GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATICA 32, 1, BRATISLAVA, MARCH 1981 Pp. 143—153

Z. VAŠÍČEK — J. MICHALÍK*

REMARKS TO THE LOWER CRETACEOUS STRATIGRAPHY AND PALEOGEOGRAPHY OF THE NORTHERN PART OF THE WESTERN CARPATHIANS

(Figs. 1—4)

Abstract: In this paper, several problems of Lower Cretaceous biostratigraphy of the West Carpathian Tethyan segment are outlined. The sequences of this area have to some degree a transitional position between both the French and Bulgarian types of the Mediterranean developments, with several Boreal elements penetrating into its northernmost zones. The authors present results of their recent biostratigraphical researches in Lower Cretaceous complexes of the Krížna-nappe (Fatric zone) in Strážovské vrchy Mts. Also, several paleogeographical pecularities and differences in paleotectonical development of both the Silesic and Fatric zones are outlined.

Резюме: Работа занимается проблемами аммонитовой биостратиграфии в нижнемеловых осадках западнокарпатского участка Тетиса. Области Западных Карпат до некоторой степени занимают переходное положение между французским и болгарским типами средиземноморского развития с некоторыми бореальными элементами в самых северных зонах. Авторы представляют результаты новых биостратиграфических исследований в нижнемеловых комплексах крижнянского покрова фатрикума Стражовских гор. Набрасывают очертания палеогеографических своеобразностей и разницы между палеотектоническим развитием областей силезикума и фатрикума.

Introduction

Lower Cretaceous sequences of the West Carpathian area are relatively poor investigated. Although they have played important role in the beginning of the Carpathian geology (L. Zeuschner, 1856; D. Štúr, 1860; V. Uhlig 1883, 1902...), only several authors studied basic features of their stratigraphy (D. Andrusov — J. Koutek, 1927; D. Andrusov, 1931, 1932, 1934...). The geological and stratigraphical researches developed rapidly in the period after new Czechoslovak state has been established (M. Maheľ, 1946, 1948, 1950, 1958...). The study of Lower Cretaceous sequence increased in importance. M. Maheľ (1958a, 1961, 1962, 1964, 1967) investigated basic lithostratigraphy and tectonics of the West Carpathian Lower Cretaceous sedimentary basins. More recently, several authors studied ammonite biostratigraphy (M. S. Eristavi, 1961; F. Bachmayer, 1963; S. M. Gąsiorowski, 1959, 1962; Z. Vašíček, 1971; 1973, 1977) and microbiostratigraphy (K. Borza, 1969, 1972, 1974; K. Borza et al., 1978, 1979...) in the West Carpathian Lower Cretaceaus sequences.

At present, the biostratigraphical researches in the Lower Cretaceous of

* Ing. Zdeněk Vašíček, CSc., Geology and Mineralogy Dept., Mining University in Ostrava, třída Vítězného února, 708 33 Ostrava-Poruba; RNDr. Jozef Michalík, CSc., Geological Inst. Slovak Acad. Sci., Dúbravská cesta, 886 25 Bratislava, Czechoslovakia.

the West Carpathians are still in beginning phase. Thoroughly and completely evaluated sections are lacking, Lower Cretaceous sequences in the majority of regions have not been stratigraphically divided in detail.

Problems of the Lower Cretaceous ammonite biostratigraphy in the Mediterranean realm

European late Mesozoic sedimentary complexes belong to two clearly different faunistical provinces: to the Boreal, and Mediterranean realm, respectively. The majority of the Tethyan sedimentary complexes belongs to the Mediterranean realm. Detailed biostratigraphical zonation of the Lower Cretaceous sequences is based on the ammonites. The stratotypes of the Mediterranean Lower Cretaceous ammonite zones lie predominantly in southeastern France. Fossiliferous localities of this area have been systematically investigated more than one-and half century ago.

Numerous new biostratigraphical researches in France, Spain, Switzerland, Bulgaria and elsewhere caused several modifications of the traditional Lower Cretaceous biostratigraphical scale. Although an uniform ammonite zonation, applicable in all the Mediterranean province does not exist yet, and, owing to its great extent and variability probable never will arise, several regularities of the faunistical sequences repeat in the majority of its regions. Several newer data have been applied by compilation of Lower Cretaceous biostratigraphical scheme (Fig. 1.): J. Wiedmann's division of Uppermost Tithonian — Berriasian of Spain (1975), the division of French Valanginian/Hauterivian, proposed by J. P. Thieuloy 1973, the scheme of French Barremian division used by R. Busnardo 1965, Aptian division of J. Sornay 1968 elaborated in France, and several data from correlation table of the Cretaceous, published by J. E. van Hinte 1976. Two most important problems of this scheme are concerned with the definition of both the Valanginian/Hauterivian and Hauterivian/Barremian boundaries.

