JOZEF MICHALÍK, EVA PLANDEROVÁ, MILAN SÝKORA*

TO THE STRATIGDAPHIC AND PALEOGEOGRAPHIC POSITION OF THE TOMANOVÁ-FORMATION IN THE UPPERMOST TRIASSIC OF THE WEST CARPATHIANS

(Fig. 1–8)

A b s t r a c t: The paper is dealing with problems connected with delimitation of the Tomanová-formation (Norian — Rhaetian) of the Tatric of the West Carpathians representing a continental development of the uppermost Triassic of this area. It interprets the main features of sedimentation environment and the paleogeographical position of the formation in relation to other formations of the uppermost Triassic in the West Carpathians. In the paper are also described so far unknown traces of coelurosaurid reptiles from the Tomanová formation in the Tichá dolina valley in the High Tatra, called *Coelurosaurichnus tatricus* n. ichnospec. and a find of microflora from the same locality. On the basis of microfloristic evaluation of claystones we have found two floras: I. lower, Norian-Rhaetian in age, poorly preserved and II. upper well preserved, equivalent to the *Choristoceas marshi* Zone (Mc-Mi Zone according to M o r b e y 1975).

Р е з ю м е: В предлагаемой статье авторы разбирают проблематику в связи с разграничением томановской формации (нор-рет) татрид Западных Карпат, которая представляет континентальное развитие самого верхнего триаса этой области. Авторы интерпретируют характерные черты осадочной среды и палеогеографическую среду формации в отношении к остальным формациям самого верхнего триаса в Западных Карпатах. Дальше описаны до сих пор неизвестные целосауридные рептилии томановской серии в долине Тиха в Высоких Татрах с названием *Coelurosaurichnus tatricus* n. ichnospec. а также и микрофлора. На основании микрофлоры в аргиллитах были определены две формы: 1. нижняя — возраста нор-рет. плохо сохранившаяся и 2. верхняя, хорошо сохранившаяся, возраста верхнего рета (зона ME-MI по Моргею 1975).

I. Views of delimitation of the Tomanová Formation (J. Michalík)

As the Tomanová beds M. R a c i b o r s k i (1890) defined a complex of variegated clastic sediments, which represent deposits of the uppermost Triassic in the Czerwone Źlebki, Tomaniarski Twardy Uplaz and Tichá dolina valley in the Tatric of the High Tatra. Their lower, variegated part parallelized V. U h l i g (1897) with the complex of the Carpathian Keuper (Carnian-Norian). Under the designation Tomanová beds all the later authors termed the complex of black claystones and light-coloured sandstones containing flora remnants (which V. U h l i g parallelized with the Gresten beds).

The Rhaetian age of the complex was adopted by many authors without reservations, others (V. U h l i g, 1897) discussed its possible competence to the Lower Liassic.

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Z. Kotański (1959) considered an Upper Norian to Lower Rhaetian age whereas A. Radwanski (1968) supposed that the beds are analogous to a part of the Rhaetian stage.

The lower boundary of the Tomanová formation is given by the lithological boundary with sediments of the Carpathian Keuper (Czerwone Żlebki) or by the transgressive (?) surface on Middle Triassic dolomites or on the Campilian claystone complex (Tomaniarski Twardy Upłaz, Tichá dolina valley — see A. Gorek, 1958, Z. Kotański 1961, A. Radwański, 1968). This uneven base (at some places possibly tectonic) should indicate the sedimentation of the complex to have begun in various times at various places (from the Lower Norian (?) to the base of the Liassic).

Even the upper boundary of this complex is not unambiguous: in the Czerwone Żlebki it is covered with talus, at other places is a more or less distinct transgression of the complex of clastic limestones. These limestones were (although with doubts sometimes) considered as „marine Rhaetian" in the past (A. Gorek 1958, F. Rabowski 1959, Z. Kotański 1959 c, 1961). According to spores, sponges, foraminifers, astroporines, serpulids, gastropods and bivalves, which A. Radwański (1968) compared with Jurassic forms (and nevertheless considers as Rhaetian), they belong to the Lower Liassic.

The complex consists of black claystones containing an abundant admixture of graphite substance. They are predominantly formed by kaolinite, subordinately by illite, limonite and chamosite (A. Radwański, 1968). The claystones contain from place to place layers of iron ore, formed by siderite, limonite, chamosite, pyrite and magnetite according to M. Turnau — Morawska (1953). The ore is often of a pisolitic habit, its origin is problematic (A. Gorek 1958, A. Radwański 1968). In the abundant banked intercalations of light-coloured sandstones (quartz predominates, sporadically are present clay and ferrous minerals, sometimes also dense laminae of heavy minerals are to be observed (A. Gorek, 1958). The sandstone layers sometimes contain abundant remnants of plants, from which M. Raciborski (1890) determined:

Equisetaceae:

Equisetum chalubinskii Raciborski (new species)
?Equisetum banburyanum Zig.
Schizoneura hoerensis (His./Schimp.) (Norian-Jurassic)

Pteridophytaceae:

Clathropteris platyphylla Brongn. (Rhaetian)
Dictyophyllum aff. dunkeri Nathorst (Rhaetian-Liassic)
Pecopteris lobata (Oldham et Morr.) (Rhaetian)
Gladophlebis roesserti (Presl) Saporta (most abundant form)

Angiospermae:

Palissya braueri Endl.
?Widdringtonites sp.

Small fragments of plants are also abundant in claystone layers. From traces after the activity of animals burrowing marks have been found only (A. Radwański, 1968 interprets those from Czerwone Żlebki as polychaetes burrows).

II. *Views of the environment of origin of the Tomanová Formations*
(J. Michalík)

Whereas the older authors supposed a near-shore origin of the complex (V. Uhlig

1897), gradually the assumption of its continental origin (F. Rabowski 1922, E. Passendorfer 1951, D. Andrusov 1959) in lacustrine (Z. Kotański 1956, 1959, Z. Wojczik 1959) or palustrine areas (M. Turnau — Morawska 1954, A. Gorek 1958, E. Passendorfer 1961) got predominance. Some authors, however, returned to the older assumption of the lagoonal-marine origin of the Tomanová beds (Z. Kotański 1961, A. Radwański 1968), contradicting to the established paleogeographical conditions of the West-Carpathians in the uppermost Triassic and to the facts observed in the complex proper.

Discussion

A. Radwański (1968) mentioned several arguments for a marine origin of the complex, which, however, are discussible.

1. (p. 87): It is difficult to imagine a transition of inland (limnic or palustrine) sedimentation into marine only with appearing of crinoids without development of transitional (beach, wash-out) structures"... The Tomanová formation of the High Tatra obviously deposited amidst the formation of Carpathian Keuper and was separated from the sea by a broad elevation in the place of the Low Tatra, with sinking of the area during transgression of the Lower Liassic sea it was inundated first with fresh water. The transgression of sea (after submersion of elevations) into limnic areas must have manifested by the change of salinity only (elsewhere, in places of elevations a transgression surface with wash-outs is distinct).
2. (p. 88): „The regular development of banks (sandstones) and their rhythmicity excludes a fluvial or limnic sedimentation, not speaking already about a palustrine one"... From the viewpoint of environment dynamics there is no difference between a larger lake and isolated marine bay. The conditions in the Tichá dolina valley point to a frequent lenticular character of banks, frequent are erosion channels and scours. The cyclicity of the Tomanová beds may be rather related to climatic factors (as already interpreted by Z. Kotański 1959, p. 128).
3. (p. 90). „The common occurrence of kaolinite in the desribed deposits does not require additional considerations (about the environment)..." According to C. E. Weaver (1959) kaolinite does not originate in marine environment and does not stand a longer transportation.
4. On the same page the author writes about the origin of clastic material, which should have been suppled by rivers, mixed with remnants of plants of inundated parts of flood plains, carried into the sea and „... scattered by currents on large areas, where it was deposited...". Several lines below he explains the isolated character of basin by „a distinct stagnation of waters". What a stagnation was concerned in an environment with its own current regime?
5. (p. 90): „... Considerable argillous character of clastic material... the decomposing plant material completely changed the chemical properties of the environment of sedimentation of the Tomanová beds...". It is a question whether such an environment isolated from the sea and with a strong fluvial inflow can be valuated as marine.
6. (p. 88): „... The basin of the Tomanová beds could not have been of local character...". In the opinion of other authors (M. Turnau — Morawska 1953, Z. Kotański 1956, 1959, 1961) the morphology of the Tatric of the High Tatra was very dissected in the uppermost Triassic. The local development is also pointed out in the opinion of Z. Kotański (1961) quoted by A. Radwański (p. 40): „... any parallelization of beds or of their groups is not possible" (between various profiles).
7. (p. 91): „... The regular development of banks with smooth bedding planes proves that the basin bottom was situated below the reach of waves but at the depth where wave activity of the open sea might have reached...". The supposition of such a depth which must have been several tens of metres in the assumed extended basin is contradicted by the way of lamination (A. Gorek 1958) and the find of traces of a terrestrial biped lizard that we are going to describe in the following chapter.

