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THE MIDDLE CRETACEOUS IN HUNGARY

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The territory of Hungary is a characteristic "internide area" within the Alpine mountain system. As a consequence of this fact the development of its Mesozoic and Tertiary formations and the tectogenetic evolution of the territory were different in character compared to the folded-napped tectonics of the Alps and Carpathians. Their spatial position reflects essentially original paleogeographic conditions, rendering recognizable some connections with the North Alpine-Carpathian and south Alpine facies areas, but, in the southern part of the country, dinaric features are also present.

The sensitivity of the internide area accounts for the good manifestation of synorogenic events.

On account of the considerable differences in the structural and geological setting of Hungary, the position of the Middle Cretaceous sediments with respect to the surface and, consequently, the degree of their exploration are markedly different in the various area units. First of all, mention should be made of the Transdanubian area, where they are, as a rule, in a near-surface position, being often represented by outcrops. Consequently, they can be said to be well-known, whereas the Mesozoic rocks buried by 1000 to 3000 metres of Tertiary sediment in the Great Hungarian Plain /Alföld/ can only vaguely be identified even to the precision of a stratigraphic system.

The Middle Cretaceous formations are the products of a sedimentary basin with an unstable bottom. Their presence has been proved in three parallel belts :

–the Transdanubian Central Mountains belt;

–the Mecsek Mountains belt;

–the Villány Mountains belt.

In addition, it is possible that strata of the same age may have been preserved in the area of transition from Jurassic to Cretaceous sedimentation, thus representing a fourth belt, the facies area of Békés.

The fossil assemblage of the Middle Cretaceous are rather rich as a rule, but their biostratigraphic value is, on account of the facies-dependent forms characteristic of most of these formations, mostly subordinate.

The Middle Cretaceous of the Transdanubian Central Mountains consists of calcareous and argillaceous sediments varying both vertically and horizontally. The Mecsek Mountains belt is mostly sandy pelites ; the Villány Mountains limestone and marl.

The Albian formations can be found in all three zones; except for the single limnic formation of the Transdanubian Central Mountains, all are marine.

Cenomanian formations are known in the Central Mountains and Mecsek Mountains belts, whereas the only known occurrence of the Turonian occurs in the Mecsek Mountains belt. Both the Cenomanian and the Turonian are marine.

Albian

1. The lack of any communication between the northeastern and southeastern ends of the Transdanubian Central Mountains was terminated by the Aptian transgression which produced crinoidal limestones. After the disappearance of the Early Cretaceous ridge that extended along the axis of the Mesozoic geosyncline the sedimentary basin was tilted to the northeast, as evidenced by the arrangement of the post-Aptian transgresive Middle Cretaceous.

The sequence includes five formations (see appendix 1), of which the first three, representing basal formations, are facies mutually replacing one another. Cited from the north to the south, these are the following :

–the Vértessomló Siltstone

–the Kõraye Limestone

–the Tès Clay

The first two are separated from each other by the syngenetic Vértessomló fault line of NNW trend, whereas the Környe Formation grades into the Tés Formation so that the former plunges over a considerable length beneath the latter, pinching out in a southwesterly direction.

1.) The Vértessomló Siltstone.

The Formation could not be subdivided into biozones, but the possibilities for this exist in principle. Although it contains a considerable quantity of smaller ammonites, frequently filled with gel-pyrite, these are completely useless excepting such forms as (/*Kossmatella jacobi* Wiedmann, *Leymeriella (Proleymeriella) revili* Jacob, *L. romani* Jacob, *Puzosia* sp., *Uhligiella* sp./). In addition to this, the macrofauna contains only : *Anisocardia*, *Corbula Rostellaria ebrayi* de Loriol, *Arca valdensis* P. et C., *Linearia connensis* de Loriol, "*Straparollus*" *pellati* Cossm., *Metacerithium albensis* d'Orb. and a few poorly preserved sea urchins.

The foraminifers are abundant, of which the benthonic species, mainly, calcareous, play the leading role ; *Gavelinella rudis* (Reuss), *G. intermedia* (Berth.), *Lenticulina*, *Tristi excavata* (Reuss), *Patellina subcretacea* Cushm et Alex, *Epistomina*, etc. The following arenaceous benthonic forms are most frequent : *Dorothia filiformis* (Berth.), *Marssonella*, *Orbitolina texana* (Roem), *Reophax*, *Textularia*, *Tritaxia*. The following are useful indices :

Flabellammina sp., *Glomospira gordialis* (Jon et Parker), *Proteonina* sp., *Triplasia goodlandensis* (Cushm. et Alex). The relatively poor planktonic foraminiferal fauna contains, besides *Globorotalites* sp., only *Hedbergella* species : *Hedbergella cretacea* (d'Orb.), *H. infracretacea* (Glaessner), *H. delrioensis* (Carsey), *H. portsdownensis* /Will.-Mitch/, *H. planispira* /Tarr./, *H. washitensis* /Carsey/ and *Ticinella* sp. Microfossiliferous horizons can be identified, primarily on the basis of abundances, within single borehole profiles, but these cannot be correlated with one another.