1. Recent French researches indicated that a biostratigraphically undocumented free interval exists between the Upper Valanginian *Saynoceras verrucosum Zone* and Lower Hauterivian *Acanthodiscus radiatus Zone*. J. P. Thieuloy (1977) proposed to divide this interval into two new ammonite zones, assigned to the topmost Valanginian (Fig. 1).

However, G. Mandov (1976) elaborated a different Hauterivian (= the overlie of *S. verrucosum Zone* in his interpretation)biostratigraphical scheme. Mandov's basal Hauterivian *Spitidiscus meneghini and Lyticoceras cryptoceras Zone* yielded characteristic ammonites of two French Uppermost Valanginian Zones together with the oldest representatives of *Crioceratites*. This zone ought be immediately followed by *Oosterella cultrataeformis & Crioceratites loryi Zone*. The „French" index species of Lowermost Hauterivian, *Acanthodiscus radiatus* is not known from Bulgaria, with exception of sole disputable finding besides of Mandov's investigated area. However, none *Crioceratites* occurs in France below the A. *radiatus Zone*. Thus, according to J. P. Thieuloy (1977), Mandov's *meneghini & cryptoceras Zone* probably comprises both two top Valanginian and a part of the basal Hauterivian zones of the French biostratigraphical scale. However, great lateral distance and differences in ammonite assemblages of these two regions pre-

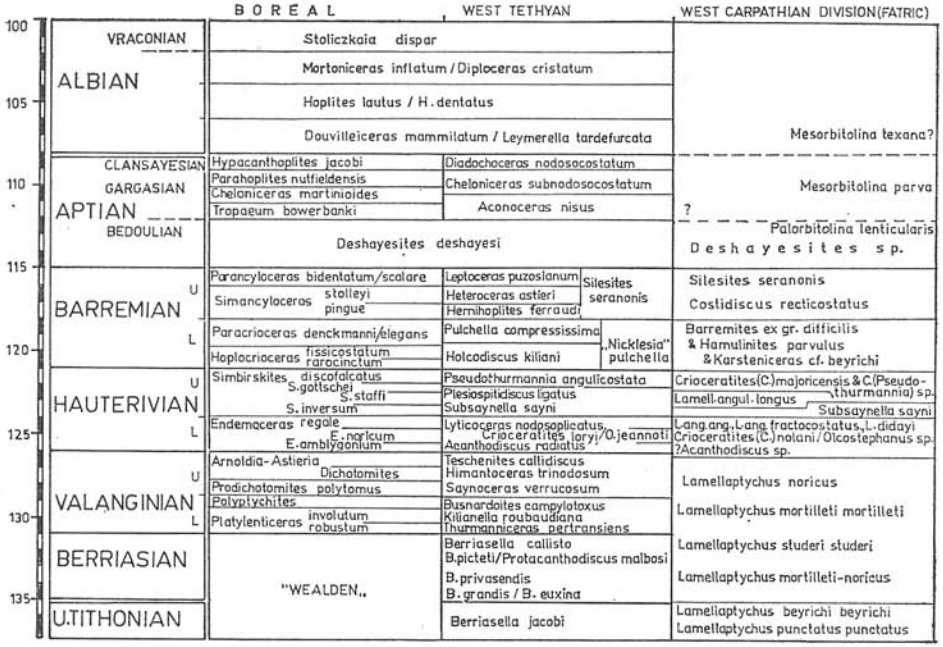

Fig. 1. Comparison of Boreal and West Tethyan (Mediterranean) Lower Cretaceous ammonite biostratigraphy with provisional Fatric (Western Carpathians) Lower Cretaceous biostratigraphical scheme based on aptychi, ammonites and orbitolinids. Personal information given us by E. Köhler used by distribution of the last group. First three columns compiled according to the data from van Hinte (1976) and from other papers, mentioned in the text.

vent definite correlation of their faunistic successions. The fauna of Vocontian trough (J. P. Thieuloy 1977) comprises abundant specimens of probably endemic genus *Breistrofferella* and its relatives, not recorded in Bulgaria. On the other hand, *Olcostephanus,* abundant in Bulgarian sequences is little known from the Vocontian trough.

2. Top Hauterivian *Pseudothurmannia angulicostata Zone* is another source of uncertainties. The holotype of its typical species has been lost. Establishing of the neotype has been impossible for long time, because juvenile whorls of incomplete specimens have been on d'Orbigny's original illustration only imprecisely additionally reconstrued. Removing these uncertainities, J. F. Lapeyre (in J. F. Lapeyre and G. Thomel 1974) demonstrated that the mentioned species occurs in France together with *Crioceratites (C.) emerici,* undoubedly Lower Barremian in age. In contrast, other species of *Pseudothurmannia* have been usually found in association with Upper Hauterivian crioceratitids only. Even when in the present work the so-called *Pseudothurmannia horizon* still figurates as the Uppermost Hauterivian, it probably will be more suitable to transform it to basal Barremian, which is also in agreement with opinions of some other authors.