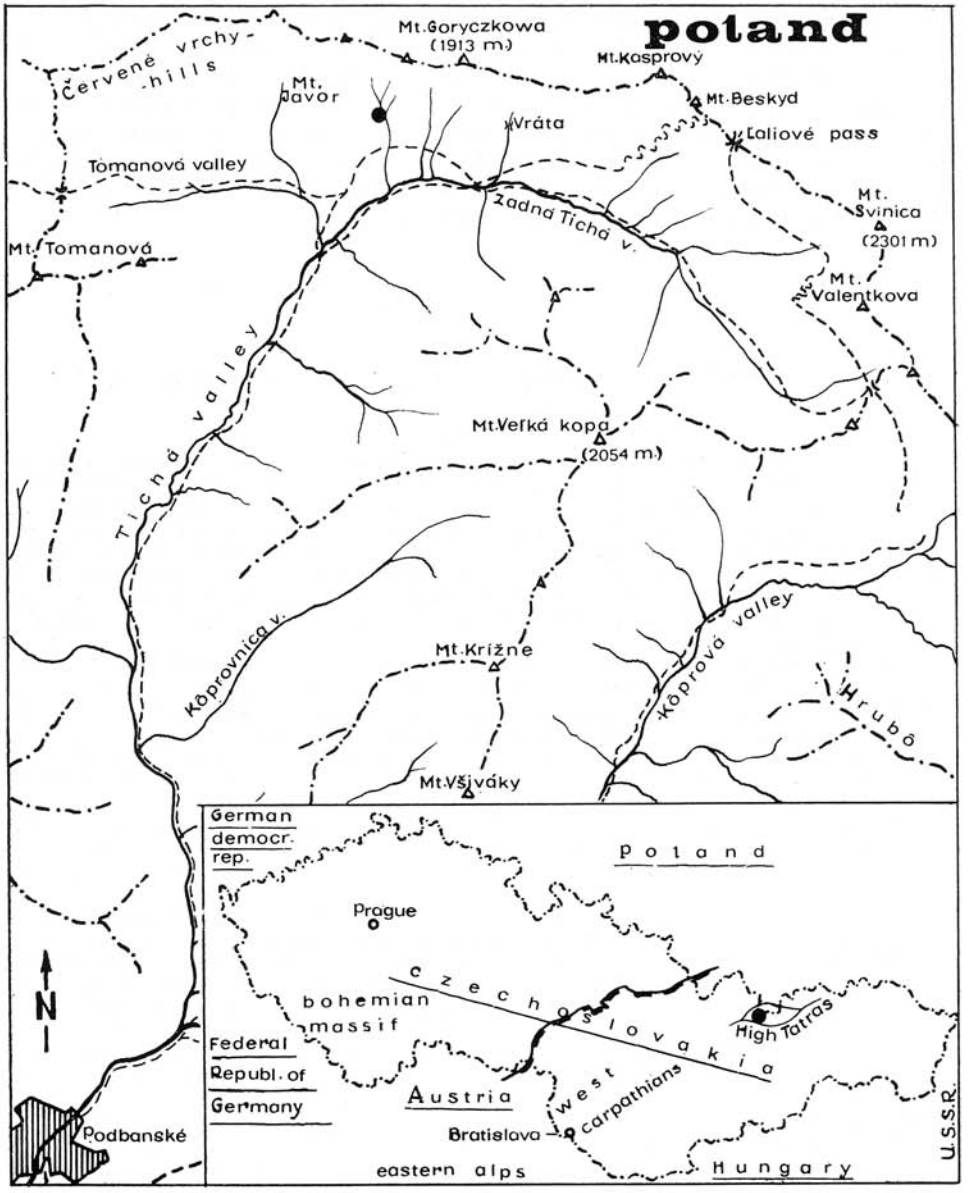
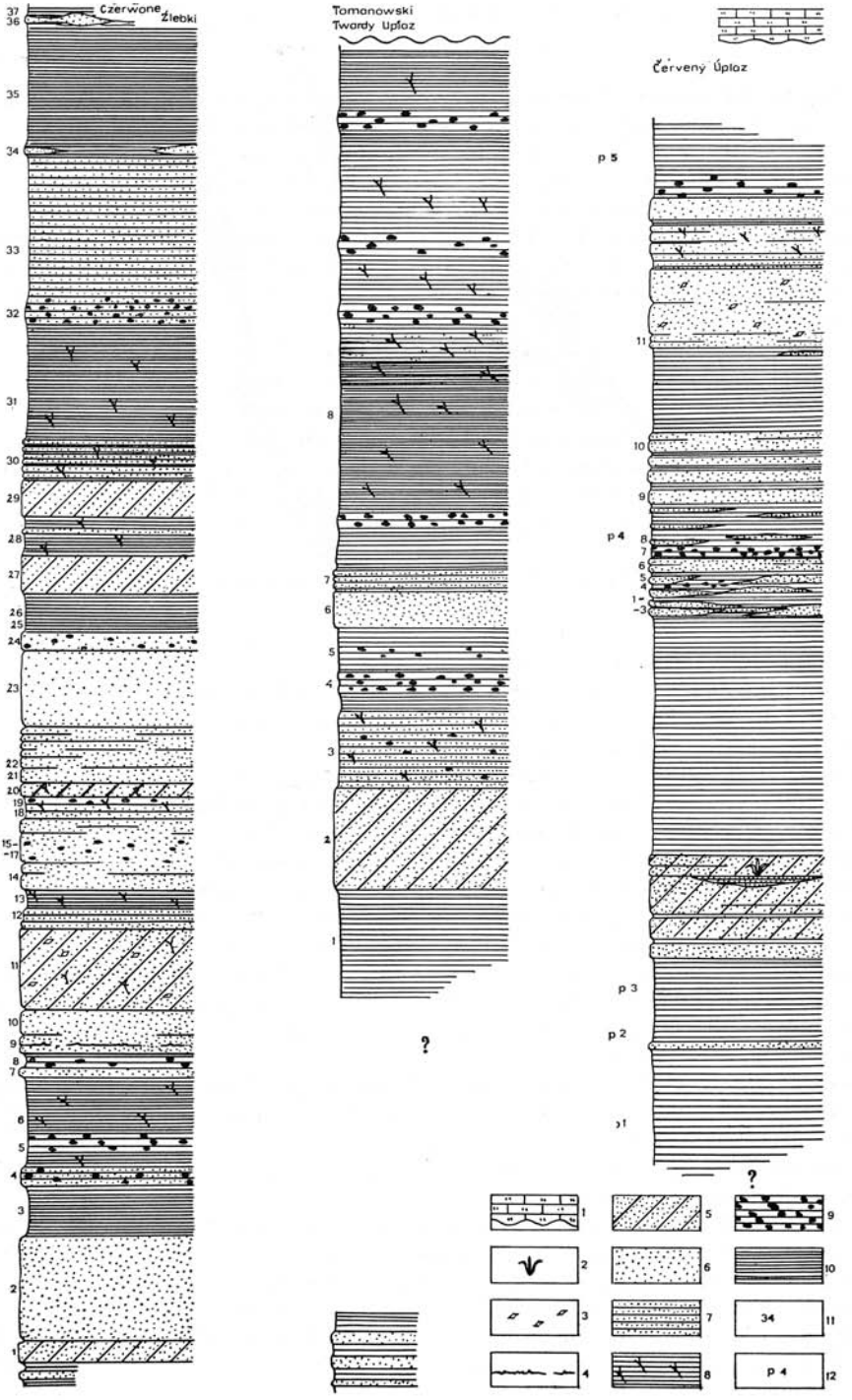


Fig. 1. Location of the profile Červený Úplaz (Black point).

Fig. 2. Correlation of three profiles of the Tomanová beds: profile Czerwone Żlebki and Tomaniarski Twardy Upłaz according to A. Radwański (1968), profile Červený úplaz according to observation of the authors. Explanations of symbols: 1 — quartz-sandy limestones of the Lower Liassic, 2 — traces of reptiles, 3 — feldspars, 4 — erosional bedding plane, 5 — quartz sandstone, 6 — sandstone, 7 — sandy claystone, 8 — black claystones with phytodetritus, 9 — siderite Fe ores, 10 — black claystone, 11 — taking of lithological samples, 12 — taking of palynological samples.


