский подъярус (трахицеровые, райнграбенские и мурцалские пласты), а именно на норийский ярус. Латеральными эквивалентами фурманецкого известняка являются афленцкий и дештянковый известняки (новая неформальная литостратиграфическая единица).

Согласно распределению отдельных фаций среднего и верхнего триаса, триас Стратенского погорья можно считать эквивалентом галлштатской фациальной области, в которой мелководную платформу в фации гохшваб окаймлял с севера „афленцкий канал" и с юга „галлштатский канал", северная часть которого представлена самой южной частью триаса силицового покрова Словацкого карста. Таким образом триас Стратенского погорья не является восточным продолжением триаса Муранской равнины, как до сих пор передавалось.

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The Stratenská hornatina Mts. Triassic is an almost exclusive representative of the Mesozoic following from the North the younger and the older Paleozoic of the tectonic unit of the first order known under the name of the "Gemericum". Therefore, in publications it is often referred to as "the North Gemeride Mesozoic" (M. Maheľ, 1955, p. 70). In addition to the Mesozoic of the Stratenská hornatina Mts., it includes also the Mesozoic of the Muránska plošina pl. and that of the Galmus Mts.[1] Its relation to its underlier has not been explained sufficiently[2], in difference from the Mesozoic of the Muránska plošina pl. which is a very distinct nappe lying on the metamorphosed Mesozoic of the Veporicum (Z. Pouba, 1951; J. Bystrický, 1959). Similarly, its relation to the Triassic of the Muránska plošina pl. ("the Muráň series" in M. Maheľ, 1964 p. 396) has not been explained yet either, its relation to the Triassic of the Slovak Karst Silica nappe ("the South Gemeride Mesozoic" in M. Maheľ, 1957 a p. 117) even the less. That is, on one hand, their facies as well as tectonic independence is stressed (D. Andrusov, V. Zoubek, 1953 p. 556; M. Maheľ, 1956—1980; S. Kovács, 1980), on the other hand their facies (J. Bystrický, 1972 p. 308) or facies and tectonic (D. Andrusov, 1975 p. 107) unity is stressed.

Despite the fact that the Triassic of the Stratenská hornatina Mts. is of a special significance due to redefinition of the "Gemericum" and problems of the West Carpathians Mts. innermost area tectonics and paleogeography connected with it (proved also by an increasing number of publications dealing with the subject), almost no attention has been paid to it in the recent twenty years. Thus, the only source of information about its stratigraphy and facies is the monograph by M. Maheľ (1957 c, 1958), later partly revised (M. Maheľ, 1964, 1967, 1968). All recent paleogeographic interpretations of its sedimentary area and correlations of it with facies areas of other tectonic units of the West Carpathians Mts. Triassic, mainly with the Strážov nappe, as well as with facies areas of the Triassic of Upper East Alpine nappes of the Northern Calcareous Alps (the N. C. A.) (D. Andrusov, 1968; A. Tollmann, 1972 a, 1975, 1976 a, b; M. Maheľ, 1979) are based on it.

The Triassic of the Stratenská hornatina Mts. characterized as follows: „it has all fundamental characteristics that distinguish other units, i. e. specific lithology and stratigraphy, specific position in the structural plan of the Inner Carpathians ..." (M. Maheľ, 1974 p. 129) has not been documented by a geological map yet (with exception of the hatched map by M. Maheľ, 1957 c, 1958). Selected parts of his revised geological map published recently (M. Maheľ, 1969 a, b, 1971, 1976) do not allow to make a picture about relations of

[1] Sometimes also the Triassic of the so called "Vernár stripe", "Vernár partial nappe" (J. Bystrický, 1959, 1973; M. Maheľ, 1964, 1968, 1975).

[2] M. Maheľ 1953—1963): the "autochtonous North Gemeride syncline", V. Zoubek (1955) the "Spiš nappe", M. Maheľ (1965 a, b): "Besník-Decke", "Besník-nappe", M. Maheľ (1968): "The North Gemeride unit of the nappe character in the W.", M. Maheľ (1974 p. 129): "The North Gemeride unit has for the most part a subautochtonous position". At present, it is taken for the Silica nappe N. part overthrusted from the Lubeník—Margecany suture from the N. to the S. (D. Andrusov, 1975), as well as for an individual tectonic unit called the "Gľac nappe" (J. Mello — M. Polák, 1978) and also the "Stratená nappe" (R. Mock, 1980) belonging to the group of the Silicicum nappes (called "the group of the Gemericum nappes" before — A. Biely — J. Bystrický — O. Fusán, 1968).

respective lithostratigraphic units, to test reliability of biostratigraphic data, let out the reliability of tectonic profiles published. M. Maheľ (1967, 1968) published a list of fauna of almost each lithostratigraphic unit. Thus it would seem, the age of almost each is biostratigraphically proved. However, they are only summed lists made up of taxonomically unrevised fauna of previously published localities (1956, 1957, 1958) supplied with new data only in few cases. Yet, it is not possible to find out whether these represented new findings or a partial taxonomic revision of older findings of fossils.

As I have already indicated (J. Bystrický, 1973 p. 66, 1978) not all biostratigraphic data are related to those lithostratigraphic units from which they are reported or determination of fossils may be incorrect. E. g. "Anisian" brachiopods should occur in the limestone ranked after stratigraphic revision to the Carnian age, "Middle Anisian" brachiopods are to occur in the same beds which are taken for Carnian after bivalves, "Anisian" corals and hydrozoa in pale limestones of the Carnian and the Norian, etc.

The above differences, as well as not always suitable criteria in definitions of lithostratigraphic units have lead me to revision of biostratigraphic data and lithostratigraphic divisions of the Middle and Upper Triassic. The results submitted here are not complex (they are based mainly on microfossils — J. Bystrický et al., in press) and they are not documented by a detailed microfacies or sedimentologic analysis; however, I believe even this stage of our investigation will contribute to the solution of the above paleogeographic and tectonic problems of the mountains so picturesque that they are called also the Slovak Paradise.

For better intelligibility and facilitation of correlation with other facies areas of the West Carpathians Mts. or the N. C. A. Triassic, I shall use terminology of informal lithostratigraphic units of the N. C. A. Triassic used also in Carpathian publications.

Lithostratigraphy

Gutenstein beds

(syn. "Klaus-Kalk", M. Maheľ, 1956 p. 59, 1958 p. 29; "the basal grey dolomites", "the dark thick-bedded and massive limestones", M. Maheľ, 1968 p. 263).

At present, the Gutenstein beds are the least studied lithostratigraphic unit of the Stratenská hornatina Mts. It consists of dark to black, in some parts also paler massive as well as bedded limestones with alternating differently thick levels of dolomitic limestones and bedded dolomites. The latter completely prevail in some profiles. At present, the only fossils known from them are dasyclads *Physoporella cf. praealpina* PIA, which I found in dark bedded limestones building the uppermost part of the bed sequence, almost under the Steinalm limestone in the profile Kolísky (J. Bystrický, 1973 p. 61).

They belong probably to the Aegean and the Bithynian stage according to their position between so called "Campil beds" of the Spathian (a non Campil Member of the Southern Calcareous Alps, ranked to the Nammalian) and the Steinalm limestone (the Pelsonian — Illyrian). Yet, their lowermost parts may well belong, similarly as in the Alps or Dinarides, to the Upper Spathian

(L. Krystyn, 1974; H. Mostler — R. Rossner, 1977 p. 15). However, their upper boundary hardly exceeds the Bithynian. M. Maheľ's (1967 p. 423) supposition that the Gutenstein beds are overlain by dark cherty limestones with ammonites of the Illyrian has been proved wrong. The cherty limestone (an equivalent of the Reifling limestone) does not overlie the Gutenstein beds but the ones of the Steinalm limestone. Unfortunately, the fauna of ammonites described by V. Kollárová-Andrusová (1964) cannot be used for age determination either of the Gutenstein beds or the Reifling limestone. The locality of her findings is unknown.[3]

Steinalm limestone

(syn. "weisse anisische Kalke", M. Maheľ, 1956 p. 59, 1958 p. 29; "the white, white-grey and pinkish limestones", M. Maheľ, 1968 p. 263).

The Steinalm limestone of the Stratenská hornatina Mts. is identical with that of different Triassic areas of Slovakia (J. Bystrický, 1972 p. 296 and ff.). Due to the fact that the fauna of ammonites (the locality Za Vyšné Rovne in M. Maheľ, 1958 p. 31) as well as that of brachiopods (the locality Červený Štros in M. Maheľ, 1958 p. 30) and also that of corals and hydrozoa (the locality Unter Garten, Ober Garten in G. Kolosváry, 1957, 1958, 1963, in M. Maheľ, 1957 c p. 50, 149, 1958 p. 30, 119) included in the summed list of the "pale to white limestones of the Anisian" (M. Maheľ, 1967 p. 423) in reality occur in different lithostratigraphic units, the Steinalm limestone is documented only by the flora of dasyclads and the fauna of foraminifers (J. Bystrický, 1973 p. 61; J. Bystrický et al. in press). Of the dasyclads, it is mainly:

Physoporella pauciforata v. *pauciforata*, *Ph. pauciforata* v. *undulata*, *Ph. pauciforata* v. *gemerica*, *Ph. pauciforata* v. *sulcata*, *Physoporella dissita*, *Ph. cf. praealpina*, *Oligoporella pilosa* v. *pilosa*, *Oligoporella pilosa* v. *intusannulata*, *Favoporella annulata*[4].