The study of the Fatric Lower Cretaceous sequence in the Strážovské vrchy Mts.

Uppermost Tithonian up to Lower Aptian deposits are developed in so-called „Neocomian facies". Their macrofrauna consists mostly of cephalopods, being dominated by ammonites, their aptychi, belemnites and less frequent rhyncholites. The ammonites are usually preserved as external molds, their shells being dissolved. This fact may indicate deep depositional environment below aragonite compensation level (ACL), but mostly above the calcite compensation level (CCL): the calcitic aptychi are preserved in unaltered form and composition. The spectra of faunal remains are very different on individual localities, reflecting inhomogenity of the primary environments of deposition. Despite of uneven relief of the bottom two different parts of the sedimentary basin are recognizable in the investigated area: a relatively deep Strážovce-zone, characterized by prevalence of aptychi in the faunistic remnants and by other sedimentary and faunal features (cf. J. Michalík — Z. Vašíček 1980, K. Borza — J. Michalík — Z. Vašíček 1980), and shallower northernmore zones (Nozdrovice-, Lietava-, Mráznica-, Horná Poruba-zone) with relatively rich fossils dominated by ammonite shells.

1. Berriasian—Valanginian sediments of the Strážovce-zone (see Fig. 2.) are imperfectly faunistically documented. Rare ammonite shells are mostly indeterminable, infrequent aptychi are represented by small forms as usually. Bellemnite rostra have been corroded before burial. The faunal diversity increases above the base of Hauterivian. Valangino—Hauterivian species *Lamellaptychus noricus* occurs in association with bochianitid ammonites and sole belemnites *Duvalia dilatata.* Relatively frequent small limonitized planispiral coiled ammonite molds are remnants of pyritized inner whorls of ammonite shells. Its aragonite shell has been dissolved in the early fossilization stage. The fossiliferous horizon in close overlie of Hauterivian base contains rich and diverse aptychi fauna, dominated by several subspecies of *L. mortilleti.* The frequence of aptychi decreases again after first free coiled crioceratitid ammonites appeared. *L. didayi, L. a. angulicostatus* and small rostra of *Pseudobelus brevis* are here the main representatives of macrofauna. Ammonites become rare in upper Lower Hauterivian. Finally, the fauna of Lower/Upper Hauterivian boundary consists mostly of reworked, redeposited broken aptychi *(L. didayi).* Similarly preserved fragments of the aptychi *(L. a. longus)* occur in Upper Hauterivian sequence: they become more abundant in its younger horizons. The youngest investigated sequence of the Strážovce-zone contains scarce *Barremites-* and *Karsteniceras*-fauna, indicating Lower Barremian age.

2. The oldest deposits of the shallower zone (by Nozdrovice, see Fig. 2) yielded an abundant fauna of relatively well preserved aptychi dominating over imperfectely preserved ammonite shells. Valanginian deposits of this zone have not been macrofaunistically documented. The oldest Hauterivian fauna consists of abundant bochianitid ammonites (subordinately also *Teschenites)* and of sole *Lamellaptychus noricus* (localities 1 and 6, see Fig. 2.). The fauna of younger horizons is enriched by several subspecies of L. mortilleti (loc. 2., 5.). The last locality yielded one fragment of *?Acanthodiscus sp.* Because lack of the crioceratitids in this association, described beds be-