Czerwone
Żlebki
Tomanowski
Twardy Upłoz
Červený Úpłoz
p 5
p 4
p 3
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p 4

III. *Description of trace of coelurosaurid reptile (J. Michalík, M. Sýkora)*

Below the bifurcation of the ravine Červený Úplaz (Jaworowa dolina valley, ravine below the Javor of older authors) in the Tichá dolina valley of the Hihg Tatra (Fig. 1) we have found three casts of three-finger traces on the lower bedding plane of the bank of quartz sandstone occurring on the right side of slope in the lower profile part of the Tomanová beds in October 1975. The traces were impressed in a lenticular layer of the sandy claystone filling in a channel-like scour in the underlying sandstone bank. The claystone layer mostly underwent weathering, however, the lower plane of the overlying sandstone bank has preserved a sufficiently detailed and true cast of traces.

Class Reptilia Laurenty 1768
Subclass Archosauria Cope 1891
Order Saurischia Seeley 1888
Suborder Theropoda Marsh 1881
Infraordo Coelurosauria Huene 1914
Ichnofam. Anchisauropodidae Lull 1904
Order Coelurosaurichnus Huene 1941

Coelurosauriichnus tatricus nov. ichnospec.
(Fig. 3)

Holotype: Large trace in the middle of Fig. 3.

Locus typicus: Červený úplaz in the Tichá dolina valley of the High Tatra.

Stratum typicum: Tomanová formation, sandstone bank near the base (see profile-Fig. 2). Rhaetian (base of *Ch. marshi* Zone?).

Material: Three traces (probably of various individuals).

Description: Wide (30 cm) and equally long three-finger distinct trace. The fingers are impressed at whole length, terminated with distinct claws.

The middle finger of the trace is most distinctly impressed in the anterior part, is the longest and strongest of all (length about 25 cm), roughly straight. Both side fingers are moderately archlike curved, arch-like into the sides and backwards. The claws of both fingers are also moderately curved in the same direction. Both fingers diverge from the posterior "heel" part of the trace, which is insignificantly narrowed and lengthened posteriorly (Fig. 3, 4). The fingers are long and slender (the ratio of width and length is 1:7) — this value, however, cannot be a diagnostic criterion in a sole impression.

Comparison: The described form differs from the form *Eubrontes veillonensis* from the French "Infralias" in having a narrower heel part, diverging slender fingers and distinct, slightly curved claws (Fig. 5).

From the form *Grallator maximus* it differs in more slender finger impressions, diverging from the heel part.

Mostly it approaches the form *Coelurosaurichnus sassendorfensis* from the "Rhaetic" of North Germany, however, differs in a more slender trace of the anterior finger and moderately curved impressions of the side fingers as well as in larger dimensions.

Remarks: Traces of land lizards have not been described from the West Carpathians so far. Traces of land fauna from Triassic deposits of near areas have been described from the Italian Alps (works of several authors), from the Góry Swieto-

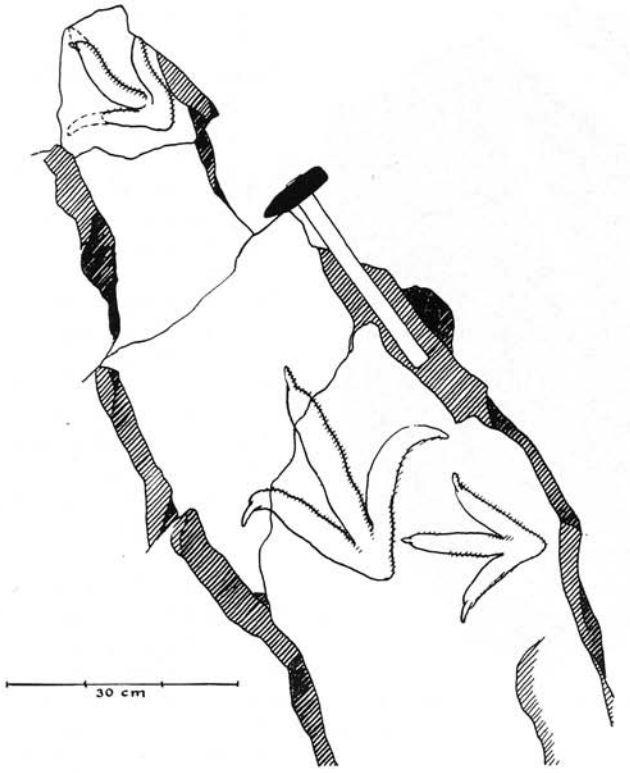


Fig. 3. Schematic outline of the bank of quartz sandstone (see Fig. 4) with casts of traces of biped reptiles at its lower surface.

krzyskie of Poland (W. Karaszewski 1966, 1969) and from North Germany (H. Haubold 1974 (Fig. 5)).

IV. Lithological description of the profile (M. Sýkora)

To a petrographic analysis was subjected a part of sandstones and siderite layers and nodules in the middle and upper part of the Tomanová beds (see Fig. 6).

The sandstone facies is represented by fine- to coarse-grained quartz sandstones (classification by J. Petránek 1963), often laminated. The share of grains in beds varies 70—90 %, locally somewhat less.

The clastic component of rocks is formed by mono- and polycrystalline grains, subordinately are represented lydites and chloritic-argillaceous grains. Working of clastic grains varies from angular to semioval, rarely rounding is more perfect. The groundmass is argillaceous-chloritic, with admixture of Fe-oxides and aleuritic quartz. Surely it contains more kinds of chlorite group minerals than mentioned by M. Turnau — Morawska (1953) from the Polish part of the Tomanová beds. In some cases the groundmass is formed by minerals of the chlorite group only. In bed 5 sporadical spherulites of siderite are found. The described sandstones are often finely jointed parallely, the joints as a rule are vertical to bedding. The joints are filled in with

Fig. 4. *Coelurosauriehnus tatricus ichnosp. n.*

minerals of the chlorite group and less with quartz. In sporadical cases, however, the joints markedly disturb the quartz grains. The quartz is often dissolved at the contact so that in some cases parts of beds acquire a mosaic texture. The described rock often contains heavy minerals, above all zircon, less tourmaline, rutile and light-coloured micas. In bed 3 chromite is present (proved optically only). The sandstones of the Tomanová beds are in general well-sorted and in higher parts more coarse-grained in the mentioned profile.

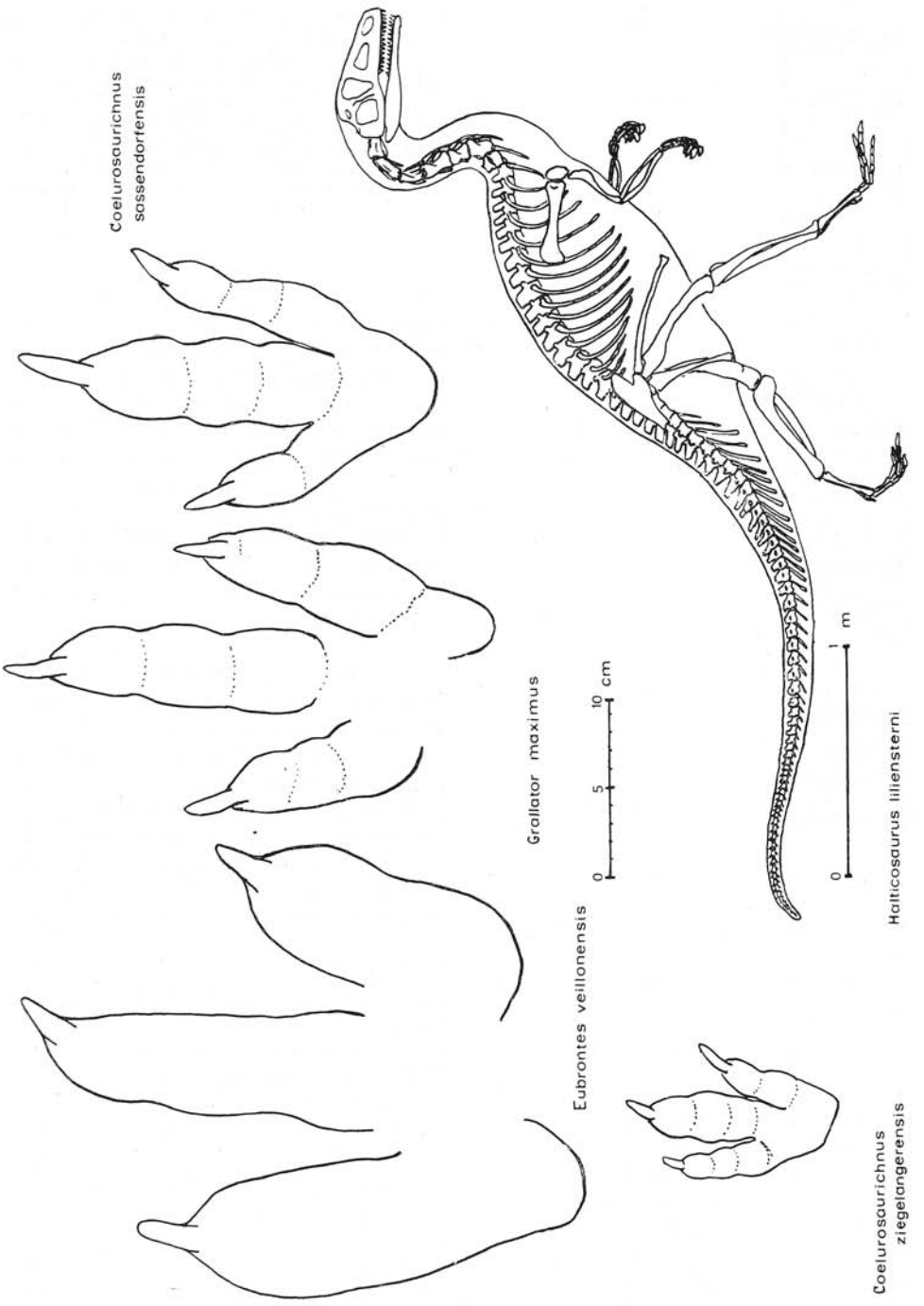
Rocks with spherulites of siderite are found in the form of nodules and layers. The established results agree with the description of older authors with the exception that in our profile perfect spherulites are present in contrast to statements of A. Kotański (1961). The spherulites are 0.7—1.2 mm in size, often impressed into one another and originated to the detriment of the argillaceous-chloritic groundmass. Similarly in bed 5 (quartz sandstones) "laths" of siderite grow round and enclose quartz grains. Spherulites are the product of early diagenesis (A. V. Carozzi 1960). According to P. V. Zarickij (1956) the association of siderite-kaolinite-pyrite in nodules of the underlier of the coal seams in the Donec basin is characteristic of the swamp and standing water facies.

