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PALAEOLOGICAL BASIS OF TRIASSIC STRATIGRAPHY
IN THE TATRA MTS.

Abstract: Triassic stratigraphy in the Tatra Mts. is based on the rather rich palaeontological evidences. The following palaeontological horizons are distinguished: Campilian *Myophoria* beds with *Myophoria costata* and *Naticella costata* (hightatric series), Lower Hydaspien horizon with *Dadocrinus grundeyi* (hightatric and subatric Křižna series) and pelecypod-gastropod fauna (hightatric series), Pelsonian horizon with brachiopods of the *Rhynchonella decurcata* zone (subatric Křižna zone), Pelsonian—Illyrian diplopore horizon with *Physoporella pauciforata*, *Ph. praealpina* and *D. annulatissima* (hightatric series and partly subatric Choč series), Fassanian horizon with *Diplopora annulata*, *D. annulatissima* and *D. uniserialis* (subatric Křižna series) and the quite different Fassian horizon with *Teutloporella herculea* and *Diplopora annulata* (subatric Choč zone). Hightatric diplopores are of the Upper Silesian-Briançonnais-Préalpine character, subatric — of the East-Alpine character and Choč series of the South Slovakian — Dinaric character, according to J. Bystrický's conclusions. The first Triassic ammonites in the Tatra Mts. have been discovered in the Choč series.

Lithological analogies of the Triassic rocks of the Tatra Mts. with the German or Alpine Triassic are so distinct, that in reality mainly that method was the basis of stratigraphy in the first period of geological investigations (V. Uhlig 1897, F. Rabowski 1921). The above mentioned method was very useful later on also (D. Andrusov 1936, K. Guzik 1936) and is still right presently (Z. Kotański 1959, 1964, 1965a, J. Debelmas 1960), but it is evidently an auxiliary method in comparison with the real palaeontological basis of stratigraphy.

Triassic age of the subatric dolomites was already determined by the first investigators who have based on such fossils as: *Encrinurus liliiformis*, *Entrochus* sp., *Coenothyris vulgaris* (Schloth.), *Spirigera* (Retzia = *Tetractinella*) *trigonella* (Schloth.) and *Spiriferina* (*Mentzelia*) *mentzeli* (Dunker) — V. Uhlig 1897 — locality near the Jaskinie Bielskie (subatric series in the Bielskie Tatry Mts.); and — *Myophoria* cf. *costata* and *Gervillia* sp., too (subatric series in the Jaworzynka valley — M. Limanowski 1903). The Rhaetian age of the formerly known Koesen beds in the subatric series was confirmed by E. Goetel (1917b) who described a very rich fauna from these beds.

Palaeontological evidences of the Triassic age of hightatric limestones and dolomites were properly found just by F. Rabowski (1931), who discovered the pelecypod fauna with *Pecten discites*, *Gervillia mytiloides* and *Modiola triquetra*.

The age determination of the Choč Triassic was based upon the lithological analogies only (W. Goetel 1917a) and comparisons with fossil discoveries in the other Central-Carpathian massifs. The lack of good determined fossils was the reason of the many years standing discussion between K. Guzik (1936, 1959) and D. Andrusov (1936, 1959), not finished to the recent time yet (Z. Kotański 1965a).

After the last war many new localities with Triassic fauna were discovered, permitting the detail age determination.

Firstly the Campilian fauna with *Myophoria costata* and *Naticella costata* was found in the hightatric series (Z. Kotański 1956a, 1959) what was a basis for distinguishing s. c. *Myophoria* beds. Discovering and detail description by J. Lefeld (1958)

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an extremely good preserved crinoids material with *Dadocrinus gruneyi* Langenhan in the hightatric Triassic, charakteristic to the Hydaspien substage, was of a very great importance. *Dadocrinus ossicles*, formerly found by E. Passendorfer (1952), were subsequently refound in many places in both hightatric (Z. Kotański 1959) and subatric (Z. Kotański 1963a, b) limestones what had very important consequences for the tectonic conclusions (Z. Kotański 1961, K. Guzik and Z. Kotański 1963a, b).