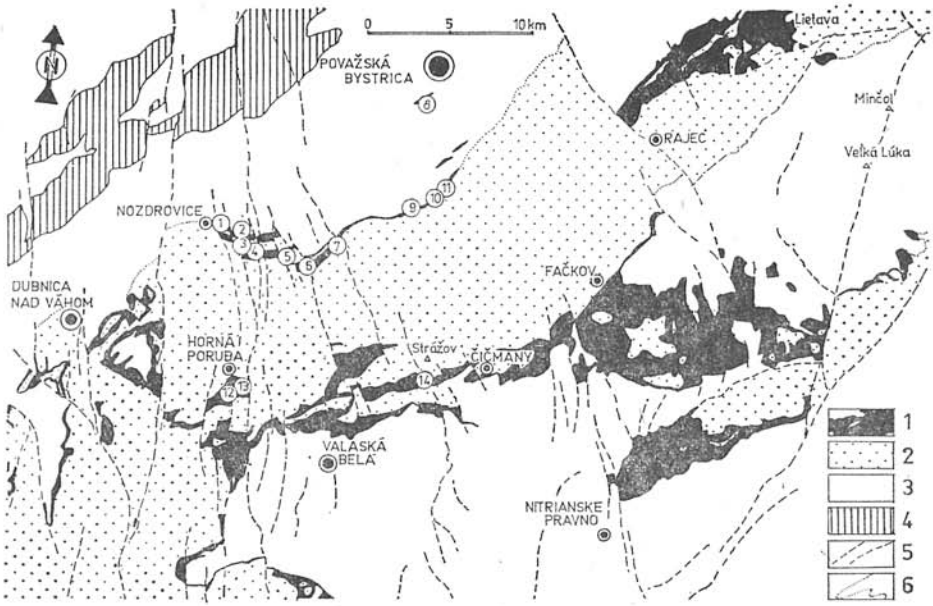

Fig. 2. Distribution of the Lower Cretaceous deposits of Krížna-nappe in the Strážovské vrchy Mts. and localisation of mentioned profiles (numbers in circles).
1 — old way from Dubníky-hill to village Nozdrovice near the water supply reservoir, 2 — forest path on southern slope of Somorova-hill, 3 — forest crest-road on Kamenná-hill, Košecká valley, 4 — escarpment of new forest road in Košecká valley above Štepnice meadows, 5 — small creek ravine below Svinorné-hill, Košecká valley, 6 — small creek ravine below abandoned settlement Mráznica, 7 — escarpment of the road Beluša-Mojtín in Mojtínska valley below Dielec-hill, 8 — road-cut below motorestaurant FIM near Považská Bystrica, 9 — escarpment of the road Visolaje-Pružina in village Tŕstie, 10 — cut of the way to cooperative farm in village Podskalie, 11 — outcrops in the way behind the church in Podskalie, 12 — cut of forest way in the small valley with electric HP-line by village Horná Poruba, 13 — Horná Poruba valley southern of the village, 14 — long escarpment along the new road Zliechov-Čičmany on the southern slope of Strážovce-hill.

Explanation of the symbols: 1 — outcrops of the Fatric Lower Cretaceous rocks in Krížna nappe, 2 — Lower Cretaceous sediments of Krížna nappe buried by younger formations or by higher tectonic units, 3 — area without Lower Cretaceous sediments of Krížna nappe (eroded or never present), 4 — Klippen Belt, 5 — young transverse faults, 6 — probable border of buried Lower Cretaceous sediments.

long probably to the lower part of *A. radiatus Zone.* The fauna of the locality 4. consists of species of *Crioceratites* and *Teschenites.* Fauna of aptychi has been reduced on *L. a. angulicostatus* and *L. a. fractocostatus.* This faunal composition indicates probable equivalence with the higher part of *A. radiatus Zone* (compare Figs. 1 and 3). Similar aptychi fauna probably top Hauterivian in age, lacked of zonal ammonites, has been ascertained on several localities behind the church in Podskalie (loc. 11 on Fig. 2). Upper Hauterivian *Subsaynella sayni Zone* has been confirmed by finding of its typical species on the localities 13 (upper part) and 3. The faunal content of overlying horizons

is relatively poor. A rich fauna has been found again in the horizon, equivalent to the ?Uppermost Hauterivian *P. angulicostata Zone.* Dominating *Crioceratites (Crioceratites)* occurs in association with *C. (Pseudothurmannia)* and with several other aberrant, but also with „regularly coiled" ammonites. The youngest aptychus *L. a. longus* occurs relatively scarcely on several localities (3, 1, 7, 13-middle part, etc.).

Lower Barremian is indicated by sudden and complete substitution of crioceratitids (in other European regions surviving up to higher Barremian) by *Barremites (B.) ex gr. difficilis.* This change was accompanied by general decrease in diversity of fauna. The *„Barremites fauna"* consists mostly of small shells of *Hamulinites* and *Karsteniceras.* Facial differences between individual localities (3, 6, 7, 9, 12—350 m, 13-middle part, 14) were evidently smoothened. The *Barremites*-fauna survived up to Late Barremian, accompanied by *Silesites seranonis,* sometimes also with *Costidiscus recticostatus* (loc. 7, 8, 9, 10, 12, see Fig. 2). Lower Aptian is macrofaunistically proved by finding of *Deshayesites sp.* on sole locality of Horná Poruba (loc. 12, 580 m).

The biostratigraphical research of the Lower Cretaceous deposits in Strážovské vrchy Mts. is complicated by lack of continual sections (with exception of loc. 14). The Tithonian and Valanginian sequences could have been dated with use of aptychi only, owing to the lack of the zonal ammonites. The present state of biostratigraphical knowledge (Fig. 3.) represents the first stage of research, which must be followed by extensive field collecting and thorough systematical evaluation of cephalopod fauna, consisting of about one thousand specimens at present.