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[3] V. Kollárová-Andrusovová (l. c.) reports ammonites, according to M. Maheľ's data, from dark cherty limestones of the Čertova dolina valley N. slope. M. Maheľ (1967 p. 423) reports them from "dark cherty limestones" which are to be the uppermost part of a "dark bedded and massive limestones" bed sequence (i. e. what we take for the Gutenstein beds); however, he does not mention them in his publication of 1968 and he writes as follows: „dark thick-bedded and massive limestone. The ammonites *Flexoptychites flexuosus* (MOJS.) and *Arthaberites alexandrae* DIENER indicate that in place this complex persists up to Illyrian".

The term Gutenstein beds is used here in sense of A. Tollmann (1972 p. 80, 1976 p. 77) as the name of an informal lithostratigraphic unit corresponding to the category of Formation including lithostratigraphic units of the lower order, such as the Gutenstein limestone, the Gutenstein dolomite, the Annaberg limestone, the Annaberg dolomite. We refuse the term „Klaus Kalk" (the Klaus limestone) not only because of the priority (Lex. strat. intern. Fasc. 8, Autriche, p. 244), but also because it is not an individual lithostratigraphic unit. It has been described under the name of the Gutenstein limestone, the Gutenstein dolomite from almost all West Carpathian tectonic units.

[4] As I have already mentioned (J. Bystrický, 1973 p. 61, 1974 p. 133), the specimen I originally took for *Diplopora annulatissima* (J. Bystrický, 1957 tab. VII, fig. 3 in M. Maheľ, 1958 tab. II, fig. 4) is more likely *Favopoporella annulata* SOKAČ. I have found fragments completely identical with *Favoporella annulata*

Of the foraminifers it is mainly *Meandrospira dinarica, M. irregularis, Meandrospiranella deformata,* etc.

At present, no more exact biostratigraphic data are available to determine the stratigraphic range of the Steinalm limestone. We have no evidence of it, as S. Kovács (K. Balogh — S. Kovács, 1981) has recently found in the region of North Hungary, beginning already in the Bithynian. The Steinalm limestone is overlain by the Schreyeralm limestone or by a locally developed Reifling limestone (the Upper Illyrian) or by the Wetterstein limestone in a reef facies. We have not found the horizon with *Diplopora annulatissima* that could be expected in its uppermost part, directly underlying the Wetterstein limestone, yet.

M. Maheľ (1956, 1957, 1958 p. 30) in sense of his definition of the „white Anisian limestone"[5] included into it not only the Wetterstein limestone in a reef facies, usually without dasyclads, but also those pale limestone complexes in which he found no dasyclads, mainly *Teutloporella herculea;* thus also the Tisovec and Furmanec limestones. Since he kept on applying the above criterion even after his stratigraphic revision, a greater part of the Steinalm limestone extention is incorrect in his geological map.

Schreyeralm limestone

This lithostratigraphic unit consists of an about 10—30 m thick bed sequence of white, pink and reddish bedded micritic limestones, some banks of which, as in the Slovak Karst, contain small nodules of red cherts. In the profiles we studied, they always overlie the Steinalm limestone and underlie the Wetterstein limestone in a reef facies (with sphinctozoa and corals).

Representation of this lithostratigraphic unit in the Stratenská hornatina Mts. Triassic was unknown for a long time (J. Bystrický, 1972 p. 294). Of its fossils, only *Flexoptychites flexuosus* (MOJS.) (in D. Andrusov — J. Kováčik, 1955; M. Maheľ, 1958 p. 31 sub *Ptychites flexuosus* MOJS.) is known so far, reported by M. Maheľ (l. c) from the locality Roveň (in M. Maheľ, l. c. „Za Vyšné Rovne") and conodonts from the locality SH—42 found by J. Mello on the left bank of the river Hnilec (J. Mello, 1979).

The above ammonite does not come from the Steinalm limestone, as it has been reported until recently, but from one of the Schreyeralm limestone banks. It is indicated also by the lithological character of the specimen found (in the deposit of V. Kollárová-Andrusová, Geol. Inst. of Slov. Acad. of Sc.).

Occurrence of the above ammonite, the conodont assemblage (determined by

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SOKAČ only in the Steinalm limestone and always in an assemblage with species *Physoporella* and *Oligoporella*, never in an assemblage with *Diplopora annulatissima* or *D. annulata*. That is why *I*, in difference with E. Ott (1972 a, 1972 b), take *Favoporella annulata* SOKAČ and *Diplopora annulatissima* PIA for two indepedendent species different from each other not only in their thalus structures but also in their age.

[5] M. Maheľ (1958 p. 30): „Für anisische halte ich einen Teil der weissen Kalke ohne Teutloporellen, die im Liegenden der Teutloporellenkalke liegen" (tr.: I take a part of the white limestones without *Teutloporella* underlying the *Teutloporella* limestones, for the Anisian).

R. M o c k), as well as their position in the sequence indicate the Upper Illyrian (the Parakellnerites zone sensu L. K r y s t y n — F. T a t z r e i t e r, 1981).

R e i f l i n g l i m e s t o n e

A dark to black thin-bedded, platy to slightly nodular limestone with dark chert nodules, that can be lithologically taken for an untypical Reifling limestone, occurrs only sporadically (J. B y s t r i c k ý, 1972 p. 294). At present, it is known only from the crest ridge of the hill Dubnica, North from the Čertová dolina valley. Its relation to the Schreyeralm limestone occurring with it here, is not clear. We believe that both these types of basinal sediments laterally interfinger, which occurrs quite often in the Slovak Karst, too. The Reifling limestone is underlain by the Steinalm limestone and overlain by the Wetterstein limestone in a reef facies. Since the "dark cherty limestones" occur N. from the Čertova dolina valley only in the above part of the ridge, at least a part of the ammonite fauna described by V. K o l l á r o v á - A n d r u s o v á (1964) cannot be excluded to come from it[6].

W e t t e r s t e i n l i m e s t o n e

(syn. "Teutloporellenkalke", M. M a h e ľ, 1956 p. 59, 1958 p. 32; "the massive limestones of the Wetterstein type", "the Diplopora or Teutloporella limestone", M. M a h e ľ, 1968 p. 263).

The Wetterstein limestone is not, as I have already mentioned, represented only by a lagoonal facies with *Teutloporella herculea*, as it would follow from its original name, but also by a reef facies with sphinctozoa and corals. The recent and at present also the only one finding of *Diplopora annulata* v. *annulata* in pale limestones of a scree on the meadow Spálenisko indicates that this lagoonal facies also occurrs in some places.

The dominant fossil is *Teutloporella herculea*, extremely abundant in some lenses. However, it is not convenient for a more exact age determination of the Wetterstein limestone. Occurring in mass mainly in the Ladinian though, it expands through the Carnian to the Norian (J. B y s t r i c k ý, 1967; E. O t t, 1972 a, b). Its position in the Middle Triassic sequence indicates its mass belongs to the Lower Ladinian. It is overlain by the Wetterstein dolomite belonging in its substancial part to the Ladinian stage as well.

W e t t e r s t e i n d o l o m i t e

This bed sequence generally consists of a grey, in some parts even dark to almost black, mostly massive dolomite. It is bedded in some parts only (in the uppermost one) or it is bedded into alternating dark and pale stripes. It occurrs in lense-forms and irregular bodies in the Wetterstein limestone, but it also forms an independent lithostratigraphic unit overlying the Wetterstein limestone reaching the lower boundary of the Reingraben beds or the "cherty dolomite".

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[6] M. M a h e ľ (personally in 1976) gained the ammonite fauna without any concrete data about the place and beds of its finding. It cannot be excluded that a part of it comes from several localities or from beds of different ages.

As in the Wetterstein limestone, its prevailing fossil is that of *Teutloporella herculea*. It occurrs also in mass in some parts, but usually it occurrs only sporadically and expands into the very underlier of the cherty dolomite. The dasyclads of *Andrusoporella duplicata*, indicating the Julian substage, occur in the profile Dešťanky (N. from the Dobšinská ľadová jaskyňa) in the uppermost part of the Wetterstein dolomite, i. e. in the very underlier of the Reingraben beds.

Dolomites appear also above the Reingraben beds, directly underlying the Tisovec limestone. However, they did not yield any fossils, thus their ranking to the Julian substage is based only on their positions. Since relation of these dolomites to the ones that should according to M. M a h e ľ's data (1956, 1958) underlie the "cherty limestone of the Norian" (the Aflenz? limestone in J. B y s t r i c k ý, 1972 p. 308) is not clear and a lateral transition of the Tisovec limestone to the dolomite is unknown at present, we do not use the term Tisovec dolomite for this part of Carnian dolomites.

M. M a h e ľ (1958 p. 34, 1968 p. 263) ranked a substantial part of the Wetterstein dolomites to the Carnian[7].

"T r a c h y c e r a s b e d s"

In general, the whole bed sequence 10—20 m thick consists of black marly limestones and marles. It is lithologically identical with the so called "Aon beds" of the Alps, at present most frequently called the Trachyceras beds (A. T o l l m a n n, 1976 p. 136) or also the "Aonoides beds" (T. B e c h s t ä d t et al., 1978)[8].