F. Rabowski's pelecypod fauna, charakteristic for the lower Hydaspien substage in the Tatra Mts., was found in many new places in the hightatric series (Z. Kotański 1959, 1961).

Gastropod fauna of the Briançonian character (*Loxonema* sp., *Omphaloptycha* sp., *O. cf. stotteri* Klipps) was found in many places in the hightatric series (J. Głazek 1963, Z. Kotański 1964, J. Piotrowski 1965) within saccharoid limestones of the lower Hydaspien. In vermicular limestones of the higher Hydaspien, the gastropods *Natica* sp. were known (Z. Kotański 1955, pl. XI, fig. 2), as well as the *Pecten* fauna collected by E. Passendorfer (1952). The first Anisian brachiopods in hightatric series have found by B. Koisar (1965, unpublished data), but in general they are very rare in this series.

Many new localities with crinoids *Encrinus* sp. and *Entrochus* sp., most frequent in the passage beds of the Anisian and Ladinian, were found mainly in the subatric series (Z. Kotański 1963a, b).

Formerly, Ladinian limestones were unknown in the subatric series at all. Just for that reason a discovery of a 30 m. thick limestone complex, that yields extremely rich fauna with *Pecten* sp., *Lima* sp., numerous gastropods, *Terebratula* sp. and onkolite structures (*Otonosia* and *Nubecularites* morphotypes) on the Sywarowe crest (Suchy Wierch unit between Mała Łąka and Miętuska valleys) is of the great importance. The Lower Ladinian (Fassanian) age of the limestones is pointed out by diplopores appearing directly at their base (Z. Kotański 1965b). Intercalations of similar fossiliferous limestones in Lower Ladinian dolomites are known in subatric (Križna) Suchy Wierch, Mała Świnica and Bobrowiec units, too (Z. Kotański 1963a, b, 1965b). The discussed fauna is now under determination.

Upper Ladinian fauna is very rare; a single *Myophoria* fragment was found in the Boczań crest in the Jaworzynka valley (Suchy Wierch unit) only (Z. Kotański 1963b).

According to current opinion, Keuper variegated beds were regarded as continental (lagoonal) deposits, however crinoids and brachiopods found in limestone intercalations permit to conclude, that they were deposited rather in a marine environment, not very far off the seashores (Z. Kotański 1956b, 1961).

Though the faunistic discoveries enumerated above are rather frequent and they are not without some stratigraphical significance, the real progress in the Triassic stratigraphy has been attained after the last discoveries of diplopores.

The first locality with diplopores was found in the autumn 1962 in the Jaworzynka valley [Suchy Wierch unit of the subatric (Križna) series] — Kotański Z. (1963a, b). They belong to the Lower Ladinian diplopore horizon with *Diplopora annulata* Schafh. and *Diplopora annulatissima* Pia. Diplopores of this horizon were found later on in many places of the Zakopane subatric zone in both southern and northern belt, what was the basis for a new tectonic synthesis (K. Guzik and Z. Kotański 1963a, b). Subsequently new other localities were found in almost all subatric (Križna) tectonic units, including Bobrowiec, Mihulče and Havran ones.

In connection with those discoveries, new detail investigations undertaken in hightatric series, led to finding in 1963 in the Organy Mt. (Kościeliska valley) and in the Kominy Tylkowe Mt., an Upper Anisian diplopore flora (M. Bac and K. Grochocka 1965, J. Piotrowski 1965), with *Physoporella praealpina* Pia, determined by the present author. Some new localities with hightatric diplopores were found during the last years by the author's collaborators. At the same time Slovakian geologists J. Bystrieký and J. Veizer (1965) discovered independently the *Physoporella praealpina* horizon in the Javor cliff (Tichá valley).