The comparison of several West Carpathian Lower Cretaceous ammonite sequences

The ammonite biostratigraphy of the West Carpathian Lower Cretaceous sequences is poorly investigated so far. The term „Neocomian" in facial sense is generally used without more precise dating. The Lower Cretaceous sequences mentioned above are comparable with equivalent sequences of the High Tatra area, studied by J. Lefeld (1974) and with Lower Cretaceous sequences of the western part of Silesic* studied by Z. Vašíček (1979, 1980).

1. Krížna nappe of the High Tatra Mts. The Upper Tithonian deposits are documented with rich ammonite fauna, which has no equivalents in Strážovské vrchy Mts. However, true Berriasian and Valanginian ammonites are lacking in the list, published by J. Lefeld. Two of several ammonite species, considered by this author as Upper Valanginian in age, belong apparently to the Lower Hauterivian. Poor Hauterivian ammonite fauna, mentioned in his paper, comprises none zonal species. It is accompanied by three Hauterivian aptychi *(L. angulicostatus, L. seranonis, L. didayi).*

J. Lefeld diagnosed the Lower Barremian by the occurrence of *Crioceratites emerici.* However, the specimen, figured in his paper (1974, pl. 12) more probably belongs to the Hauterivian form *Crioceratites (C.) nolani* (Kilian).

* Do not confuse with a homonymous unit of the Bohemican massif. Probably a new term is needed.

Fig. 3. Hauterivian division based on ammonite-, aptychal- and microplanctic successions in Krížna nappe of Strážovské vrchy Mts. (with use of the data in Borza K. — Köhler, E. — Samuel, O. 1978 and Borza, K. — Michalík, J. — Vašíček, Z. 1979).

On the other hand, the sole fragment of *Silesites aff. seranonis* is with no doubts of Upper Barremian age.

The Lower Cretaceous fauna, collected by J. Lefeld in this part of the Fatric, seems be incomparable poorer than our collections of Strážovské vrchy Mts. area, lying primary (before Alpine orogenesis) less than two hundred kilometers to the southwest (Fig. 4). Its small faunistical diversity could indicate deep-water environment. However, the aptychi fauna is also poor represented. Thus, some secondary factors like incomplete collecting or tectonical disturbance of the sequence must be taken in consideration. The Early Hauterivian (*Olcostephanus astierianus* horizon) or Late Barremian (*Silesites seranonis* Zone) intervals may be used in the future correlations.

2. Těšín- and Godula — nappe (Silesic) of the Moravskoslezské Beskydy Mts.

Valangino — Aptian sequence consists of dark pelites with pelosiderite lenses and with (more or less) rhythmical sandstone intercalations. Locally it obtains a flyschoid character.

The Berriasian carbonates contain sporadic remnants of cephalopods, indeterminable for the most part. The Valanginian fauna, dominated with ammonites and belemnites (the aptychi are rare) comes from pelosiderite concretions. The „French" zonal ammonites (*Thurmanniceras pertransiens, Kilianella pexiptycha, Busnardoites campylotoxus, Neocomites callidiscus*) occur in association with the Boreal Early Valanginian genus *Platylenticeras*.

Lower Hauterivian sediments contain (V. H o u š a 1976) both the typically Mediterranean *(Acanthodiscus radiatus)* and Boreal elements *(Endemoceras amblygonium)*. Sole exclusively Mediterranean ammonites, belemnites and aptychi have been found in top Hauterivian sequence. Moderately increased sand admixture (in the Těšín area predominantly) accompanied by volcanics, may indicate moderate shallowing.

The Barremian deposits contain rich and diverse exclusively Mediterranean ammonite fauna (approximately 60 species according to Z. V a š í č e k 1972, etc.). Remarkable abundance of aberrant ammonites, inoceramid bivalves and other macrofauna, accompanied by frequent remnants of land plants, indicate relative proximity of dry land.