We recorded the bed sequence only in the forrest road in the upper part of the meadow Belá. No fossils are known from it. It is not well uncovered and only its general geological conditions make us suppose it underlies the Reingraben beds occurring here.

R e i n g r a b e n b e d s

Dark, strongly disintegrating clay shales form only a 10—20 m thick sequence. Its thickness small size, disintegration and being covered by dolomite slope debris are the reason why it can be followed only for a short distance in the field and mostly it is not possible to find up whether it consists of only one level or — as M. M a h e ľ (1958 p. 34) reports — of several ones. In the region we studied, there only one level containing intercalations of quartzy sandstones in some parts, resembling sandstones of the Lunz beds was found.

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[7] M. M a h e ľ (1958 p. 34): „Das Karn-Alter der Dolomite folgt aus iher stratigraphischen Lage im Liegenden der durch Fauna nachgewiesenen norischen Kalke und im Hangenden der ladinischen Teutloporellenkalke, bzw. Dolomite."

[8] None of the above names is suitable for the West Carpatian area. The „Aon beds" of the West Carpathians are so poor in fossils that naming this informal lithostratigraphic unit after its fossils could lead to incorrect ideas. Since I do not find introduction of a new name for an informal lithostratigraphic unit necessary, I prefer the name „Trachyceras beds" here, because rare though, *Trachyceras (Trachyceras)* sp. (V. K o l l á r o v á - A n d r u s o v o v á, 1974 p. 129) and *Trachyceras (Trachyceras) aonoides* (M. M a h e ľ, 1980 p. 61) was found in these beds of the West Carpathians Mts.

Microfauna of these beds was not studied. Since they overlie dolomites with *Andrusoporella duplicata* we find them to be of the Julian substage.

Cherty dolomite

(syn. "eine Lage dolomitischer, hornsteinhaltiger Kalke", M. Maheľ, 1958 p. 35).

It is a special dolomite type with large nodules of dark cherts. It occurrs sporadically as a 20 m thick level between the Wetterstein dolomite and the Tisovec limestone. At present, it cannot be determined whether it is an equivalent of the so called Hallstatt dolomite or the Reifling dolomite of the N. C. A. (A. Tollmann, 1976 p. 130, 185) or whether it is just a local phenomenon.

This dolomite type had been found by M. Maheľ (1956 p. 59, 1957 c p. 57). He had taken it for a lateral equivalent of the "dark Upper Triassic limestone" of the hill Matka Božia N. slope and ranked it to the Lower Norian. After his stratigraphic revision of pale limestones overlying them and ranking them from the Norian to the Carnian (M. Maheľ, 1967 p. 424) he ranked them to the Carnian, too. He does not mention them in his later publications (1968).

We rank them to the Julian substage because they directly overlie the dark dolomites with *Teutloporella herculea* (cuts in forrest roads on the hill Remiaška S. slope) and directly underlie the Tisovec limestone with brachiopods and bivalves of the Carnian (a cut in the highway near the turning to the village Hrabušice).

Tisovec limestone

(syn. the "light-coloured limestone — Upper Carnian", M. Maheľ, 1968 p. 263).

The Upper Triassic of a shallow water carbonate platform is represented by a facies of pale to white, in upper parts grey to dark grey limestones. We call its lower part consisting mostly of pale to white limestones of the Carnian the Tisovec limestone, its upper part consisting of pale but mostly dark grey to dark limestones of the Norian — the Furmanec limestone. Since they gradually transit into each other the boundary between them is lithologically indistinct and conventional. The Tisovec limestone can be well distinguished only where it is overlain by Norian basinal deposits (e. g. the profiles Dešťanky, Belá).

M. Maheľ (1956, 1957, 1958) finding out that a part of the pale massive limestones previously taken for the Wetterstein limestone of the Ladinian stage belongs to the Upper Triassic, took all Upper Triassic limestones for the Norian stage. Later he revised a part of them, previously documented by "Norian" brachiopods, too (the locality "on the right bank of the river Hnilec", M. Maheľ, 1958 p. 39) and he ranked it to the Upper Carnian (M. Maheľ, 1967 p. 424, 1968 p. 263) on the basis of brachiopod and bivalve faunas (M. Kochanová, 1963; J. Pevný, 1963) and corals (G. Kolosváry, 1963 p. 214). In addition to this part of the pale limestones which he at first had taken for the Norian (however, G. Kolosváry, 1963 p. 214 for "? the Carnian"), after the revision of his geological map and stratigraphy, he ranked the part of the pale massive limestones which he had ranked (1956, 1957, 1958) to the

Upper Anisian (Illyrian) before, to the Carnian, too (M. Maheľ in A. Klinec, 1976). However, in his publications of 1967 and 1968 (M. Maheľ, l. c.) he still considered fossils of these to the Carnian or even the Norian ranked pale massive limestones an evidence of the Anisian. It concerns corals and hydrozoa in the localities Unter Garten (Nižná záhrada) and Ober Garten (Vyšná záhrada) (M. Maheľ, 1967 p. 423) and brachiopods in the locality Červený Štros (M. Maheľ, 1967 p. 424, 1968 p. 263).

Since there are differences between stratigraphic evaluation of these limestones and their paleontological contents, I find it necessary to touch on them.

a) The region of the pale massive limestones of the crest Ober Garten (Vyšná záhrada).

G. Kolosváry described corals and hydrozoa of three localities of this region: the Unter Garten, the Ober Garten (1957, 1958) and "from the valley leading up to the Unter Garten" (1963 p. 213). In difference with M. Maheľ (1957 c, 1958), he did not take them for the Anisian, but for "? the Middle Triassic" (at that time, also the substage Cordevolian was ranked to the Middle Triassic) and he even reported *?Heterastridium conglobatum* REUSS (1957 p. 100) which was omitted in M. Maheľ's (1957 p. 149, 1958 p. 119) list of fossils. Since in the map of paleontological localities (M. Maheľ, 1957 c, 1958) it is not possible to find out which of them is the "Unter Garten" and which the "Ober Garten", we cannot find out which of them occurrs in the Tisovec and which in the Furmanec limestone[9]. However, in any case, it may be observed that the coral and hydrozoa faunas of the above localities are not Anisian, but Upper Triassic (the Upper Carnian to the Lower Norian).

b) The region of the Červený Štros pale massive limestones.

M. Maheľ at first considered the pale massive limestones of the hill Červený Štros summit part "the white Anisian limestones" and reported Anisian brachiopods from them (the locality "Červený Štros S. from the P. 1162", M. Maheľ, 1957 c p. 50, 1958 p. 30). After the revision of these limestones and their ranking to the Carnian[10] he still takes this locality fauna for evidence of the "pale Anisian limestone" Anisian age (M. Maheľ, 1967 p. 424, 1968, p. 263).

At present, no biostratigraphic data of these limestones are available to enable to determine their age more exactly. In any case, they are of the Upper Triassic, where "Anisian" brachiopods are more than improbable. Thus, these Upper

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[9] There are considerable differences between the lists of fossils from the above localities by G. Kolosváry and by M. Maheľ. There are even differences between M. Maheľ's data of 1957 (p. 149) and 1958 (p. 119). E. g. in 1957, he reports 6 coral species from the locality Unter Garten (however, without? *Heterastridum conglobatum* REUSS reported by G. Kolosváry — l. c.) in 1958, he reports only one species from the same locality, *Craspedophyllia maheli*, and he remarks: „After all, no other fauna was found in the stripe of these limestones".

[10] The text (M. Maheľ, 1968 pp. 263—264): „In the outer structure of the Stratenská hornatina the Carnian limestones are underlain by dark shaly marlstone . . .etc." referrs to the pale limestones of the Červený Štros, with a brachiopod fauna of the „Anisian stage".

Triassic limestones do not normally underlie the "Teutloporella limestones" or dolomites, as M. Maheľ (1957 c profile 22, 1958 profile 22) supposed, but they contact tectonically.

Thus, only the bivalves and brachiopods coming from the turning of the highway to Hrabušice can be taken for Tisovec limestone fossils. They were determined by M. Kochanová (1963) and by J. Pevný (1963) and summed up by M. Maheľ (1967 p. 424, 1968 p. 263). When the data about the bivalves reported by him are concerned, they have to be corrected on the basis of M. Kochanová's revision (unpublished report)[11] as follows:

a) the right bank of the river Hnilec: *Aulacothyris dualis depressa, Cruratula eudoxa, "Rhynchonella" carantana, Posidonia* sp., *Chlamys* sp.,

b) the left bank of the river Hnilec: *Leptochondria* ex gr. *vadaszsi* (or *?Chlamys (Praechlamys) broilii), ?Pleuronectites sp.*

A rich assemblage of microproblematics described by K. Borza (1975) and by K. Borza and O. Samuel (1977) also comes from this region.

The following fossils are reported from the Tisovec limestone appearing on the meadow Spálenisko: *Spiriferina halobiarum, "Terebratula" praepunctata* (J. Pevný, 1963) and *Leptochondria* cf. *tirolica* and *?Prospondylus* sp. of the bivalves (on the basis of M. Kochanová's revision).