In summer 1964 my wife, Halina K o t a ŋ s k a, M. Sc, has found the first specimen with perfectly preserved diplopores *Teutloporella herculea* in the Choč dolomite (Male Koryeiska valley — western slopes of the Chochołowska valley). In the autumn of the same year I found Lower Ladinian *Teutloporellae* also in Tiesňavy (Juráňová valley, Oravice). Presently the horizon with *Teutloporella herculea* is known very well from the Male Koryeiska rocklets and from the whole Choč belt as far as Juráňová valley. In a result, the Ladinian age of the Choč dolomite in the West Tatra Mts. has been established, in contrary to D. Andrusov's opinion (1959), who compared this dolomite with the East-Alpine Upper-Triassic Hauptdolomit; while it agrees very well with the last supposition of the present author. Z. K o t a ŋ s k i (1965a) who emphasized its full lithological analogies with the Wetterstein dolomite.

The Upper Anisian diplopore horizon with *Physoporella pauciforata* (G ü m b.) was recognized in some subatric units — Wolarnia unit (Križna series) and Uplaz unit (Choč series) — Z. K o t a ŋ s k i (1965b), as well as in Križna scales in the Zakopane deep boring (Z. K o t a ŋ s k i 1967).

Diplopore Middle Triassic assemblages from the hightatric, Križna and Choč series and all presently known localities are enumerated below. Each list of diplopores includes all the species known from the horizon, while in individual localities not all the listed species must be naturally found.

Upper Anisian (Pelsonian—Illyrian)

A. Hightatric series

Physoporella praealpina Pia, *Ph. pauciforata* (G ü m b.), *Physoporella* sp., *Diplopore annulatissima* Pia, *D. helvetica* Pia, *D. hexaster* Pia, *Macroporella* sp., *Poikiloporella* sp., *Griphoporella* sp. (= IInd diplopore horizon of the Briançonnais series).

1. Organy [right slope of the Kościeliska valley; Czerwone Wierchy series, Organy unit (Czerwone Wierchy „fold”)]; M. Bac and K. Grochocka (1965).

2. Ździary [right slope of the Kościeliska valley above the Pisana alp; Czerwone Wierchy series, Ździary unit (Czerwone Wierchy „fold”)]; M. Bac and K. Grochocka (1965).

3. Kominy Tylkowe (southern slope above Iwaniacka pass — many places); Kominy Tylkowe series of the autochthonous unit; J. Piotrowski (1965); fragmentary material from 1955—1956 — Z. K o t a ŋ s k i (1959).

4. Javor (Tichá valley); Czerwone Wierchy series, separated scale in overturned limb of the synclinal Stoly stretch fold; J. Bystrieký and J. Veizer (1965).

5. Źar (eastern part); Wąwóz Kraków series of the autochthonous unit; B. Koisar (1965, unpublished data).

B. Subtatric Križna series

Physoporella pauciforata (G ü m b.), *Ph. cf. praealpina* P i a. *Ph. cf. dissita* (G ü m b.) P i a.

1. Tourist rout on the Gładkie Uplaziańskie slope above the Mała Świstówka valley; Wolarnia unit; Z. K o t a ń s k i (1965b).

2. Zakopane deep boring; Križna scales between hightatric scales below the main Križna synclinal unit; Z. K o t a ń s k i (1967).

C. Subtatric Choč series

Physoporella pauciforata (G ü m b.), *Ph. praealpina* P i a. *Ph. cf. dissita* (G ü m b.) P i a, *Diplopora annulatissima* P i a and *D. cf. uniserialis* P i a.

1. Kotaszka (Hala pod Uplazem — right slope of the Kościeliska valley); Uplaz intrageoanticlinal series in the Uplaz scale; Z. K o t a ń s k i (1965b).

2. Wielkie Koryciska valley (left slopes of the Chocholowska valley); Furkaska unit — the Reifling limestone and Partnach beds; Z. K o t a ń s k i (1965a).

Lower Ladinian (Fassanian)

A. Subtatric Križna series

Diplopora annulata (S c h a f f h.) S c h a f f h. subsp. *annulata*, *D. annulata* S c h a f f h. subsp. *dolomitica* (P i a) H e r a k, *Macroporella* sp. and *Teutloporella* sp.