The ostracod fauna is diversified and rich in individuals : *Cytherella, Dolocytheridea, Schuleridea, Habrocythere, Acrocythere, Paracypris, Cythereis, Triebellocythere,* etc. The study of the nannofossil content of the formation has not yet been undertaken.

The rich assemblage of sporomorphs is characterized /pl 1/ by :

a/ the fact that gymnosperms are still absent :

b/ the great abundance of angiosperm pollen grains and fern spores. Of the pteridophytes, it is the spores of tropical fern families that predominates : Schizaeceae, Gleicheniaceae, Matoniaceae. First of all, we have the *Trilites* group which can be assigned to Schizaeaceae. In addition, the striate forms of the same fern family *(Cicatricosisporites, Appendicisporites)* as well as species of the Gleicheniaceae occur abundantly *(Gleicheniidites, Clavifera* and *Ornamentifera).*

Of the gymnosperms, *Classopollis torosus* is a predominant form. Bisaccate coniferous pollen grains *(Alisporites, Parvisaccites, Abietinae-pollenites)* and the monosaccate *Glialasporites* are less abundant.

The sporomorph assemblage shows a rather marked affinity to the spore-pollen assemblages of Barremo-Aptian sediments.

The formation is made up of rather homogeneous grey calcareous and slightly sandy siltstones with subordinate silty marls or calcareous sandstones. The last-mentioned rock type is characteristic of the line of contact with the Környe Limestone.

2. The Környe Limestone

The faunal assemblage of the formation is constituted mainly by reef-building macrofossils and other kinds of benthonic microorganisms unsuitable for the discrimination of zones. Among the macrofossils the molluscs are by far the most widely distributed : *Toucasia carinata* (Matheson), *Lopha rectangularis* (Roemer), *Agriopleura* sp., *Lamellotis* sp., *Astarte urgonensis* Cossm., *Cardium cureti* Cossm. Furthermore, there are hermatypic and minor abermatypic corals and algae.

In addition, gastropods ar abundant, mainly in the basal beds (*Cerithium* and *Nerinea*).

The microfauna is characterized by larger Foraminifera : *Orbitolina beremendensis* Méhes and, *Orbitolina texana* Roemer. Among the smaller Foraminifera occuring in fair to low numbers and, exclusively benthonic (mainly arenaceous) the following are relatively significant, *Cuneolina conica* d'Orb., *C. walteri* Cush.-Wat., *F. magna* Alex-Smith., several *Haplophragmoides* and *Reophax* species *Gaudinella barremiana* Bettenstaedt, *G. cf. intermedia* Berth., *Choffatella decipiens* Schlumb., *Involutina hungarica* (Sidó) and *Meandrospira washitensis* Loebl.-Tappan.

The rather poor ostracod fauna is not significant even stratigraphically : *Cytherella ovata* /Roemer/, *C. cf. parallela* /Reuss/, *Schuleridea derooi* Damotte-Grosdidier, *Dolocytheridea intermedia* Oertli, *Stravia brevis* /Cornuel/ etc.

The Környe Limestone was not examined for nannofossils.

In accordance with its position with respect to the reef body, the limestone is massive, thick- or thin-bedded, containing bioclasts of varying size and quantity. The colour of the limestone is whitish or dark gray, sometimes light red. The interbedded thin clay and argillaceous marl layers gradually increase in number towards the Tés Clay.

3. The Tés Clay.

Representing, all in all, a brackish-water deposit, the Tés Clay is the result of sedimentation in environments of alternatively freshwater to subnormal salinity. The attempts at stratigraphic zonation thus far undertaken have failed to yield satisfactory results, though the fossils are rather diversified. This fossil content, is characterized for the most part by an abundance in specimens rather than in species.