The Tisovec limestone of the region studied is represented mainly by a reef facies so dasyclads are relatively rare there. The dasyclad assemblage that does occur in it is identical with that of the Slovak Karst Tisovec limestone: *Andrusoporella duplicata, Physoporella heraki* v. *heraki, Ph. heraki* v. *tenuipora, Uragiella supratriasica* and *Teutloporella herculea* (for more detailed data about their occurrence as well as about that of foraminifers see J. Bystrický et al. in press).

Furmanec limestone

(syn. "the massive white, whitish-grey, partly pink and motted in white-grey limestones", M. Maheľ, 1968 p. 264; "Wandkalk" A. Tollmann, 1972 pp. 195—196, 1976 b p. 471).

As I have already mentioned, pale, grey but mainly dark grey and almost black limestones of a Norian stage reef facies belong to this lithostratigraphic unit. Thus, basically they are the limestones in which M. Maheľ (1957, 1958) found the rich brachiopod fauna of the Norian stage in several localities (mainly in the limestone of the Karst pl. Geravy). Since the brachiopod fauna reported by M. Maheľ (l. c.) has not been correlated with redefined ammonite zones of the Norian or Rhaetian stage (sensu E. T. Tozer, 1979; L. Krystyn, 1980) yet, it is not possible to report its age more exactly. So far, the substage Alaunian may be suggested to be represented in it according to its ammonites *Cladiscites* cf. *tornatus, Cyrtopleurites* sp.

We take the first appearance of the dasyclad genus *Heteroporella* (J. Bystrický, 1973 p. 73) and the foraminiferal species *Trocholina permodiscoides* for the lower boundary of the Furmanec limestone. Its uppermost part is repre-

[11] Kochanová has revised taxonomy of paleontological material of 1963 dealing with bivalves recently and kindly provided me results of her revision, for which I thank her here.

sented by dark grey limestones of the pl. Geravy, containing *Heteroporella carpatica* and *Heteroporella zankli* (J. Bystrický, 1979 pp. 334, 336) of dasyclads and *Triasina hantkeni* (O. Jendrejaková in J. Bystrický et. al., 1973 p. 63) of foraminifers. To determine their stratigraphic position will be possible only after a complex evaluation of microfossils of the Bleskový prameň limestone (the village Drnava, the Slovak Karst) at present not to be taken for the Sevatian but for the Lower Rhaetian due to occurrence of the ammonite *Vandaites stuerzenbaumi* (E. Tozer, 1979 p. 17; L. Krystyn, 1980).

A dasyclad assemblage with *Aciculella nikleri, Aciculela sokači, Heteroporella carpatica, Gyroporella aff. vesiculifera, Griphoporella aff. curvata, Palaeodasycladus sp.* (J. Bystrický, 1979) and a rich foraminiferal assemblage (O. Jendrejaková in J. Bystrický et al., in press) occur in limestones of the quarry at the village Dolka containing *Cladiscites cf. tornatus and? Heterastridium conglobatum* (M. Maheľ, 1958 pp. 39—40; G. Kolosváry, 1957 p. 100). *"Macroporella" spectabilis* occurrs in the basal part of the Furmanec limestone in the profile Remiaška. Thus, the above species, so far known only from the Carnian, does not occur here in the uppermost part of the Carnian stage as I have reported before (J. Bystrický, 1979 p. 322). but with regard to occurrence of foraminifers of *Trocholina permodiscoides* as high as the basal part of the Norian. The Furmanec limestone upper part is represented by dark grey to dark limestones with *Heteroporella carpatica* and other unidentifiable endospore dasyclads.

A special assemblage of Furmanec limestone dasyclads is represented by *„Petrascula" stratenica* (J. Bystrický, 1979 pp. 330—331) occurring in the direct overlier of the limestones with *„Macroporella" spectabilis.*

M. Maheľ (1969 a, b) stratigraphically revised the upper part of the hill Remiaška limestone complex (i. e. a substantial part of our Furmanec limestone) which he had considered the Norian on the basis of brachiopods from the locality Havrania skala (1957 c p. 61, 1958 p. 38)[12] and he ranked it to the Middle Triassic; he tectonically interprets these „light coloured limestones — Middle Triassic" as thrusted over the limestones he takes for the „light coloured limestones — Rhaetic" (M. Maheľ, l. c. p. 21, profile A).

However, I found only Upper Triassic limestones in the above region; they are in the normal sequence: the cherty dolomite, the Tisovec limestone, the Furmanec limestone and the Dachstein limestone. Thus, the Lower Triassic beds in the profile Havrania skala cannot be connected with the above overthrust. If the Lower Triassic beds do occur in the profile (which has not been proved stratigraphically, neither has been the age of beds near them, marked as „Middle Anisian — dark-coloured shales, marlstones, dark-coloured limestone intercalations"[13] in the geological map) they are much more probably a part of a diapir that penetrated along a fissure to the Furmanec limestone from the bottom.

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[12] M. Maheľ (1969 a, b) does not report this locality in his geological map.

[13] J. Pevný (1963) reports *Austrirhynchia* cf. *cornigera* from the locality „West from the Havrania skala, dark limestones and shales" and according to the species takes it for the Rhaetian. Since dark shales appear only in one place of the above region, it is clear they are the beds M. Maheľ takes for the „Middle Anisian" in his geological map.

Dachstein limestone

The well-bedded pale limestones with megalodonts are in their facies (limestone breccia levels, cavity and fissure fillings) and position in the sequence identical with the Dachstein limestone of the Muránska plošina pl. (J. Bystrický, 1959; K. Borza, 1977). At present, they are known only to overlie the Furmanec limestone N. from the hill Remiaška. They may be also age equivalents (the Sevatian) of the Muránska plošina pl. Dachstein limestone. So far, the age of the pale limestones with megalodonts found in the Furmanec limestone of the crest Vyšná záhrada has not been determined.

Dešťanky limestone

We introduce this name for an informal lithostratigraphic unit of the Norian stage, named after the hill Dešťanky. It is a bed sequence of dark, in some places even black, thick as well as thin-bedded limestones with levels of grey and red-greyish spotted bedded limestones with indications of nodules and with a characteristical „tree bark" of yellow, red, green and carmine colours on surfaces of individual banks.

The unit directly overlies the Tisovec limestone in the profile Dešťanky as well as in the profile on the SSE. slope of the hill Kopa. On the contrary, it appears considerably higher in the profile on the hill Belá. Here, the Tisovec limestone is overlain at first by a bed sequence of alternating white and pinkish bedded micritic limestones gradually transiting into a bed sequence of pink to reddish bedded limestones in the hill Belá summit part. Dark bedded limestones lithologically identical with the Dešťanky limestone of the profile Dešťanky overlie the above „colourful bed sequence".

This "colourful bed sequence" considerably resembles the Hallstatt limestones of the profile Silická Brezová lower part and it would be reasonable to differenciate it from the Dešťanky limestone also in nomenclature. So far, we do not intend to do it here due to lack of data dealing with their facies relations and we shall reffer to them further as to the "colourful facies of the Dešťanky limestone".

The following macrofossils are reported from the Dešťanky limestone in publications: *Monotis* cf. *rudis* (in M. Maheľ, 1967 p. 425 sub *Monotis* cf. *hoernesi*) and *Monotis* cf. *digona* (M. Kochanová, 1963) as well as *Halorella amphitoma* (J. Pevný, 1963) included by M. Maheľ (1967 p. 425, 1968 p. 264) in his summed list of the Furmanec limestone fauna. After taxonomic revision of original specimens by M. Kochanová (unpublished report) bivalves are represented by *Monotis* sp., *Monotis* cf. *rudis* and *Halobia* sp. and they come from the Dešťanky limestone uncovered in a cut of the forrest road leading from the village Dolka to the hill Dešťanky.

Samples we studied from this profile with regard to conodonts, were almost all sterile. Only the sample no. 9 78 from a level of a light grey, slightly pinkish limestone with crinoids (and weathered brachiopods *Halorella amphitoma*, determined by J. Pevný — l. c. — seems to come from this level) contained: *Metapolygnathus bidentatus*, *Metapolygnathus posterus* and *Gondolella steinbergensis*. Pink bedded limestones of the P. Belá summit part contained the following fossils in the „colourful facies of the Dešťanky limestone": *Gondolel-*

la navicula, Gondolella steinbergensis (J. Papšová in J. Bystrický et al., in press). According to the above conodont assemblages, the sample no. 9 78 represents the Alaunian 2 IV — the Sevatian, the sample from the hill Belá the Alaunian 1 I — the Alaunian 2/IV (sensu L. Krystyn, 1980). Foraminifers of the both facies of the Dešťanky limestone are published elsewhere (O. Jendrejaková in J. Bystrický et al., in press).

In recent publications, the Dešťanky limestone has been evaluated lithologically and stratigraphically in very different ways. M. Maheľ (1957c, 1958, profile 22) had considered it „dark limestones and shales of the Anisian stage" Then, after his stratigraphic revision (1967 pp. 424—425, 1968 p. 264) he took it for the limestone described as the Furmanec limestone here. In his geological map (in A. Klinec, 1976), he defined it as the „dark limestones, partly organogenic, the Norian-Carnian(?)", but, in the geological profile (1979 c pp. 120, 127), he reports it as the "dark-coloured limestones with cherts and cherty limestones — Carnian" and takes it for identical with beds described bellow as the Mürztal beds. In the above profile, he draws them as normally underlying the "light-coloured limestones — Upper Carnian to Rhaetian" building the hill Kopa. In fact, the Dešťanky limestone normally overlies the Tisovec limestone here, which is together with the dolomites underlying it sepparated from the hill Kopa Furmanec limestone by a distinct dislocation almost paralel with the Muráň fault line (see fig. 1 profile A).