Overlying the Tomanová beds in the ravine Pod Goryčkovou (east of Červený Úplaz) are brownish-grey claystones (with the gastropod *Pseudomelania* sp.), above them are sandy limestones with dwarfed bivalves *Astarte* sp. and *Nucula* sp., typical of the base of the Hettangian according to personal communication by M. Kochanová.

V. Palynological evaluation of the profile (E. Planderová)

From the locality Červený Úplaz in the Tichá dolina valley we have evaluated palynologically several samples from five layers of black clystones. The samples were

Fig. 5. Comparison of some traces of coelurosaurid reptiles from the uppermost Triassic of France and Germany. Reconstruction of skeleton of the coelurosaurid reptile *H. liliensterni* from the Upper Triassic of North Germany. According to H. Haubold (1975).


Coelurosaurichnus sassendorfensis
Grallator maximus
Eubrontes veillonensis
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1 m
Coelurosaurichnus ziegelangerensis
Halticosaurus liliensterni

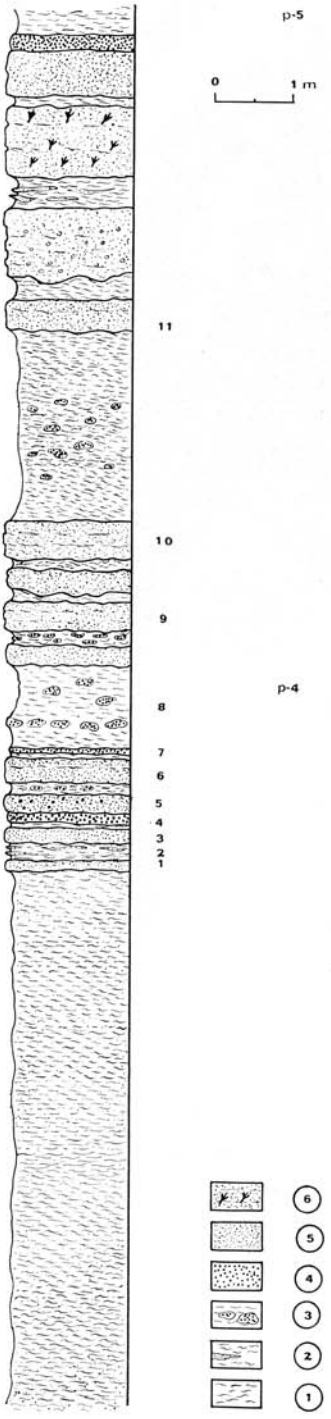


Fig. 6. Lithological profile of Červený Úplaz. The numbers beside the column are numbers of lithological samples, the numbers with index p are palynological samples. Explanations: 1 — dark claystone, 2 — dark claystone with sandstone intercalations, 3 — dark claystone with siderite nodules, 4 — layers of siderite ore, 5 — sandstone, 6 — laminated sandstone with plant detritus. Orig. M. Sýkora.

taken from lower (sample p-1, 2, 3) and upper (p-4, 5) layers of the complex (regarding to the bank with traces, see Fig. 2). Both parts of the complex are relatively rich in sporomorphs, however, the samples from the "lower" claystones (p-1-3), have a poorly preserved microflora and mostly determinable to genera whilst "upper" claystones (p-4,5) contain a well determinable undisturbed microflora. Because of different microfloristic composition both parts are treated apart in the next.

1. The "lower" claystones (samples p. 1-3 profile Fig. 2), contained a flora determinable only in part due to the strong graphitic coating at the surface of pollen grains and spores. Among the determined pollen species are present almost exclusively bisaccate grains of the genera *Taeniaesporites, Protohaploxypinus, Triadispora ?*. As to species we have determined the following ones only: *Protohaploxypinus subcarpathicus* P a u t s c h (1973), *Ovalipollis ovalis* (K r u t z s c h 1955) S c h e u r i n g 1970, *cf. Infirmisporites fragillis* P a u t s c h 1973. Subordinately are represented spores including the species *Enzonalosporites* cf. tenuis K l a u s 1960 and Camarozonosporites fsp. Biostratigraphically important species of the genera *Circulina, Praecirculina* and *Classopollis* we have not found in the samples.

2. The "upper" claystones (samples p-4, 5) contained a very well preserved microflora, composed exclusively from spores of Spermophyta and species of the genera *Classopollis, Circulina* and some others, so far undetermined genera. Composition of

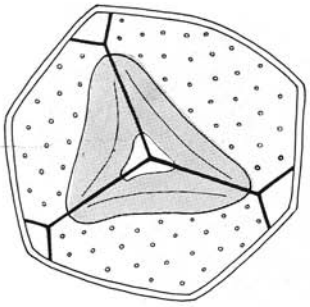


Fig. 7. Schematic representation of the species *Distanulisporites tomanovae sp.* n.

the microflora is as follows: *Cyathitides australis rimalis* Balme 1957, *Cyathitides* fsp., *Disctyophyllitides harrisii* Couper 1958, *Retusotriletes mesozoicus* Klaus 1964, *Distanulatisporites punctus* Klaus 1960, *Bianulisporites badius* Pautsch 1971, *Maratiopsis hoerensis* (Schimp) Thomas 1937, *Toroisporis auritorus* Reinhardt 1962, *Toroisporis mesozoicus* Döring 1965, *Cycadopites follicularis* Wills. et Webst. 1946, *Classopollis torosus* (Reisinger) Balme 1957, *Praecirculina tersa* Norris 1965, *Eucommiidites cf. troedsonii Erdtman* 1948, *Sporites* fsp., other nearer not determined spores and a described new species. As to percentage the species *Classopolis torosus* and *Circulina meyeriana* were predominating.

Intraturma Murornati R. Potonié et Kremp 1954
Genus *Distanulisporites* Klaus 1960
Genotypus: *Distanulisporites punctus* Klaus 1960
Distanulisporites tomanovae n. sp.
(Pl. 4, Fig. 1-3)

Holotypus: *Distanulisporites tomanovae* n. sp., pl. 4, F-1-3, deposited in the collections of the Dionýz Štúr Institute of Geology in Bratislava.

Locus typicus: High Tatra, Tichá dolina valley, locality Červený úplaz, higher part of the Tomanová formation (Zone Me-Mi sensu S. J. Morbey, 1975).

Derivatio nominis: According to Mt. Tomanová and Tomanová - valley in the High Tatra and the geological term Tomanová formation derived from them.

Diagnosis: Size of spore is 30×30 μ, shape pentagonal. The exina is thin, smooth, two-bedded. The sculpture is fine, distinctly granulate. Y mark reaches 5/5 of spore body. The central part (anulus) is triangular in shape, around the Y mark the anulus is triangularly notched. The arms of Y mark are straight, branching at the ends.