The overwhelming majority of the macrofauna consists of Bivalvia and Gastropoda. *Ostrea, Exogyra* and *Lima* (*L. essertensis* Loriol) are often abundant, even lumachelle-like, but various representatives of *Corbula, Arca* and *Modiola* are not infrequent. Besides being richer in species, compared to the lamellibranchs, the gastropods are not outnumbered significantly by the former, in number of specimens : *Cerithium* sp., *Procerithium* sp. ind., *Paracerithium baconicum* Vadász, *Metacerithium intermedium* Cossm., *M. trimonile* (Michelin), *Rostrocerothium baconicum* Vadász, *R. vialovi* Benkőné, *Cerithiella tenuiplicata* Cossm., *Calliostoma sociale* Cossm., *Pseudomelania urgonensis* Cossm., *P. allardi* Cossm., *Nerinea aptiensis, Haustator vibrayeanus* (d'Orb.), *Acteonella baconica* Vadász, *Trochactaeon, Ovactaeonina* sp., etc.

In spite of their low number, the following brachiopods may be characteristic of some subbasins : *Terebratula sella* Sow., *T. praelonga* Sow., *T.* cf. *depressa* Lamk., etc... Among the echinoids, there are species of *Pseudodiadema, Holectypus, Archiacia,* and *Enallaster.* The anthozoans are represented by *Thecosmilia* sp., *Trochosmilia* sp., *Cyclolites* sp. and *Trochocyathus* cf. *subconulus* Pillet.

The foraminiferal assemblage of the formation consists of sparse benthonic forms in a poor state of preservation. Species of *Orbitolina* are often well preserved : *O. lenticularis* Lamk., *O. discoidea* Gras., *O.* cf. *concava* Lamk. In addition, the following forms are worth mentioning : *Choffatella decipiens* Schlumberger, *Flabellamina (F. alexanderi* Cush. et Wath., *F. magna* Alex et Smith), *Ammobaculites, Cuneolina* and *Involutina.*

The formation is rather rich in ostracods. Half of the species are endemic forms described from this formation, so that they need not be quoted here. As for the rest, mainly the following genera are worth notice : *Cytherella ovata* (Roemer), *C.* cf. parallela (Reuss.), *Cytherella stroiata* (Jones-Hinde), *Macrocypris, Darwinula, Pontocyprella rara* Gründel, *P. maynci* Oertli, *Paracypris, Cythereis büchlerae* Oertli, *C. bartensteini* Oertli, *Neocythere, Dolocytheridea bosquetiana* Jones-Hinde, *D. intermedia* Oertli, *Schuleridea jonesiana* (Bosquet), *S. derooi* Damotte-Grosd., *Homocythere reticulata* Kaye, *Veenia florentinensis* Damotte, *Saida, Stravia, Mandocythere,* etc.

The nannofossil content of the formation is extremely poor. Just a few representatives of *Nannoconus* and single species of *Watznaueria, Markalius, Braarudosphaera* and *Lithastrinus* are known.

The flora is represented by *Munieria baconica* Deecke, an algal species frequently occurring in abundance, and a specifically rich sporomorph assemblage (Plate 2).

The first angiosperm pollen appears already in the lower beds. (Their first representatives are thin-walled tricolpate or thick-exined monosulcate forms.). Of the pteridophyte spores, the number of *Trilites* species is greatly reduced and striate spores can also be found in a smaller number of species and specimens. The afore-mentioned Schizaeceae spores are replaced by new, mainly smooth spore forms of uncertain botanical relations (*Dupexisporites, Purgatisporites, Conbaculatisporites*). The Matoniaceae, Gleicheniaceae fern families are represented by a few new species. The Lygodiumtype spores of Schizeaceae occur in a great number.

Of the gymnosperm pollen, the number of *Classopollis* is geatly reduced, their place being occupied by *Araucariacites hungaricus* and a few *Inaperturopollenites* species. Bisaccate pollen is extremely rare. *Ephedripites dudarensis* is a characteristic species of this formation. The predominant rock of the Tés Formation is argillaceous marl, but interbbeded layers of marls and calcareous marls and clays are also frequent ; moreover, limestone beds with *Munieria* can also be observed. The colour of the rock varies from grey to variegated, the latter being predominant. Colour, carbonate and fossil content vary from subbasin to subbasin. The rock is always more or less silty ; in rare cases sandstone and carbonaceous clay intercalations also occur. Moreover, in the vicinity of Zirc, the base of the sequence is made up to pizoidic detritus consisting of products of weathering of older Mesozoic rocks (mainly cherts). The formation is underlain in some places by bauxite lenses.