The „colourful facies of the Dešťanky limestone" as well as the Tisovec limestone underlying it had been taken by M. Maheľ (1957 c, 1958) for the „white Anisian limestone" of the Illyrian. Both lithological units were united and marked as the „Tisovec-Furmanec limestone, Carnian to Norian" in his geological map (in A. Klinec, 1976).

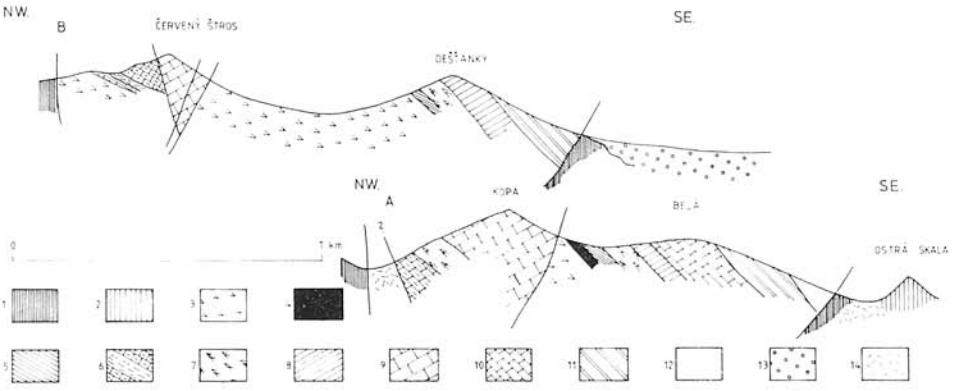

Fig. 1. Profils of the Upper Triassic from the area of Dobšinská ľadová jaskyňa. *Explanations:* 1 — Werfen Formation, Lower Triassic, 2 — Steinalm limestone, Middle to Upper Anisian, 3 — Westterstein dolomite, Upper Ladinian to Lowermost Carnian, 4 — Trachyceras beds, Julian, 5 — Reingraben beds, Julian, 6 — Mürztal beds, Julian, 7 — Dolomite, Lower Carnian, 8 — Tisovec limestone, Upper Carnian, 9 — Tisovec and Furmanec limestone, Upper Carnian to Norian, 10 — "colourful facies of the Dešťanky limestone", Norian, 11 — Dešťanky limestone, Norian, 12 — pale limestone of undetermined age, 13 — Conglomerat, Upper Cretaceous, 14 — scree

The Dešťanky limestone is most probably a lateral equivalent of dark cherty limestones of the hill Matka Božia N. slopes (Aflenz? limestone in J. Bystrický, 1972) containing also shell rocks with *Halorella amphitoma*. They differ mainly in that the Dešťanky limestone contains no dark cherts and that no levels of brighter coloured limestones are reported from the Aflenz limestone.

Beds overlying the Dešťanky limestone are unknown so far (they end on a tectonic line). No fossils are known from the pale massive limestone that may have overlain thern. They may be equivalents of the pale massive limestones M. Maheľ (1957 c, 1958, M. Maheľ in M. Maheľ — J. Vozár, 1971) takes for normally overlying the Aflenz? limestone and ranks them to the Norian or Rhaetian. However, even their stratigraphic position is still problematic. Foraminiferes occurring there (O. Jendrejaková in J. Bystrický et al., in press) enable only to suppose they may be of the Upper Triassic age[14].

Aflenz? limestone

(syn. "Dunkle obertriadische Kalke", M. Maheľ, 1958 p. 34, "Die dunklen, hornsteinknolligen Kalke", M. Maheľ, 1956 p. 61).

Only very few data are available about the facies character and stratigraphic range of this lithostratigraphic unit. It is a bed sequence described by M. Maheľ (l. c.) as dark grey and black limestones with levels of paler limestones abundant in cherts of different sizes and shapes in some parts, from the N. slope of the hill Matka Božia. Levels of shales and thin intercalations of clay and marly shales occur in some parts of these limestones. He ranked them to the Norian on the basis of shell rocks with *Halorella amphitoma* he found in them on the hill Breziny W. slope and on the hill Matka Božia E. slope and he took them for a facies characteristic for a local development he called the Lešnica development (1958 p. 49). On the basis of preliminary studies in the hill Matka Božia region, I considered these limestones a most probable equivalent of the Aflenz limestone of the N. C. A. (J. Bystrický, 1972), which here should, in difference with the Hallstatt region of the N. C. A. where it was taken for a representative of the southernmost "channel" (A. Tollmann, 1972 a) at that time, follow margins of the reef shallow water platform of the Hochschwab development from the North, i. e. it should be N. from the "Hallstatt channel". Further biostratigraphic and facies investigation of this region will prove whether the above correlation and paralelization with the Aflenz limestone of the N. C. A. is adequate. I have had no possibility to observe the Aflenz limestone of the N. C. A.

[14] A. Csiskó (1943, geol. map) takes these pale limestones for normally underlying the „dark cherty limestones" (Aflenz? limestone in J. Bystrický, 1972). Even the borehole SM-2 (M. Maheľ — J. Vozár, 1971 pp. 52—53) provided only insufficient information about the stratigraphy of the hill Matka Božia bed sequence. Pale as well as dark limestones have not been stratigraphically evaluated. Noticeable are the data about „laminae of volcanic clastic material" occurring in the pale limestone which is to form a level in the „dark-grey limestone". No effects of volcanic activity are known in the Norian or the Rhaetian stage of the Alpine Triassic. Paralelizing these limestones with those of the profile Matka Božia is therefore doubtful.

M ü r z t a l ? b e d s

(syn. "Dunkle Kalke und Schiefer", M. M a h e ľ, 1956 p. 59, 1958 p. 27, "the dark-grey and black clayey and marly shales and marlstones accompany dark limestone" and "dark shaly marlstones with interbeds of massive and granular, partly crinoidal limestone, in place with chert nodules", M. M a h e ľ, 1968 pp. 263, 264).

It is the sequence M. M a h e ľ (1956, p. 59) described as a new informal lithostratigraphic unit and supposing it to normally overlie so called Basalel dolomite (the Lower Anisian) and to underlie the "white Anisian limestone" (the Illyrian), took it for the Middle Anisian (M. M a h e ľ, 1958 p. 48). This age was to be documented by a brachiopod fauna of several localities (M. M a h e ľ, 1958 p. 28). Later, he devided this unit into two independent units sepparated by the Steinalm and Wetterstein limestones or Wetterstein dolomite. The lower one containing "Anisian" brachiopods should belong to the Anisian (M. M a h e ľ, 1968 p. 263), the upper one with bivalves — to the Carnian (M. M a h e ľ, l. c. p. 264). In fact, it is just one lithostratigraphic unit according to its conodont fauna belonging to the Lower Carnian (the Julian substage sensu L. K r y s t y n, 1978).

Its type profile (the meadows Vernárske lúky) consists of dark to black bedded limestones, in some parts abundant in others poor in concretions of cherts sepparated by a level of dark shales with intercalations of sandstone tuff. The lower part of the dark limestones is richer in cherts; in addition to the cherty concretions, some cm thick interbeds of cherts occur in it as well. Cherts are sporadic in the upper part — overlying the dark shales — and the whole of it is more varied in its facies. Levels of organodentritic limestones, crinoid (?alodapic) limestones with dasyclads, marly limestones, even marls occur there. All macrofossils published so far (M. M a h e ľ, 1958 p. 28, 1968 pp. 263, 264) are to occur in beds overlying the dark shales according to the map of paleontological localities (M. M a h e ľ, 1957, 1958).

Respective lithostratigraphic units in the profile Vernárske lúky are in the following sequence (see fig. 1 profile B):

a) The Werfen Formation

b) Dolomites of an unknown age (connection with the Werfen Formation is tectonical)

c) The Mürztal beds:

1. dark bedded limestones with concretions or interbeds of dark cherts. Samples 3/78, 3 81: *Gladigondolella malayensis*, *Gondolella polygnathiformis*, *Gondolella foliata foliata*, *Gondolella foliata inclinata*,

2. dark shales with sandstone tuff intercalations,

3. dark bedded limestones with sporadic cherts and a level of a crinoid (?alodapic) limestone with the dasyclads: "*Macroporella*" *sturi*, *Physoporella heraki* v. *heraki* (J. B y s t r i c k ý, 1979). Samples 1/78, 2/78: *Gondolella polygnathiformis*, *Gondolella tadpole*, *Gondolella foliata foliata*, *Gondolella foliata inclinata*,

4. dark bedded limestones. Sample 6/78 (about 10 alt. m above the sample 1 78): *Gondolella polygnathiformis*,

5. dark bedded limestones forming the uppermost part of outcrops. Sample 4 78: *Gondolella polygnathiformis*.