Comparison: The new species differs from the species *D. punctus* in the anulus, which is not circular but distinctly triangular (Fig. 7).

Comparing the pollen pattern of the profile Červený úplaz (I and II) with the microflora of the Upper Triassic mainly from Poland, Germany, Austria and England we have found out that the majority of our species are also present in the pollen horizons of the Upper Triassic of these regions. We have mainly used data on the Keuper and "Rhaetian" flora of these regions (M. E. Pautsch 1958, 1971, E. Schulz 1967 and S. J. Morbey 1975). Significant is especially the work of the latter author, who proposed division of the uppermost Triassic into microfloristic zones and introduced the criterii for distinguishing of the Norian stage from the "Rhaetian sensu

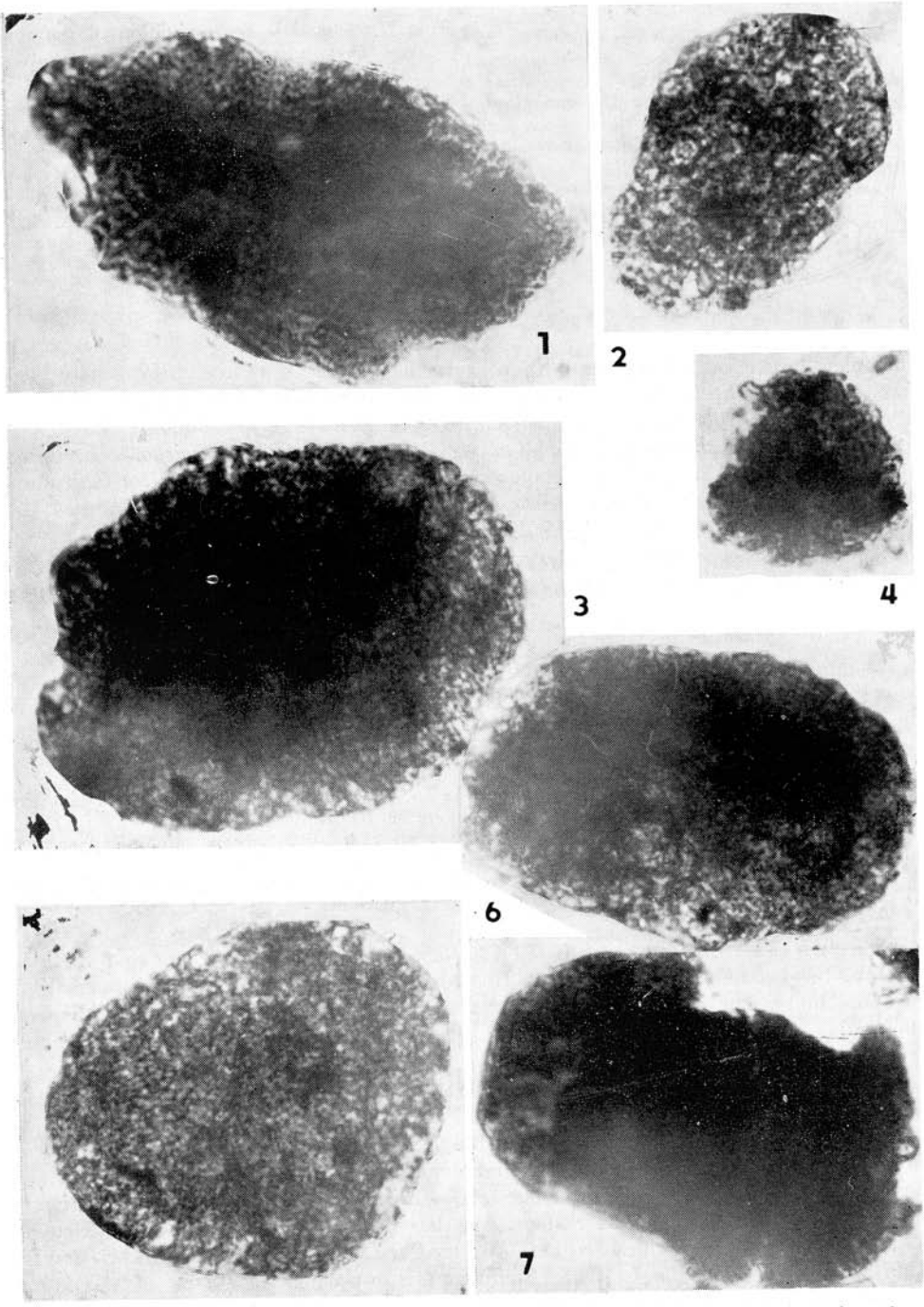


Plate I: 1 — *Ovalipollis ovalis*, 2 — *Taeniaesporites fsp.*, 3 — *Protohaploxypinus fsp.*, 4 — *Camarozonosporites* fsp., 5 — *cf. Triadispora*, 6 — *Protohaploxypinus cf. subcarpaticus*, 7 — bisaccate pollen grain.

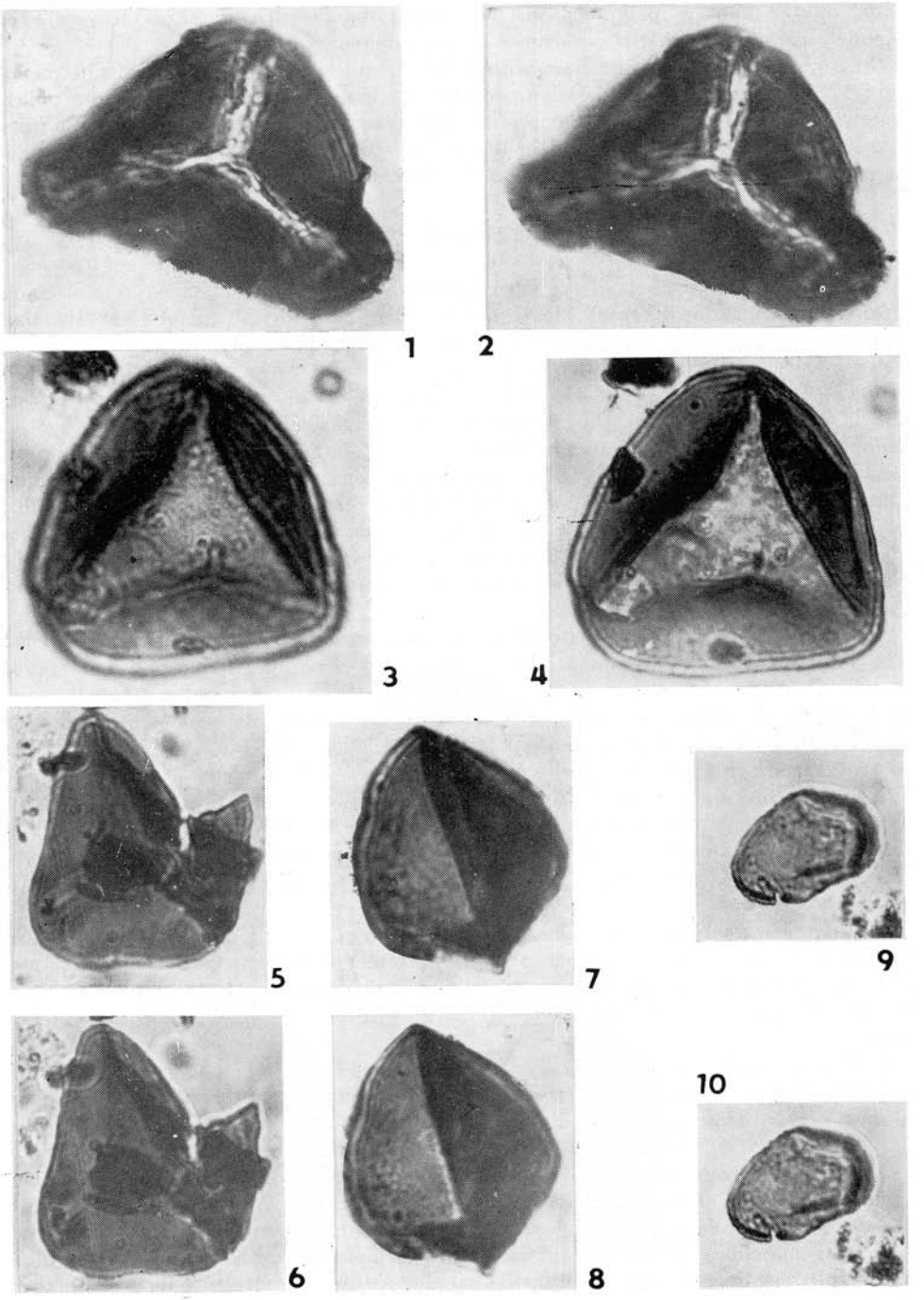


Plate II: 1—2 — *Leiotriletes adrienniforma*, 3—4 — *Cyathitides australis rimalis*, 5—8 — *Cyathitides* ſsp., 9—10 — *Maratiopsis hoerensis*.

lato" on the basis of palynomorphs, correlating the floristic zones in the profile of Kendelbachgraben with the occurrence of macrofauna.