The Zirc Limestone

The Zirc Limestone grades rapidly and continuously from the underlying Tés Clay. On the basis of its lithology and fossil content, it can be split up, over much of the area, into several, vertically successive units (of member rank). Most characteristic and everywhere recognizable is the lowermost limestone, very rich in *Pachydonta*, though the *Orbitolina* limestone immediately overlying it and the uppermost, so-called "platy", limestone are frequently also characteristic. The formation can be called rich both macro- and microfaunistically ; richness implying number of specimens rather than species.

The most significant macrofossil group of the formation is the molluscs : *Requienia ammonia* Gold., *Agria blumenbachi* Studer, *Toucasia carinata* Matheron, *Pseudotoucasia santanderensis* Douvillé, representatives of *Lamellotis* and *Exogyra* ; furthermore *Nerinea archimedi* d'Orb., *N. gigantea* d'Orb., *N. (Dizoptyxis) coquandiana* d'Orb., *Acteonella baconica* Czabalay, *Globiconcha baconica* Hantken, *Fusus* sp., *Avellana* sp. In the younger members of the formation, the number of echinoids increases / *Holaster laevi* Deluc, *Pseudoholaster baconica* Szörényi, *Hemiaster baconicus* Szörényi, *Caenoholectypus macropygus* (Désar), *Catopygus nasutus* (Désar) ; *Caenoholectypus macropygus* (Désar) / ; ammonites also accour : *Stoliczkaia dispar* (d'Orb.).

The microfauna consists of benthonic foraminifers. Of these, only the *Orbitolina* are worthy of being mentioned : *Orbitolina praeconica* Méhes, *O. texana lata* Méhes and *Orbitolina baconica* Méhes.

Only larger nannofossils are known at present : *Stomiosphaera sphaerica* (Kaufman), *Pithonella ovalis* (Kaufman), *Pithonella trejoi* Bonet.

The limestone is, over much of the area, light grey to yellowish-gray ; in the upper third it becomes gradually more and more glauconitic. The lithology is calcareous-sandy, thin bedded, with uneven bedding planes. In the southwestern extremity of the formation, the limestone is greyish-white, light brownish-grey; in the lower part it becomes pink. Here the formation is thick-bedded and, unlike the previous case, indivisible. The transition between the two areas cannot be followed due to postgenetic denudation.

The Pénzeskut Marl.

The Pénzeskut Marl is the only Middle Cretaceous formation that can be satisfactorily subdivided into zones. Despite its striking difference in lithological features from the Zirc Limestone, it does not appear to overly a sediment older than this. A rather insignificant hiatus, increasing to the northeast, can be shown to exist between the two formations.

The age of the formation is shown, by the very rich and well-preserved macro- and microfauna, to correspond to the "Vraconian", though the fact that it extends into the Cenomanian where not eroded can also be evidenced by the fauna. Both subzones, *substuderi* (Spath, 1941) and *dispar-perinflatum* (Spath, 1941), of the Vraconian can be distinguished and identified. The *substuderi* subzone is represented by the following ammonites : *Stoliczkaia (Farandiella) rhamonota* (Seeley), *S. blanchei* (Pict.-Camp.), *S. sexangulatus* (Seeley), *S. nota* (Seeley), *Mortoniceras (Cantabrigites) minor* Spath, *M. cantabriginense* Spath, *Salazaciceras slazacense* (Héb. Mun.-Ch.), *Scaphites hugardianus* d'Orb., *S. simplex* Juk.-Br., *Turrilitoides hugardianus* d'Orb., *T. toucasi* (Héb.-Mun.-Ch.), *T. intermedius* (Pict.-Camp.), *Paraturrilites gresslyi* (Pict. Camp.), *P. nobilis* (Juk.-Br.), *P. escheriana* (Pict.), *Anisoceras suaussureanum* (Pict.), *A. pseudoelegans* Pict.-Camp., *A. nanaense* (Hauer), *Hamites virgulatus* Brongn. The *dispar-perinflatum* Subzone includes the following forms : *Stoliczkaia dispar* (d'Orb.), *S. dorsetensis* Spath, *S. clavigera* Neum., *Mortoniceras (Durnovarites) perinflatum* (Spath), *Puzosia mayeriana* (d'Orb.), *Discohoplites valbonesis* (Héb.-Mun.-Ch.), *D. subfoleatus* (Semenow.), *Paraturrilites (Bergericeras) beyeri* (Brongn.), *Ostlingoceras puzosianum* (d'Orb.).