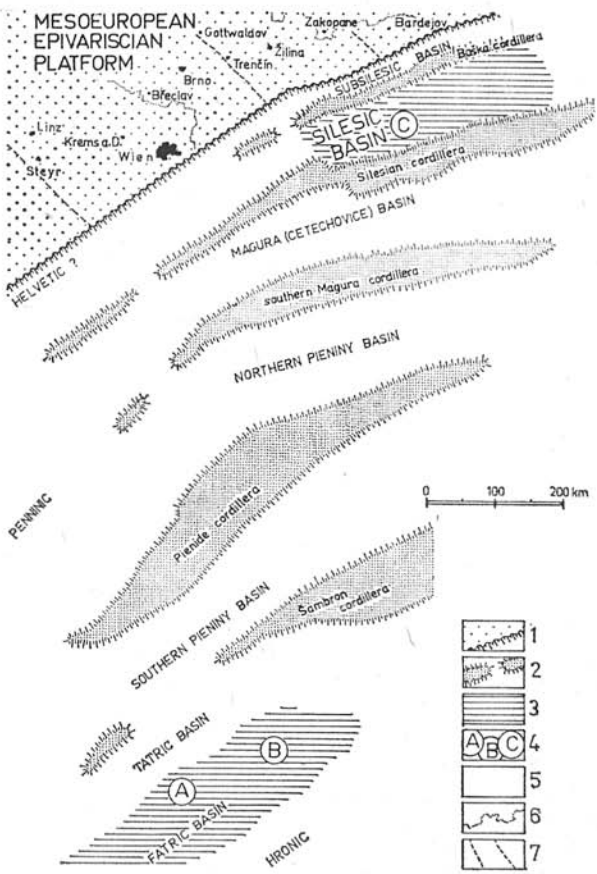

Fig. 4. Approximate situation of correlated regions in Silesic and Fatric in palinspastic map of the West Carpathian area before Middle Cretaceous tectonogenesis. Original, Outer Carpathian palinspastics according to R. U n r u g (1979). *Explanations:* 1 — border of the foreland cratogene, 2 — elevated areas, 3 — correlated basins, 4 — the areas mentioned in the text (A — Strážovské vrchy Mts., B — High Tatra Mts., C — Moravskoslezské Beskydy Mts.), 5 — other basinal areas, 6 — state frontiers, 7 — important fault zones in the cratogene, rejuvenated by later orogeny.

The Lower Aptian sediments are poorer in macrofauna, again. They contain ammonite zonal species *Procheloniceras albrechtiaustriae* and rare specimens of *Deshayesites*.

Conclusions

Owing to imperfect knowledge of the Lower Cretaceous ammonite sequences only two West Carpathian units could have been compared: the Silesic and the Fatric (=Krížna nappe s. l.). The sedimentary areas of both the units were divided by approximately 800—900 km wide zone of Magura-flysch units, Klippen Belt and Tatric, at least. (Fig. 4.).

Considerable facial variability is typical for the Tithonian/Berriasian time in the West Carpathian area. However, the absence of zonal ammonites causes considerable problems with correlation of the sequences in various areas. Carbonate sedimentation in the Silesic finished in the Berriasian. In the same time, the Fatric area deepened and sedimentation rate here considerably slowered. Berriasian fauna is rare, represented mostly by aptychi.

A pelitic sedimentation with rich mixed Mediterranean — Boreal cephalopod fauna started in Valanginian in the Silesic. In contrast, the Valaginian sequence of Fatric is characterised with slowered relatively deep-water marly and carbonate sedimentation, accompanied by local condensation horizons (?) and dissolving of calcitic organic remains.

The Hauterivian sedimentation has been denoted in the Silesic by increasing support of clastics, by volcanism and decreasing of faunistical diversity. On the other hand, the shallowing and increased rate of sedimentation in the Fatric has been accompanied with increasing diversity and abundance of cephalopod (but also benthic) fauna. None Boreal ammonites, abundant in the Silesic, have been found in the Fatric area. This difference was emphasized also by abundance of aptychi, which are almost completely lacking in the Boreal realm.

Finally, the Barremian fauna is of certainly Mediterranean character in the whole Western Carpathians. However, the high diversity and abundance of the Silesic fauna contrasted with the sudden decreasing of the faunal assemblage diversities in the Fatric. Semibenthic crioceratitid fauna has been substituted here by monotonnous pelagic barremitid fauna. All these facts clearly indicate general (?) deepening in the Fatric (which probably caused also submergence of the bariers, separating since Tithonian up to Late Hauterivian both the Fatric and Silesic areas), but increasing of contrasts in bottom morphology of the whole West Carpathian area since Early Barriemian. These changes were probably combined with the effects of arising upwelling of deep oceanic currents, which influenced Carpathian area in the Middle Cretaceous (J. N. Seňkovskij 1978).

Translated by Ing. J. VITKO

REFERENCES

ANDRUSOV, D. — KOUTEK, J., 1927: O rozšíření a stratigrafickém významu vápenců s Calpionella alpina v Západních Karpatech. Věstn. SGÚ (Praha), 3., p. 97—108.

ANDRUSOV, D., 1931: O stratigrafickém rozdělení spodní křídy spodního subtatranského příkrovu na středním Slovensku. Věstn. SGÚ (Praha), 7, 2., p. 152—160.