In comparison of our microflora with these microfloristic zones the local differenees had to be taken into consideration, due to which not all the species of our pollen spectrum have been found in the profile studied by Morbey. According to data from the literature all the species found in the profile studied by us are present in the time interval from the uppermost Norian to the Lower Liassic.

VI. Remarks to stratigraphy (E. Planderová, J. Michalík)

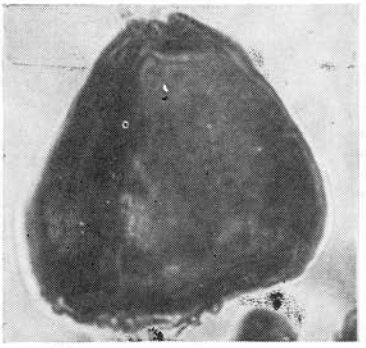
The stratigraphic content of the Rhaetian stage was not unambiguously defined and during investigation different ideas of the range and definition of the Rhaetian appeared, considerably differing. According to the original definition the Rhaetian stage was characterized by the occurrence of bivalves *Rhaetavicula contorta* and *Gervillia inflata*, later by the occurrence of ammonite *Rhaetites rhaeticus* and at last the latter was replaced by the ammonite *Choristoceras marshi*. According to several authors, however, the maximum of the occurrence of the species *R. contorta* is deep below the species *Ch. marshi*. This way different zones have been established, which both had to characterize the "Rhaetian" but did not coincide mutually. The applicability of both conceptions for the West Carpathians is complicated due to the fact that the species *Ch. marshi* has not been found here and the species *R. contorta* is abundant in the Fatra Member in close underlier of the concordant Gresten formation of the Hettangian.

The Tomanová Formation as a continental complex do not contain any marine fossils. The only fossils of stratigraphic value found so far are palynomorphs and sporomorps. Therefore the attempt of S. J. M o r b e y (1975) is particularly valuable for us to divide the uppermost Triassic by microflora in the profile Kendelbachgraben of the Rhaetic in the Northern Kalkalps and its correlation with the profile Bunny Hills of the Rhaetic in England. The common validity of this division of the uppermost Triassic fo the whole Central European region, however, should be confirmed by a detailed correlation with tens further profiles, on the basis of solety two profiles it is difficult to make out what changes of the microflora are resulting from facial influences, what are only of close regional importance and what can be of common, global stratigraphic validity.

Stratigraphic analysis of the microflora from Červený úplaz is made difficult by the fact that in the given case there are two different microfloristic assemblages, not differing very much in age but can be different ecologically only. Considerations on the possible causes and the interpretation of these differences will be mentioned in the next.

I. The microflora of the "lower" claystones (samples p-1-3) contains pollen grains corresponding in age to the Upper Triassic, however, mentioned mainly from the Upper Keuper of Germany and Poland. They are above all the species *Ovalipollis ovalis* (K r u t z s c h 1955) S c h e u r i n g 1970, *Protohaploxypinus subcarpathicus* P a u t s c h 1973. The bad preservation of the microflora hinders from a more precise evaluation of age of this part of the complex, according to the data on stratigraphic range of all the microflora species, however, probably a Norian-Rhaetic age may be ascribed.

II. The microflora of the "upper" claystones (samples p-4-5) contains spores, which are mainly mentioned from the Rhaetian of the Northern Kalkalps, North Germany, England and Poland. Our microflora resembles most the microflora association of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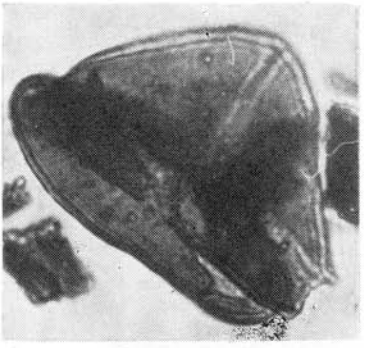
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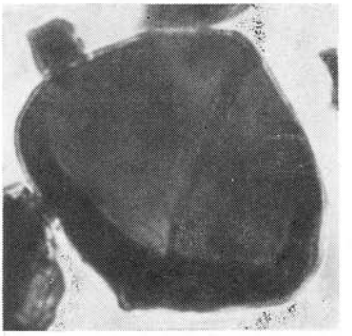
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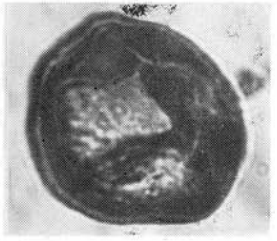
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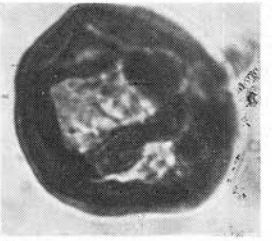
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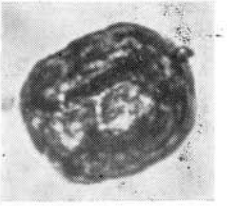
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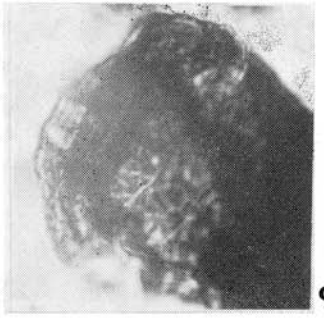
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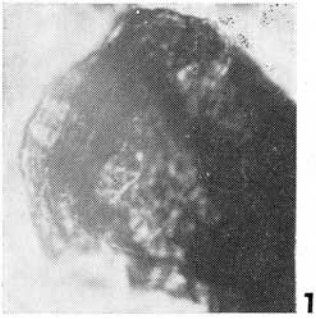
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Plate III. 1—4 *Dictyophylitides harrisii;* 5—6 *Retusotriletes mesozoicus;* 7—8 *Distanulisporites punctus;* 9—10 *Bianulisporites badius.*