Fig. 2. Outline of the extension of the Upper Triassic in the Stratenská hornatina Mts. (According to M. Maheľ, 1957—1963; SW part adapted by J. Bystrický, 1980).
Explanations: 1 — Werfen Formation, Lower Triassic, 2 — Limestones and dolomites of Middle Triassic, 3 — Schreyeralm limestone, Reifling limestone, Upper Illyrian, 4 — Tisovec and Furmanec limestone, Upper Carnian and Norian (to ?Rhaetian), 5 — Aflenz limestone, Norian, 6 — Dešťanky limestone, Norian, 7 — Mürztal beds, Julian, 8 — pale massive limestone of undetermined age, 9 — Liassic, 10 — Munieria limestone, ?Lower Cretaceous, 11 — Conglomerats, Upper Cretaceous.

d) Pale massive limestones of a reef facies building the hill Červený Štros summit part, the Upper Triassic (the Furmanec and or the Tisovec limestone) (connection with the c 5 levels is tectonical.).

We collected 5 samples from dark bedded limestones overlying the dark shales in the profile Kopanec:
Sample K—1/78: the basal bed of rock outerops — *Gondolella polygnathiformis, Gondolella foliata foliata.*
Sample K—2 78: dark bedded limestones, about 5 alt. m above the basis of the rock outcrops — *Gondolella polygnathiformis, Gondolella foliata foliata, Gondolella foliata inclinata.*
Sample K—3 78: dark bedded limestones of the uppermost part of the rock outcrops — *Gondolella polygnathiformis.*
Sample K—4 78: dark bedded limestones at a tectonical connection with Upper Triassic pale massive limestones (here, a tectonic breccia) — a transitional form between *Gondolella foliata foliata* and *Gondolella tadpole.*
Sample K—5 78: dark bedded limestones with sporadic concretions of dark cherts (the top of the forrest road ascend, approximately the same locality as the one reported by M. Maheľ — 1957 c pp. 43, 44, 1958 p. 28 — containing "Anisian" brachiopods and, later, *Chlamys* cf. *subalternicostata*[15] — M. Maheľ, 1968 p. 264) — *Gondolella polygnathiformis.*

On the basis of the above conodont fauna (J. Papšová in J. Bystrický et al., in press) the above bed sequence belongs to the Julian substage, yet, its reaching the Tuvalian substage cannot be excluded. On the basis of biostratigraphic data we gained, occurrence of "Anisian" brachiopods is very improbable.

M. Maheľ (1967 p. 423, 1968 p. 263) added the folowing species to his list of "Anisian" brachiopods of this lithostratigraphic unit: *Coenothyris vulgaris, Coenothyris krafti, Coenothyris cuccensis, Mentzelia mentzelii acrorhyncha* and *Pexidella sturi.* Since there are no data published about the place or beds which this fauna is to come from, it cannot be considered evidence of the described lithostratigraphic unit Anisian age nor the Anisian stage. M. Maheľ, as I have already mentioned above, understood this lithostratigraphic unit differently in different publications and sometimes included even beds belonging to other lithostratigraphic units into it (e. g. the Gutenstein beds, the Dešťanky

[15] According to M. Kochanová' s revision (unpublished report) it is *Chlamys (Praechlamys)* sp. related with *Ch. inaequicostatus* PARONA or *Ch. subaltenicostatus* BITTN. The species *Dimyodon (Dimyopsis) intusornatus* (BITTN.). (in M. Maheľ, 1967 p. 424, 1968 p. 264) comes from the dark limestone with cherts occurring in the locality Vernárske lúky N. from the hill Červený Štros and according to the revision, it is *Atreta* cf. *intusornata* (BITTN.)

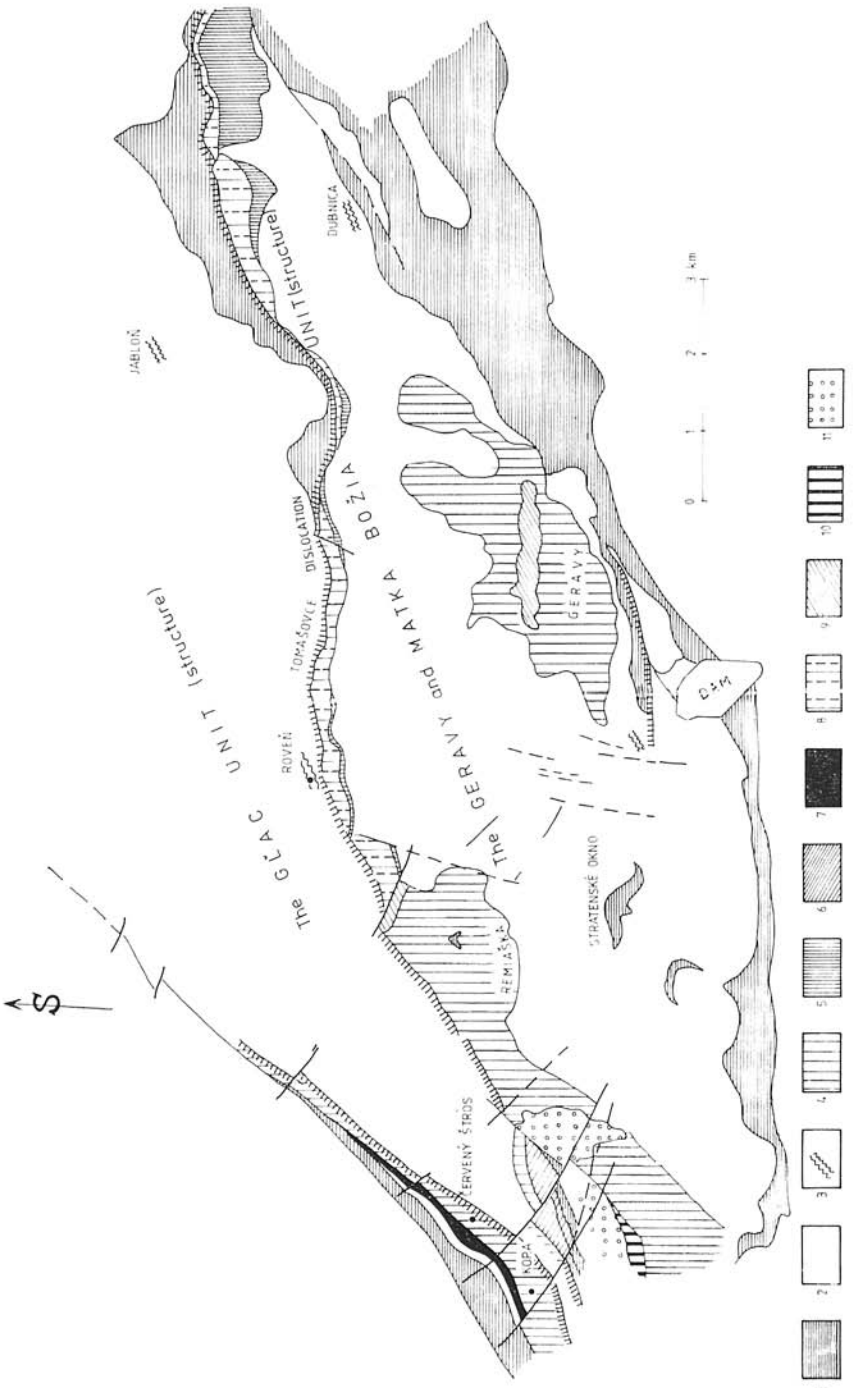
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Fig. 3. Geological sketch map of the area of Dobšinská ľadová jaskyňa.
Explanations: 1 — earth, 2 — scree, 3 — Conglomerats, Upper Cretaceous, 4 — Munieria limestone, ?Lower Cretaceous, 5 — Tisovec and Furmanec limestone, Upper Carnian to Norian, 6 — Furmanec limestone, Norian, 7 — Furmanec limestone, dark grey and almost black limestones, Norian, 8 — Dachstein limestone, Upper Norian (Sevatian?), 9 — Tisovec limestone, Upper Carnian, 10 — Dolomite, Lower Carnian, 11 — Mürztal beds, Julian, 12 — Reingraben beds, Julian, 13 — Trachyceras beds, Julian, 14 — Dešťanky limestone, Norian, 15 — "colourful facies of the Dešťanky limestone, Norian, 16 — Wetterstein dolomite, Upper Ladinian to Lowermost Carnian, 17 — Cherty dolomite, Julian?, 18 — Wetterstein limestone, Lower Ladinian, 19 — Steinalm limestone, Pelsonian to Lower Illyrian, 20 — Werfen Formation, Lower Triassic, 21 — dark bedded limestone with sporadic cherts-undetermined age, 22 — Dolomites of undetermined age, 23 — pale massive limestone of undetermined age, 24 — Localities of Teutloporella herculea, 25 — Localities of macrofossils (sensu M. Maheľ 1958), 26 — Localities of microfossils (foraminifers, dasyclads, conodonts, in J. Bystrický — O. Jendrejáková — J. Papšová in press).

beds, dark limestone with *Munieria grambasti* probably of the Lower Cretaceous and even beds of their age unknown so far).