ANDRUSOV, D., 1932: Geologická studia v pohorí Větrných holí. Věstn. SGÚ (Praha), 8., p. 71—74.
ANDRUSOV, D., 1934: Nová stratigrafie křídy spodního subtatranského příkrovu. Věstn. SGÚ (Praha), 10, 1., p. 225.
BACHMAYER, F., 1963: Beiträge zur Paläontologie oberjurassischer Riffe I—II. Ann. Naturh. Mus. (Wien), 66., p. 125—138.
BORZA, K., 1969: Die Mikrofazies und Mikrofossilien der Oberjuras und der Unterkreide der Klippenzone der Westkarpaten. Bratislava, SAV. 301 p.
BORZA, K. — KÖHLER, E. — SAMUEL, O., 1972: Microfauna and lithostratigraphy of the Palaeogene and adjacent Cretaceous of the middle Váh valley (West Carpathians). Bratislava, GÚDŠ. 246 p., 180 pls.
BORZA, K., 1974: Die stratigraphische Verwendung von Calpionelliden in den Westkarpaten. Proc. X-th CBGA Congr., Strat.-lit. (Bratislava), 1973, I., p. 31—35.
BORZA, K. — KÖHLER, E. — SAMUEL, O., 1978: Chronostratigraphy of Lower Cretaceous with application on West Carpathians. Geol. práce, Správy (Bratislava), 71., p. 123—156.
BORZA, K. — MICHALÍK, J. — VAŠÍČEK, Z., 1979: Stratigrafia a paleogeografia spodnokriedových uložení krížňanského príkrovu v Strážovských vrchoch. Manuscript, Geofond Bratislava. 180 p.
BORZA, K. — MICHALÍK, J. — VAŠÍČEK, Z., 1980: An Upper Jurassic/Lower Cretaceous sequence of the Krížna nappe (Fatric) in Strážovce section, Strážovské vrchy Mts. (Western Carpathians). Geol. zborn. Geol. Carp. (Bratislava), 31, 4, p. 541—562.
BUSNARDO, R., 1965: La stratotype du Barrémien. Lithologie et macrofaune. Mém. Bur. rech. geol. min. (Paris), 34., p. 101—106.
ERISTAVI, M. S., 1961: Nekotoryje nižnemelovyje golovonogije Centraľnych Karpat. Geol. práce, Správy (Bratislava), 21., p. 81—108.
GĄSIOROWSKI, S. M., 1959: Succession of Aptychi-faunas in the Western Tethys during the Bajocian/Barremian time. Bull. Ac. Pol. Sci. (Warszawa), 7, 9., p. 715—722.
GĄSIOROWSKI, S. M., 1962: Aptychi from the Dogger, Malm and Neocomian in the Western Carpathians and their stratigraphical value. Stud. geol. Polon. (Warszawa), 10., p. 1—144.
HOUŠA, V., 1976: Spodnokřídové formace, doprovázející tělesa tithonských vápenců u Štramberka I—II. Čas. slez. Mus. (Opava), A 25, I., p. 63—85, 119—131.
LAPEYRE, J. F., 1974: Révision de l'ammonite spécies-index Pseudothurmannia angulicostata d'Orbigny. Ann. Mus. Hist. Nat. (Nice), 2., p. 81—86.
LAPEYRE, J. F.— THOMEL, G., 1974: Considération sur la valeur et la position stratigraphique précise de la zone á Angulicostata (Néocomien). C. R. hebd. séanc. Ac. Sci. (Paris), D 278., p. 288—2992.
LEFELD, J., 1974: Middle/Upper Jurassic and Lower Cretaceous biostratigraphy and sedimentology of the sub-tatric succession in the Tatra Mts. (Western Carpathians). Acta geol. Polon. (Warszawa), 24, 2., p. 277—366.
MAHEĽ, M., 1946: Geológia strednej časti Strážovskej hornatiny. Geol. práce, Zošity (Bratislava), 14., p. 5—116.
MAHEĽ, M., 1948: Tektonika územia medzi stredným tokom Váhu a hornou Nitrou. Geol. práce, Zošity (Bratislava), 18., p. 1—78.
MAHEĽ, M., 1950: Tektonika subtatranských príkrovov v strednej časti Strážovskej hornatiny. Geol. sborn. SAV (Bratislava), 1, 2—4., p. 251—252.
MAHEĽ, M., 1958 a: Príspevok k chápaniu tektonického zmyslu maloštruktúr a megaštruktúr krížňanskej jednotky v Strážovskej hornatine. Geol. práce, Zprávy (Bratislava), 14., p. 9—12.
MAHEĽ, M., 1958 b: Vápence v albe západoslovenskej série v Strážovskej hornatine. Geol. práce, Zprávy (Bratislava), 14., p. 13—16.
MAHEĽ, M., 1961: Nové poznatky z niektorých „kľúčových území" v Strážovskej hornatine. Geol. práce, Zprávy (Bratislava), 20., p. 29—70.
MAHEĽ, M., 1962: Stratigrafický prínos vo výskume jury a spodnej kriedy Centrálnych Západných Karpát a jeho dôsledky. Geol. práce, Zprávy (Bratislava), 62., p. 187—204.
MAHEĽ, M. et col., 1962: Vysvetlivky ku geologickej mape ČSSR 1 : 200 000, list Žilina. Bratislava, Geofond. p. 5—272, 4 pls.