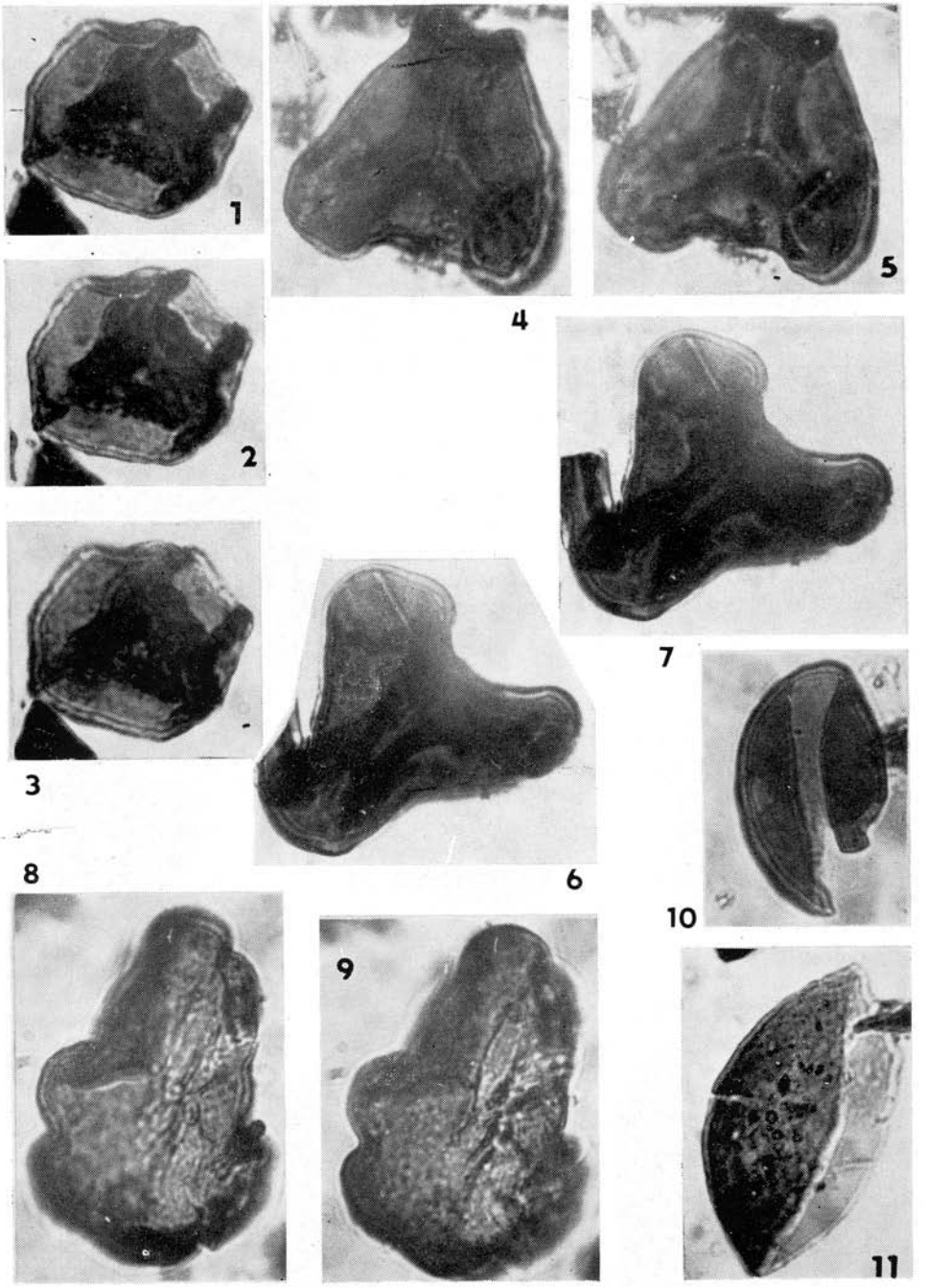

Plate IV. 1—3 *Distanulisporites tomanovae;* 4—5 *Toroiosporis auritorius;* 6—7 *Toroiosporis mesozoicus;* 8—9 *Sporites indet.,* 10 *Monosulcites cf. minimus;* 11 *Cycadopites follicularis.*

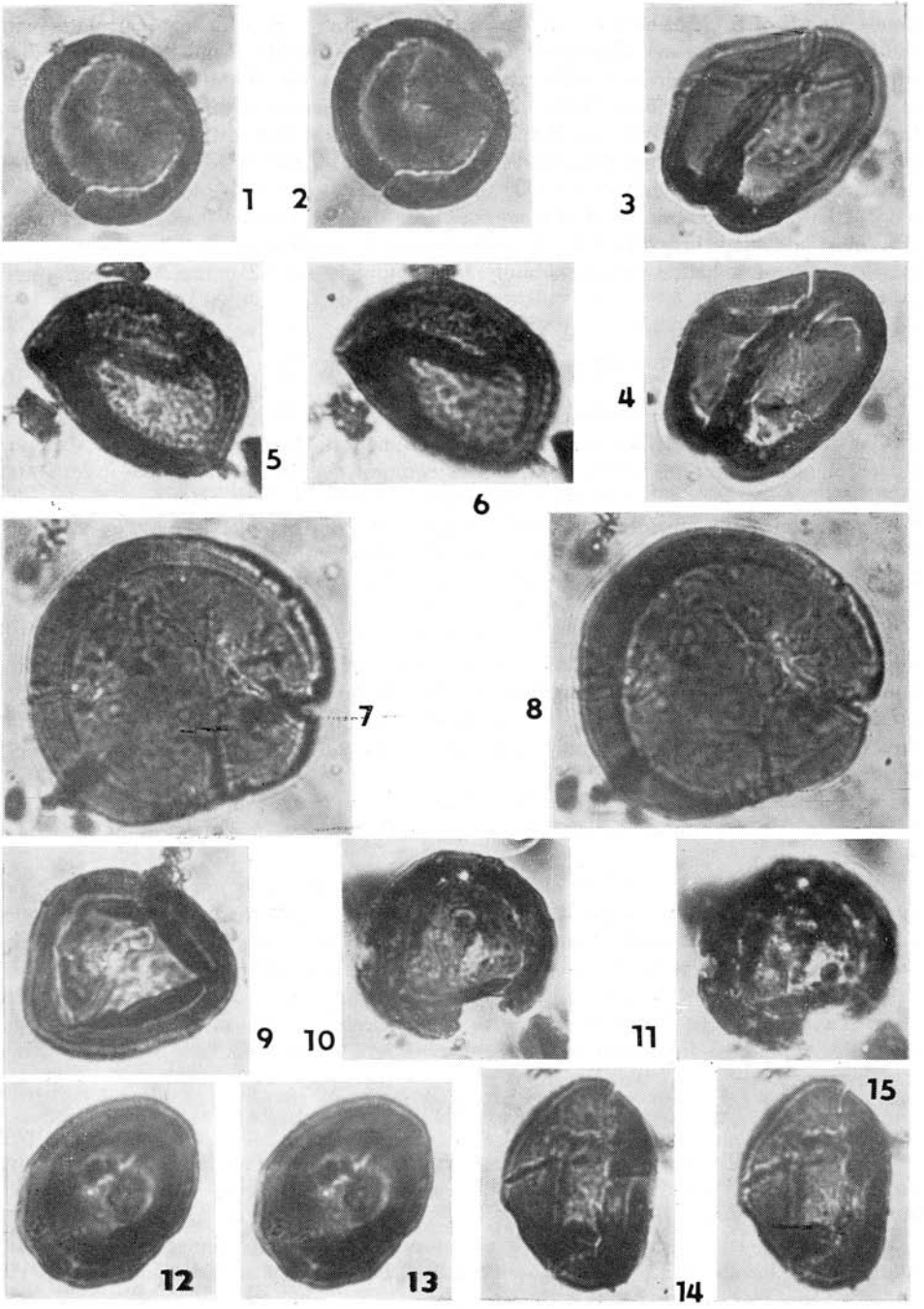

Plate V. 1, 2, 5, 6, 9 *Circulina meyeriana;* 3—4 *Praecirculina granifer,* 7—8 *Circulina tersa,* 11—13 *Classopollis torosus;* 14—15 *Eucomiidites cf. troedssonii.*

Zones Me-Mi of S. J. Morbey (1975), mainly of that part, which he correlates with the range of the Biozone *Choristoceras marshi* in the profile Kendelbachgraben. The set of our microflora agrees chiefly with rich representation of the species *Classopollis torosus, Circulina meyeriana, Toroiosporis mesozoicus, Eucommiidites troidsonii.* Therefore to a certain degree we are justified to suppose that the investigated part of the complex is equivalent to the Zone *Choristoceras marshi* of the profile Kendelbachgraben and corresponds to the higher part of the „Rhaetian sensu lato" (sensu S. J. Morbey 1975). More certainity in determination of the age can be brought with further and more detailed investigation of microflora and profiles of the Tomanová beds, investigation of a better preserved and more complete set of microfauna from more numerous samples.

VII. Paleogeological evaluation (E. Planderová, J. Michalík)

The petrographic and microfloristic differences of the individual parts of the studied profile force us to consider not only two sedimentation periods but also different paleoecological conditions of environment. A common feature of the whole investigated part of the complex is the absence of representatives of Acritarcha in spore pollen horizons, typical of marine sediments. On the basis of this fact it may be supposed that the sedimentation basin had no communication with the sea (this circumstance is also indicated by the investigation of Upper Triassic complexes in adjacent areas of continental development).

The "lower" claystones contain a high percentage of pollen with air sacs, what together with their bad preservation can be a mark of allochthonous microflora, drifted into fresh-water (lacustrine?) environment. The flora of the "upper" claystones was exclusively composed of hydrophilous, probably palustrine Spermophyta. The preservation of spores permits to conclude only on an insignificant transportation, probably within the same environment.

Intercalations of allogene light-coloured quartz sandstones amidst dark claystones confirm the assumption of distinct changes of the environment character in the course of sedimentation.

On the basis of up to present observations as most probable appears the following interpretation: The area of the Tomanová formation represented a depression under a relatively dry continental climate. In more humid seasons sandy washed material accumulated in this area, derived from higher-lying arid areas. Many times an extensive shallow lake with clay sedimentation could have formed, which changed into a low bog-swamp area by drying up, with coelurosaurid lizards and swamp vegetation prevailing including an important component of fern plants.

VIII. Conclusions

The complex, lithological-paleontological investigation of the profile of the Tomanová beds in Červený Úplaz (Tatric, Tichá dolina valley of the High Tatra) has resulted in the following conclusions:

1. Concerned is a complex of dark claystones with intercalations of quartz sandstones and siderite ores, lying in the overlier of Lower Triassic sediments and in the underlier of Liassic quartz-sandy limestones.

2. Extension of the complex is discontinuous due to the influence of later alpine type tectonics and perhaps also primary dissection (?) of the sedimentation area.

3. The complex corresponds to the lithological characteristics of foregoing authors with the exception that in the section studied petrographically the rock is getting more coarse-grained towards the overlier.