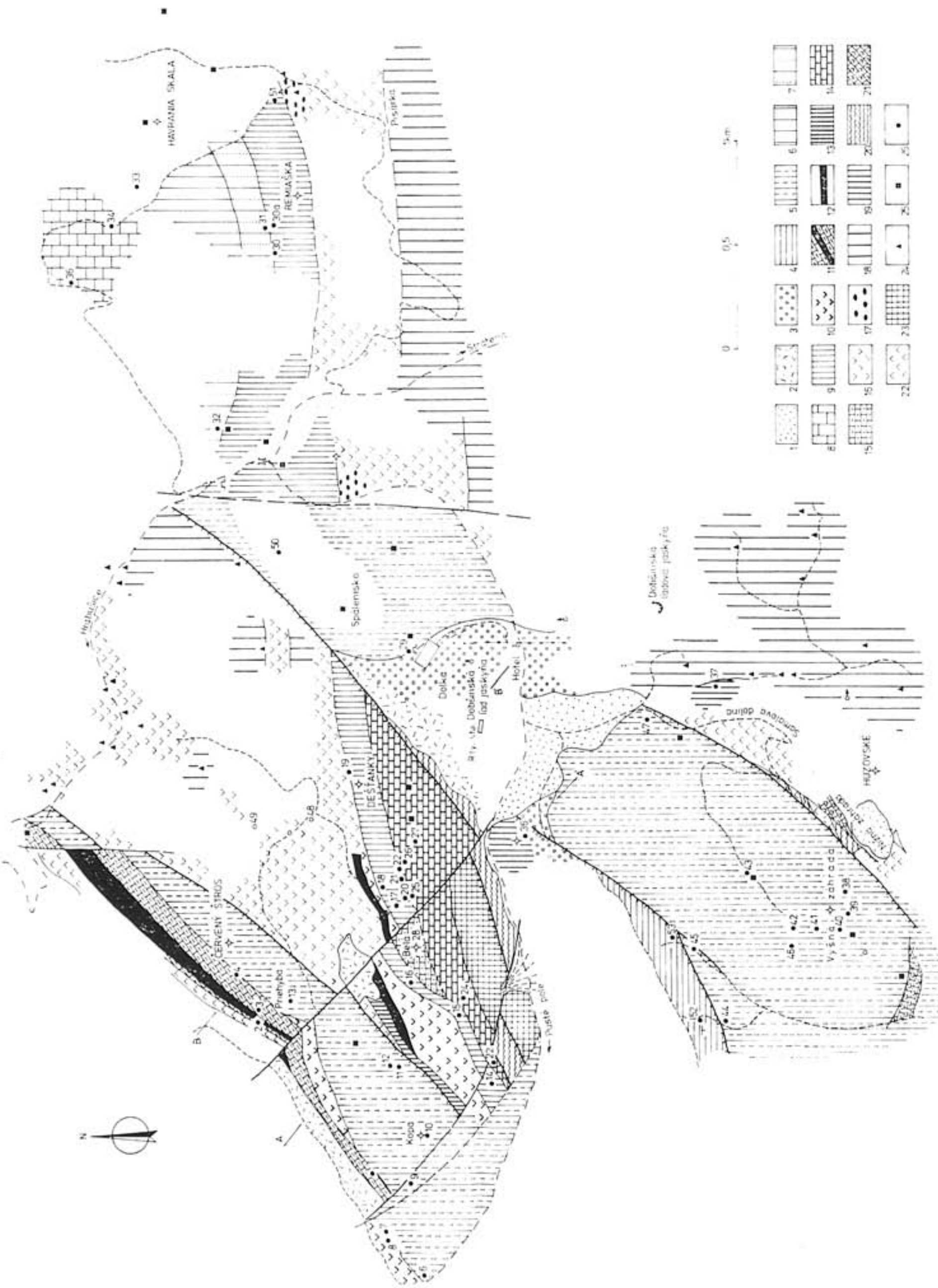
The above described Mürztal beds facies have no equivalent in the Upper Triassic either of the Stratenská hornatina Mts. or of the West Carpathians at all. By its facies and age it can be taken for an equivalent of the Mürztal beds of the N. C. A. (A. Tollmann, 1976 b). Basinal deposits of the metamorphosed Foederata series — dark cherty limestones with intercalations of dark shales and dark shales with intercalations of dark cherty limestones — the Carnian age of which has been proved recently also by a conodont fauna (P. Straka, 1981) resemble them by their facies and age the most of West Carpathians lithostratigraphic units. No such data on the Mürztal beds extention in the Stratenská hornatina Mts. or on their relation either to the Reingraben beds or to other Upper Triassic sediments that would enable to picture their paleogeography in the interval of the Carnian stage more exactly and to solve the much discussed problem of the Foederata series tectonics are available.

Facies patterns

The deposits of the West Carpathian Upper Triassic indicate a changing continental margin between Paleoeurope in the N. (Carpathian Keuper facies) and the open ocean in the S. (Hallstatt facies, Meliata bed sequence)[16].

The Stratenská hornatina Mts. Triassic correlating with facies areas of Oberostalpine tectonic units of the N. C. A. Upper Triassic were paralelized with the Dachsteinkalk facies area (J. Bystrický, 1972). A. Tollmann (1972 p. 197, 1975 p. 116, 1976 b p. 496) referring to the Muránska plošina pl. Triassic, saw an equivalent of the Hohe Wand facies area in it. Thus, the Triassic of the

[16] M. Mišík's et al. (1977, 1981) interpretation about existence of two Oberostalpine type Triassic sequences sepparated from each other by the Upper Triassic in the Carpathian Keuper facies (the Tatricum and the Fatricum) is in contrast with all recent interpretations of the Upper Triassic paleogeography of the Alps as well as the West Carpathians. Due to unsolved problems of Cretaceous conglomerates of the West Carpathian Klippen Belt origine (J. Bystrický, 1976 p. 48, 1978 p. 21, T. Bechstädt, 1978 p. 106) in the paleogeography of the West Carpathians Mts. Upper Triassic it is not taken into consideration (J. Michalík, 1978, 1979).


HAVRANIA SKALA
REMIAŠKA
ČERVENÝ ŠTROS
DEŠŤANKY
Spálenisko
Hotel
Dolka
Kopa
HUZOVSKÉ
Stratená
Pusté pole

Stratenská hornatina Mts. and of the Slovak Karst Silica nappe N. part should be an equivalent of Kalkhochalpine tectonic units while the Slovak Karst Silica nappe S. part should be an equivalent of southernmost Oberostalpine units occurring at the root zone of the Central Alps, i. e. so called "Central zone North alpine slices". The Strážov nappe as well as the so called "Vernár stripe", I ranked to the Hauptdolomite facies area due to their Upper Triassic character (J. Bystrický, 1972), sensu A. Tollmann (l. c.) should not belong to the "Gemeride nappes" group (A. Biely — J. Bystrický — O. Fusán, 1968; J. Bystrický — M. Maheľ, 1970), but they should represent an equivalent of the N. C. A. southernmost Kalkvoralpine tectonic units (the Triesting facies area sensu A. Tollmann, l. c.). If basinal facies deposits, reflecting the synsedimentary tectonic activity of the taphrogenetic character, are taken for the basic criterion of the Middle and Upper Triassic facies areas definition, no substantial differences can be observed between the Middle Triassic of the Muránska plošina pl., the Stratenská hornatina Mts., the Galmus Mts. (i. e. "the North Gemeride unit" sensu M. Maheľ, 1968) and that of the Slovak Karst Silica nappe. At the beginning of the Illyrian, a reef shallow water platform formed by the Steinalm limestone subsided into a system of elevations and depressions with a different intensity of subsidence in the whole of the above area. Basinal facies sedimentation (the Reifling limestone, the Schreyeralm limestone, the "Pseudoreifling limestone", the Nadaska limestone) took a longer time — even to the Longobardian some places, (e. g. in the Slovak Karst Silica nappe) in being restricted to the Illyrian only in others. The facies division of the Stratenská hornatina Mts. Triassic sensu M. Maheľ (1957, 1958, 1974) based on the "varied development of the Anisian" (M. Maheľ, 1968 p. 263, 1974 p. 129) cannot be accepted.[17] It is based, which follows from the chapter on lithostratigraphy, on an inadequate correlation of lithostratigraphic units of different ages.

At present, no complete data on bathymetric conditions of respective Middle Triassic basins are available, that is why they cannot be evaluated after the criteria applied in the N. C. A. (D. A. Donofrio — H. Mostler, 1978; T. Bechstädt — R. Brander — H. Mostler, 1978). J. Mello's, 1975 studies as well as previous findings on the fast vertical and lateral transition of basinal deposits to the ones of the Carbonate shallow water platform, on

[17] M. Maheľ (1955 p. 6, 1958 p. 24) distinguished so called basic development he named „the North Gemeride development", later (1964 p. 396, 1967 p. 420) „the Stratená series" or (1968 p. 262) „ the Stratená subunit" or (p. 261) „the Stratená facies" and (1969 b p. 16) also the „Stratená group". This is to laterally transit into two local developments, into the local „Lešnica development" or (1979 b p. 32) „the Lešnica dolomite development" as well as into „the Klaus development" or (in 1964 p. 396) „the Glac development". Since the terms used by M. Maheľ — „series", „unit", „subunit" as well as „group" belong to the category of tectonic facies units and often include the whole sequence of the Mesozoic (sometimes even of the Paleozoic) they cannot be understood as terms of lithostratigraphic units of Triassic facies areas. E. g. the stratigraphic range of the „Zliechov subunit" (sensu M. Maheľ, 1968 fig. IIb) is the Lower Triassic to the Albian, of the „Stratená subunit" or the Stratená group" — the Permian to the Liassic. The fact that he does confuses terms of different categories is obvious from his suggestion (1979, footnote in Slovak only) that „West Carpathian tectonic units would be more exactly named by terms monoseries and polyseries instead of monofacies and polyfacies".

tuffs and tufites sedimentation character in the Middle Triassic, as well as occurrence of dasyclads *(Diplopora annulatissima)* in the Schreyeralm limestone with ammonites (J. Bystrický, 1972 p. 294; M. Kuthan, 1959), similarly, data of the N. C. A. (H. Zapfe, 1959) indicate a relatively small depth of the basinal deposits (max. to 200 m). However, this is inconsistent with so far the only one finding on "psychrosphaeric" ostracods occurrence. K. Kozur (1972 p. 17), on the basis of a new genus *Gombasekella* (with the type species *G. mocki* KOZUR) which he takes for "an element of psychrosphaeric ostracods of the Reifling limestone", suggests the depth of the sea where the Slovak Karst Reifling limestone was originating 500 m or more.