MAHEL, M. et al., 1964: Geologická mapa ČSSR, mapa predštvrtohorných útvarov 1 : 200 000, list Žilina. Bratislava ÚÚG.
MAHEL, M. et al., 1967: Regionální geologie ČSSR II, 1. Praha ČSAV. 486 p.
MANDOV, G., 1976: Chotrivskijt etaž v Zapadnite Balkanidy i negovata amonitna fauna. God. Sof. Univ. (Sofia), 67., p. 11—99.
MICHALÍK, J. — VAŠÍČEK, Z., 1980: K problémom palinspastickej a paleogeografickej rekonštrukcie spodnokriedového sedimentačného priestoru krížňanského príkrovu v Strážovskej hornatine. In: Vážnejšie problémy... etc. Zborn. mat. sem. symp. konf. GÚDŠ (Bratislava), 3., in print.
SEŇKOVSKIJ, J. N., 1978: Paleookeanografija karpatskogo melovogo apvellinga. Geol. žurn. (Moskva), 38, 6., p. 54—63.
SORNAY, J., 1968: Termes stratigraphiques majeurs, article Aptien. In: Lexique stratigraphique international. Paris, 8. p. 109.
STUR, D., 1860: Bericht über die geologische Übersichtsaufnahme des Wassergebietes der Waag und Neutra. Jb. geol. Reichsanst. (Wien), 11, 1., p. 17—151.
THIEULOY, J. P., 1977: La zone á Callidiscus du Valanginien supérieur (sud-est de la France). Lithostratigraphie, ammonites-faune, limite Valanginien/Hauterivien, corrélations. Géol. Alpine (Grenoble), 53., p. 83—142.
UHLIG, V., 1883: Die Cephalopoden der Wernsdorfer Schichten. Denkschr. Wiss., math.-nat. Kl. (Wien), 46., p. 127—290.
UHLIG, V. 1902: Über die Cephalopodenfauna der Teschener und Grodischter Schichten. Denkschr. Ak. Wiss., math.-nat. Kl. (Wien), 72., 87 p.
UNRUG, R., 1979: Palinspastic reconstruction of the Carpathian arc before the Neogene tectonogenesis. Roczn. Pol. Tow. geol. (Krakow), 49, 1/2., p. 3—21.
Van HINTE, J. E., 1976: A Cretaceous time-scale. Am. Ass. Petr. Geol. Bull. (Tulsa), 60, 4., p. 498—516.
VAŠÍČEK, Z., 1971: Zur Biostratigraphie des tieferen Teils (Malm-Alb) der Schlesischen Einheit (Beskiden, Tschechoslowakei). N. Jb. Geol. Paläont., Mh. (Stuttgart), 1971, 3., p. 181—192.
VAŠÍČEK, Z., 1972: Ammonoidea of the Těšín—Hradiště Formation (Lower Cretaceous) in the Moravskoslezské Beskydy Mts. Rozpravy ÚÚG (Praha), 38, 103 p.
VAŠÍČEK, Z., 1973: K biostratigrafii i paleogeografii nižnej časti silezijskoj jedinicy v jeje godulskom razvitii (verchnjaja jura — nižnij apt). Mat. X. Kongr. KBGA (Bratislava), 1973, I., p. 217—223.
VAŠÍČEK, Z., 1977: Makrofaunistická charakteristika dílčích tektonických šupin ve slezské jednotce (malm-cenoman). Sb. věd. prací VŠB, Ř. horn.-geol. (Ostrava), 23, 1., p. 177—194.
VAŠÍČEK, Z., 1980: Biostratigraphie des Mesozoikums der silesischen Einheit in Nordos Mähren. Sb. věd. prací VŠB, ř. horn.-geol. (Ostrava), 24, 1978, p. 1—28.
VAŠÍČEK, Z.,1979: Die Cephalopodenfauna der schlesischen Unterkreide und ihre paläogeographische Bedeutung. Aspekte der Kreide Europas. IUGS Ser. A, 6, p. 323—334.
WIEDMANN, J., 1975: The Jurassic/Cretaceous boundary as one of the Mesozoic system boundaries. In: Colloque sur la limité Jurassique — Crétacé, Lyon — Neuchâtel. Bur. Rech. géol. min. (Paris), 86., p. 358—362.
ZEUSCHNER, L., 1856: Geognostische Beschreibung des Liaskalkes in der Fatra und in den angrenzenden Gebieten. Sonderb. Ak. Wiss. (Wien), 19., p. 136—182.

Manuscript received April 28, 1980