4. An interesting fact is the occurrence of chromite in sandstone bed 3.

5. On the sandstone bank in the lower complex part (Rig. 2, 3) casts of traces of a biped coelurosaurid reptile, called *Coelurosaurichnus tatricus n. ichnospec.* were found.

6. Described was one new species *Distanulisporites* t o m a n o v a e n. sp.

7. On the basis of microfloristic investigation we have established two floras close in age, differing in preservation and composition. The age of the lower part of beds is probably Norian-Rhaetian and the age of the upper part very probably corresponds to the Zone *Choristoceras marshi* (upper part of Zone Me and lower part of Zone Mi sensu S. J. M o r b e y 1975).

8. From the paleobiogrographical viewpoint an autochtonous palustrine flora (upper part) and a Gymnospermae flora with the possibility of allochthonous origin (lower part)is concerned.

9. The paleoecological evaluation of organic remains justifies us to the assumption that the sedimentation area of the complex was a continental depression under dry climate, with episodic flood-swamp-limnic sedimentation. Beside others it is proved by the autochthonous character of younger flora and the absence of marine plankton (Acritarcha).

10. The Tomanová beds represent an independent formation, the correlation of which with other formations of the uppermost Triassic of the West Carpathians will have to be carried out in future.

Translated by J. PEVNÝ

REFERENCES

ANDRUSOV, D., 1959: Geológia československých Karpát. Bratislava, Vyd. Slov. akad. vied, 375 p.

BALME, B. E., 1957: Spores and pollen grains from the Mesozoic of Western Australia. Reference T. C. (Chastwood), 25, p. 1—48.

BYSTRICKÝ, J., 1975: The Kössen Beds in the West Carpathians and the problems of their stratigraphical division. Geol. zborn. SAV (Bratislava), Geol. Carp. 26, 2, p. 177—197.

CAROZZI, A. V., 1960: Microscopic sedimentary petrography. N. York—London, J. Willey and Sons. Inc., 485 p.

CLARKE, R. F. A., 1965: Keuper miospores from Wocestershire, England. Paleontology (London), 8, 2, p. 249—321.

COUPER, R. A., 1958: British Mesozoic microspores and pollen grains, a Systematic and Stratigraphic Study. Palaeontographica (Stuttgart), B, 103, p. 75—179.

GOREK, A., 1958: Geologické pomery skupiny Červených vrchov, Tomanovej a Tichej doliny. Geol. sborn. SAV (Bratislava), IX, 2, p. 203—240, t. V-X.

HAUBOLD, H., 1974: Die fossilen Saurierfährten. Wittenberg Lutherstadt, Die Neue Brehm Bucherei 479, A. Z. Verl., 168 p., 94 f., 11 pl.

KARASZEWSKI, W., 1966: Tropy gadów i ślady wleczenia na powierzchni piaskovca retu z Jarug pod Ostrowcem Świętokrzyskim. Kwart. Geol. (Warszawa), 10, 2, p. 327—334.

KARASZEWSKI, W., 1969: Tropy gadów w dolnym liasie świętokrzyskim. Kwart. Geol. (Warszawa), 13, 1, p. 115—119, 4 pl.

KLAUS, W., 1960: Sporen der Karnischen Stufe des ostalpinen Trias. Jb. geol. Bundesanst. (Wien), 5, 5, p. 107—183.

KOTAŃSKI, Z., 1956: O stratigrafii i paleogeografii kajpru wierchowego w Tatrach. Acta geol. Polon. (Warszawa), 6, 3, p. 273—286, t. I—II.

KOTAŃSKI, Z., 1956: O triase wierchowym w Tatrach. Przegląd geolog. (Warszawa), 7, p. 319—323.

KOTAŃSKI, Z., 1959: Stratigraphy, sedimentology and palaeogeography of the high-tatric Triassic in the Tatra Mts. Acta geol. Polonica (Warszawa), 9, 2, p. 113–145.
KOTAŃSKI, Z., 1959: Trias wierchowy. Z badań geologicznych wykonanych w Tatrach i na Podhalu. Biul. Inst. Geol. (Warszawa), 149, p. 143–157.
KOTAŃSKI, Z., 1961: Tektonogeneza i rekonstrukcja paleogeografii pasma wierchowego w Tatrach. Acta geol. Polon. (Warszawa), 9, 2–3, p. 187–476.
LESCHIK, G., 1955: Die Keuperflora von Neuwelt bei Basel II. Iso- und Mikrosporen. Schweiz. Paläont. Abh. (Basel), 70, p. 1–70.
MÄDLER, K., 1964: Die geologische Verbreitung von Sporen und Pollen in der deutschen Trias. Geol. Jb. (Hannover), 65, p. 1–147.
MARCINKIEWICZ, T., 1969: Granica między retykiem i liasem w Polsce pozakarpackiej na podstawie badań florystycznych. Kwart. geol. (Warszawa), 13, 1, p. 99–114.
MORBEY, S. J., 1975: The palynostratigraphy of the Rhaetian stage, Upper Triassic in the Kendelbachgraben, Austria. Palaeontographica (Stuttgart), B, 152, 1–3, p. 1–75, 19 pl., 37 f., 3 tab.
NORRIS, G., 1965: Triassic and Jurassic miospores and acritarchs from the Beacon and Ferar Groups, Victoria Land, Antarctica. New Zeal. Journ. Geol. Geoph. (Wellington), 8, 2, p. 236–277.
PASSENDORFER, E., 1951: Trias. In: Regionalna geologia Polski I, 1. Kraków, Pol. Tow. Geol., p. 1–48.
PASSENDORFER, E., 1961: Rozwój paleogeograficzny Tatr. Roczn. Pol. Tow. Geol. (Kraków), 30, 4, p. 381–387.
PAUTSCH, M. E., 1958: Keuper sporomorphs from Świerczyna, Poland. Micropaleontology (New York), 4, 3, p. 321–325.
PAUTSCH, M. E., 1971: Sporomorphs of the Upper Triassic from a borehole at Turciana near Mielec. Acta Paleobot. (Kraków), 12, 1, p. 1–56.
PETRÁNEK, J., 1963: Usazené horniny, jejich složení, vznik a ložiska. Akademia Praha, 720 p.
RABOWSKI, F., 1922: Sprawozdanie z badań geologicznych, wykonanych w r. 1921 w Tatrach, w Niżnich Tatrach, na plycie Muranów i w Pieninach. Posiedz. Nauk. Państw. Inst. Geol. (Warszawa), 3, p. 11–15.
RABOWSKI, F., 1959: Serie wierchowe w Tatrach zachodnich. Prace Inst. geol. (Warszawa), 27, p. 5–178, 127 fig., 48 tab.
RACIBORSKI, M., 1890: Flora retycka w Tatrach. Rozpr. Wydz. Mat.-Przyr. Akad. Umiejtn. (Kraków), 21, II, 1, p. 243–260, tab. III.
RADWAŃSKI, A., 1968: Studium petrograficzne i sedimentologiczne retyku wierchowego Tatr. Stud. geol. Polon. (Warszawa), 25, p. 1–146, f. 1–6, t. 1–9, tab. I–LIV.
SCHEURING, W., 1970: Palynologische und palynostratigraphische Untersuchungen des Keupers im Bölchentunnel. Schweiz. Paläontol. Abhandl. (Basel), 98, p. 1–121.
SCHULZ, E., 1967: Sporenpaleontologische Untersuchungen rätoliasischer Schichten im Zentralteil der Germanischen Beckens. Pal. Abh. Abt. B. Paleobotanik (Berlin), p. 427–633.
TURNAU-MORAWSKA, M., 1953: Kajper tatrzański, jego petrografia i sedimentologia. Acta geol. Polon. (Warszawa), 3, 1, p. 33–102, 10 pl.
TURNAU-MORAWSKA, M., 1954: Petrografia skal osadowych. Warszawa, Wydaw. Geol., 444 p.
UHLIG, V., 1879: Die Geologie des Tatragebirges. Denkschr. Akad. Wiss. Wien, Math.-Naturw. Cl. (Wien), 64, p. 643–684.
WEAVER, C. E., 1959: The clay petrology of sediments. Clays and Clay Min., Proc. 6-th Conf., New York, Pergamon Press, p. 154–187.
WOJCZIK, Z., 1959: Serie wierchowe południowych zboczy Bobrowca. Acta geol. Polon. (Warszawa), 9, 2, p. 165–202.
ZARICKIJ, P. V., 1956: Karbonatnyje konkrecii uglonosnych otloženij kak pokazateli faciaľnych uslovij osadkonakoplenija. Dokl. Ak. Nauk SSSR (Moskva), 110, 4, p. 634–637.

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