If representation of the Wetterstein dolomite greater in the Triassic of the Stratenská hornatina Mts. than of the Slovak Karst is not taken into consideration, distinct facies differences between the so called "North Gemeride unit" and the "South Gemeride unit" occur only at the beginning of the Julian substage. In the Stratenská hornatina Mts. as well as in the Muránska plošina pl. ("the North Gemeride unit") there the Wetterstein dolomite is covered by a thin sequence of the Reingraben beds not occurring in the Silica nappe region of the Slovak Karst ("the South Gemeride unit"). Even greater facies differenciation of the above tectonic units sedimentary area appeared as high as the Norian stage. It is represented only by deposits of a shallow water platform in the Muránska plošina pl. (the Furmanec, Dachstein, Skalka limestones, etc.), in addition to shallow water platform deposits (the Furmanec, Dachstein limestones) also by basinal deposits (the Aflenz? and Dešťanky limestones) in the Stratenská hornatina Mts. and by the Hallstatt limestone and the Zlambach Formation in the southernmost part of the Slovak Karst.

The spacial distribution of the Norian basinal deposits indicate that the Stratenská hornatina Mts. Triassic can also be taken for an equivalent of the N. C. A. Hallstatt facies area. The facies areas sequence from the S. to the N. in the area of "the Gemericum Triassic"[18]: the Hallstatt facies area, the shallow water platform in the Hochschwab facies, the Aflenz facies area, the shallow water platform in the Hohe Wand facies corresponds approximately to the Upper Triassic facies zone sequence reported from the N. C. A. East margin by A. Tollmann (1976 b p. 496), even more, to the recent paleogeographic sketch of the N. C. A. Hallstatt facies area by R. Lein (1981). R. Lein (l. c.) in difference with previous interpretations (A. Tollmann, 1972 a, 1975, 1976 b), applied to Carpathian conditions by H. Kozur and R. Mock (1973)[19], does not consider the Aflenz facies area "a part of the Southern Juvanian Channel" extending southward from the Hochschwab facies area shallow water platform, but an innerplatform basin with the Mürztal and Aflenz facies of the Upper Triassic extending northward while the "Hallstatt channel" with dark and colourful Hallstatt limestones facies extended southward from the shallow water platform in the Hochschwab facies.

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[18] After selecting the Meliata series and its equivalents called the „Silicicum" at present (J. Mello in J. Mello — M. Polák, 1978 p. 304).

[19] H. Kozur and R. Mock (1973, 1977) in difference with A. Tollmann (l. c.) paralelize the Silica nappe Triassic with the Mürztal facies area of the N. C. A. despite the fact that the most characteristic bed sequence of this facies area — the Mürztal beds — does not occur in the Slovak Karst.

However, the relation of the Mürztal facies to the Aflenz one of the Upper Triassic remains unsolved in the Stratenská hornatina Mts. as well as in the N. C. A.[20].

As it follows from above, the Stratenská hornatina Mts. Triassic is not the E. part of the Muránska plošina pl. Triassic as it has been traditionally believed until recently and the Triassic of the Stratenská hornatina Mts. and of the Slovak Karst Silica nappe represents a common sedimentary area equivalent to the N. C. A. Hallstatt facies area.

Disintegration of the shallow water platform into a system of elevations (or horsts) and depressions with different subsidence rate is generally ascribed to synsedimentary tectonic movements of the taphrogenetic character volcanic activity. These tectonic movements, as the examples of the Triassic areas in the Slovak Karst and the Stratenská hornatina Mts. indicate, did not always give rise to more distinct faults. Original boundaries of respective basins in the Middle or Upper Triassic are unknown so far. However, in any case, they must have communicated with one another as well as with the open sea (occurrence of *Monotis salinaria* in the Slovak Karst Hallstatt limestone, the Muránska plošina pl. Dachstein limestone, occurrence of *monotises* in the Stratenská hornatina Mts. Dešťanky limestone, etc.). One thing can be stated, however, and it is the fact that the distribution of basins in the Middle Triassic is not identical with that in the Upper Triassic, certainly not in the Norian stage. Thus, the synsedimentary movements in the Upper Triassic did not lead to "rejuvenation" of the boundary areas of the shallow water platform and the basins (or "faults") of the Middle Triassic origin. Faults, as e. g. the Muráň fault, the Rožňava fault, the Tomášovce dislocation, considered "an old dislocation, to a various rejuvenated" (M. Maheľ, 1969 b pp. 16, 18) and responsible for the Triassic facies variability have nothing in common with the synsedimentary tectonics during the Triassic. They are young faults, and, as it can be observed in the geological map, they originated after folding and also after overthrusting of the Mesozoic in a form of a nappe (or nappes). They all diagonally cut of fold structures (J. Bystrický, 1964). Due to that, we cannot accept M. Maheľ's (1977 p. 210, 1978 p. 15) opinion that the Rožňava fault, or the "Rožňava lineament" is an original boundary between the "Dinaride type" of the Triassic (i. e. the Triassic of the Slovak Karst Silica nappe and of the Meliata series) and the "Austroalpine" type of the Triassic expanding northward from the above fault. Except the facts above (the facies identity in the Middle Triassic, the common shallow water platform in the Stratenská hornatina Mts. and in the N. part of the Upper Triassic of the Slovak Karst Silica nappe), he disregards

[20] It concerns mostly relation of the Foederata series Carnian beds to the Stratenská hornatina Mts. Mürztal beds. V. Homola (1951 p. 178) reports without detailed data that the Triassic of the Muránska plošina pl. and of the Stratenská hornatina Mts. transits into the Foederata series, which he, in difference with R. Schönenberg (1948) does not take for „the sill development" but on the contrary, for "a deeper development". M. Maheľ taking the Foederata series for one of the developments of the „Struženík unit" defined by him (1968 p. 260), considers it (1957 c p. 126, 1958 p. 94, 1981) also a sill sedimentary area (a sill between two tectonic zones) inspite of the fact that Triassic deposits of this tectonic unit indicate a basinal development. It is not possible to solve whether it is a tectonic unit of the Silicicum or a Meliata series equivalent (R. Mock, 1980) or the Veporicum Mesozoic (M. Maheľ, 1968 p. 257), on the basis of data available at present.

even the well known facts about the Meliata series extention northward from the Rožňava fault and of the Radzim outlier of the Middle Triassic (approx. half distance between the Slovak Karst Triassic N. margin and the Stratenská hornatina Mts. Triassic S. margin) being of the same Middle Triassic development as the Slovak Karst Silica nappe, as well as the "North Gemeride Triassic" of the Stratenská hornatina Mts.

Due to the above aspects, also interpretation of the relation of the Muránska plošina pl. Triassic to the Strážov nappe one will have to be revised. The Triassic of the Strážov nappe as well as that of the Vernár partial nappe was taken for an equivalent of the N. C. A. Hauptdolomite facies area (J. Bystrický, 1972), but, as a tectonic unit it was considered a partial nappe of the group of the Gemeride nappes (A. Biely — J. Bystrický — O. Fusán, 1968)[21]. Also the opinion that the Strážov nappe Triassic sedimentary area was probably westward and not northward from the "Gemericum" nappe Triassic sedimentary area (J. Bystrický, 1972 p. 308) accepted even by M. Maheľ (1979 b p. 37) will have to be modified by new information on the facies variability of the Strážov nappe Middle Triassic. It has to be taken into consideration that ranking the Strážov nappe Triassic to the Hauptdolomite facies area followed from the facies character of the Čachtické pohorie Mts. Upper Triassic (called the Nedzovské pohorie Mts. before) and not from the Strážov nappe type region of the Strážovská hornatina Mts. The Strážov nappe Triassic, of the Strážovská hornatina Mts. except the Lower Carnian, is unknown so far.

Translated by K. Bystrická

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[21] This interpretation has been indicated already by Z. Pouba (1951 p. 284): „Thus, it will have to be considered whether the Strážov nappe does not belong by its development rather to the Gemerides than to the Subtatricum". V. Homola (1951 p. 178), on the other hand, points out to the common sedimentary area of the Triassic of the Slovak Karst and of the Strážov nappe, but he admits they may be different tectonic units.

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