1. Jaworzynka valley (northern slope, many localities); Suchy Wierch unit; Z. K o t a ń s k i (1963a, b).

2. Przełęcz między Kopami (N of Gąsielica alp); Suchy Wierch unit; Z. K o t a ń s k i (1963a, b).

3. Bacug (slope above the Mała Łąka alp); Suchy Wierch unit; Z. K o t a ń s k i (1963 and in A. I w a n o w 1965).

4. Sywarowe (slope above the Mała Łąka alp); Suchy Wierch unit; Z. K o t a ń s k i (1963a, b, 1965b).

5. Sywarowe (on the crest); Suchy Wierch unit; M. B a c and K. G r o c h o c k a (1963 — unpublished data) and Z. K o t a ń s k i (1963a, b, 1965).

6. Hala na Wyżnie (Gładkie Uplaziańskie ridge); Suchy Wierch unit; Z. K o t a ń s k i (1963a, b, 1965).

7. Tourist route below Hala pod Uplazem; Suchy Wierch unit; Z. K o t a ń s k i (1965b).

8. Tourist route from the Jamy alp to the Chocholowska valley; Bobrowiec unit; Z. K o t a ń s k i (1965b).

9. The mouth of the Głębowiec valley to the Chocholowska valley; Bobrowiec unit; Z. K o t a ń s k i (1965b).

10. Lower part of the Głębowiec valley; Bobrowiec unit; Z. K o t a ń s k i (1965b).

11. Southern Pod Ciń slope of the Głębowiec valley; Bobrowiec unit; Z. K o t a ń s k i (1964 — unpublished data).

12. Bobrowiec Mt., above Mnichy Chocholowskie rocklets; Bobrowiec unit; Z. K o t a ń s k i (1965b).

13. Bobrowiec Mt., above Bobrowiecka pass; Bobrowiec unit; M. B a c (1965 — unpublished data).

14. Northern Pod Słonko slope of the Głębowiec valley; Bobrowiec unit; M. B a c (1965 — unpublished data).

15. Opalone Mt. (between the Chocholowska and Lejowa valleys); Bobrowiec unit; M. B a c (1966 — unpublished data).

16. Mihulče (Oravice); Mihulče unit; Z. K o t a ŋ s k i (fragmentary materials from the 1964 year — unpublished data).

17. Alp with little hut above Chłabówka; Mała Świnica unit; Z. K o t a ŋ s k i (1963b).

18. Na Capki valley (norther slope of the Krokiew Mt.); Mała Świnica unit; Z. K o t a ŋ s k i (1963b).

19. Kazalnica and Koryciska rocklets in the Biały valley; Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b).

20. Ku Dziurze valley (western branch); Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b).

21. Strążyska valley (N of Kominy Strążyskie rocklets); Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b).

22. Za Bramką valley (many localities); Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b).

23. Pod Kohutem alp (Mały Żleb valley); Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b).

24. Rabusiowa Turnia (right slope of the Mała Łąka valley); Mała Świnica unit; Z. K o t a ŋ s k i (1963a, b) — only megascopic data.

25. „Gates“ in the Za Bramką valleys; Samkowa Czuba unit; Z. K o t a ŋ s k i (1963a, b) — megascopic data only.

26. Crest separating Spadowiec valley from the Ku Dziurze valley; Spadowiec unit; Z. K o t a ŋ s k i (1963a, b).

27. Southern slope of the Havran Mt. (Bielskie Tatry Mts.); Havran unit; Z. K o t a ŋ s k i (fragmentary materials from the 1957, unpublished data).

28. Southern slope of the Hlúpy Mt. (Bielskie Tatry Mts.); Havran unit; Z. K o t a ŋ s k i (fragmentary materials from the 1957, unpublished data).

29. Zakopane deep boring: main synclinal Křižna unit; material obtained in 1965 from the Geological Institute (Geological Survey of Poland) with permission of Prof. Dr. S. S o k o ł o w s k i — Z. K o t a ŋ s k i (1967).

There are real possibilities to record new diplopore localities in many places in the East Tatra Mts. [Sucha Woda valley, northern slope of Mała Koszysta above Przysłop Waksmundzki alp, Waksmundzka valley, pod Wołoszynem alp, Gęsia Szyja Mt., Filipka valley (N of the Filipka rocklet), and in the Bialka valley on the slopes of Skalka and Holica Mt.].

B. Choč series

Teutloporella herculea (S t o p p.), *T. cf. aequalis* (G ü m b.), *T. tenuis* P i a, *Diploporella annulata* S c h a f f. var. *annulata*, *Macroporella* sp. and other diplopores; moreover algae (*Acicularia* sp., *Mitcheldeania* sp. and *Solenopora*) and gastropods (*Chemnitzia* sp.), pelecypods and ammonites.

1. Male Koryciska valley (left slopes of the Chocholowska valley); Koryciska unit; H. K o t a ŋ s k a (1964, unpublished data).

2. Male Koryciska (northern slope); Koryciska unit; Z. K o t a ŋ s k i (1966, unpublished data).

3. Western slope of the Tiesňavy gorge (Juráňová valley — Oravice): Koryciska unit; Z. K o t a Ň s k í (1964, unpublished data). *Teutloporella herculea* and *Diploporella annulata* are present here in one thin section).

4. Eastern slope of the Tiesňavy gorge (Juráňová valley — Oravice); Koryciska valley; Z. K o t a Ň s k í (1964 unpublished data).

Above reviewed localities confirm the opinion of fundamental importance of diplopores to the Triassic stratigraphy. The Tatra Mts. may be regarded now as one of the most important diplopore-bearing area in the Alpine system in Europe.

Besides the age differences of diplopores in the Tatra Mts., we can observe, in result of a very great tectonic approachment of facies caused by the nappe overthrusting — an extremely strong differentiation of diplopore flora, beginning from the high tatic series of the Upper Silesian-Préalpine-Briançonian character, through the Krížna series of the East-Alpine feature, to the Choč series with the South Slovakian and even Dinaric diplopore assemblage. This opinion agrees to J. B y s t r i c k ý's (J. B y s t r i c k ý 1964, A. B i e l y and J. B y s t r i c k ý 1964) one undertaken by him after an investigation of very rich and valuable materials of the whole Triassic from the Slovakian Central Carpathians. Author's diplopore collection from the Tatra Mts. and Upper Silesia (where *Physoporella praealpina* is present, too) are the subject of detail palaeobotanical studies now.

New discoveries of Triassic ammonites and amphibians merit an attention too. These First Triassic ammonites in the Tatra Mts. were collected by the author in the Choč dolomites (Lower Ladinian of the Koryciska unit) while ammonites and Labyrinthodonts — in Partnach beds (Furkaska unit) in the Wielkie Koryciska valley. These beds have been hitherto regarded by K. G u z i k (1936, 1959) and D. A n d r u s o v (1959a, b) as Rhaetian — Lower Liassic in age. Palaeontological materials from the Rhaetian of the Furkaska unit, assembled by K. G u z i k, have been not published, and the age of those beds is not surely determined. Lithological analogies and new fossils collected by the present author seem to suggest the Anisian age (Reifling limestone and Partnach beds cf. Z. K o t a Ň s k í 1955a). In such a case, very interesting are the Rhaetian exposures in the Kończysta scale (Miętusia valley) very abundant in brachiopods and pelecypods.

New stratigraphical possibilities are connected with palynological investigations undertaken by Mrs. H. K o t a Ň s k a, M. Sc., and with the discovering of conodonts in the Partnach beds by Mrs. K. Z a w i d z k a, M. Sc.

The most important results for the stratigraphy and tectonics in the last years, are however connected with the microfacial analysis (cf. Z. K o t a Ň s k í 1965b, 1967, M. B a c and K. G r o c h o c k a 1965, J. P i o t r o w s k i 1965). The first microfacial monograph by A. R a d w a Ň s k í, dealing with the so far poorly known high tatic Rhaetian, is presently in print. An atlas of the Triassic microfacies is now prepared by the present author.

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