Both subzones include the following forms : *Mortoniceras rostratum* (Spw.), *Desmoceras latidorsatum* (Mich.), *Lechites quadini* (Pict.-Camp.), *Lechites fasciata* Scholz, *Scaphites meriani* Pict.-Camp., *Anisoceras armatum*, (Sow.), *A. perarmatum* Pict.-Camp. Bivalves and gastropods are also stratigraphically important. Echinoids are of great importance, both specifically with 13 species, and in numbers. They can also be used for distinguishing biozones. Accordingly, the glauconitic lower member can be correlated with the *Holaster subglobosus* (Leske) biozone, the part overlying it, with the *Holaster trecensis* Leymerie biozone.

The foraminiferal assemblage is important. There are many planktonic and benthonic forms, the latter, mainly at the base of the sequence. The number of foraminiferal species exceeds 160. Two of the 3 biozones identifiable within the formation on the basis of planktonic Foraminifera belong to the "Vraconian" : 1. *Planomalina buxtorfi* - *Rotalipora appenninica*, 2. *Globigerinelloides aeglefordensis* - *Rotalipora* cf. *greenhornensis*, and, essentially, they agree with the ammonite-based biozones.

The ostracod fauna is poor in individuals and rich in species. The species *Cytherella ovata* (Roemer), *C.* cf. *parallela* (Reuss) and *Pontocyprella maynci* Oertli are the most frequent, but *Cythereis büchlerae* Oertli, *C. gatyensis* Dam.-Gros., *C. lürmannae* Triebel, *C. matronae* Dam.-Gros., tec., *Neocythere lingenesis* Mertens, *N. semilaeva* Kayet, etc., *Bairdia pseudoseptentrionalis* (Mertens), *Isocythereis*, *Dolocytheridea*, are also frequent.

The nannofossils, though significant, have not been studied in detail up to the present, apart from forms of comparatively larger size, such as *Stomiosphaera*, *Pithonella* and *Calcispherula*.

The Pénzeskut Marl contains a poor sporomorph assemblage which is, however, rich in forms (Plate 3) and which can be shown to be akin to the sporomorph assemblage of the Tés Clay. The main difference is the larger specific and individual number of angiosperm pollen grains. Beside monosulcate *Clavatipollenites* and *Crassipollis*, numerous species of tricolpate *Tricolpites* appear in the formation under consideration.

Of the pteridophytes spores, those of the Lycopodiaceae show an increase (*Vadaszisporites*, *Camarazonosporites*).

though fern spores invariably retain their predominant role. Striate spores (*Corniculatisporites*, *Appendicisporites*) increase in number again. *Trilites* occurs sporadically.

The quantity of gymnosperm pollen decreases in relation to the older Albian sediments ; this is particularly true for the inaperturate, monosaccate and bisaccate forms. *Classipollis* species are replaced by *Classoidites* species.

The rock consists of limestones, calcareous marls and nodular, dark grey to greenish-grey silty marls, with an extremely high glauconite content in the lower 5 to 20 metres, and a lesser content in the upper beds. The lime content shows a slightly decreasing trend upwards. The youngest beds of the formation extend into the Cenomanian.

Albian is not found in certain parts of the **Mecsek Mountains.** Over the rest of the range, however, some boreholes have penetrated probably.

Albian formations.

Little sampling has been carried out in this area of rapid facies changes which is why it has not been possible to establish the stratigraphic sequence nor to produce a biostratigraphic zonation. The foot-wall of the formation is usually a volcanic sedimentary one, of Early Cretaceous age.

The fauna consists of varying abundances of Foraminifera which are often in a poor state of preservation, being characterized locally by the predominance of benthonic forms, in other places by that of planktonic species. The latter consists of *Hedbergella delrioensis* Carsey and *Ticinella roberti* Gandolfi ; *Rotalipora* sp. also occurs. In addition, there are representatives of the *Radiolaria*, *Cadosina*, *Globochaeta* and Ostracoda.

In the Danube-Tisza interfluvial area (Kaskantyu-1, Soltvadkert-7, Lajosmizse-1) many rocks belonging to this formation can be encountered : conglomerates, sandstones, clays, marls and limestones. Marls of varying carbonate content and usually dark, greenish or brownish in colour represent the commonest rock type.

Interbedded tuff layers are not infrequent ; also agglomerates of diabases occur within the sequence. Some of the limestone is bioclastic and glauconitic.

In **Transdanubia**, a characteristically Albian fauna was only found in the dary grey, siliceous, bituminous calcareous marls of the borehole Tamási-1. Accordingly, the rocks of similar lithology recovered from the borehole Ebes-1 in the Tiszántul (area lying east of the Tisza river) also seem to correspond to the Albian.

In the **Villány Mountains belt**, the Albian is represented by one limestone formation (Nagyharsány Limestone) and one marl formation (Bisse Marl).

The age of the upper member of the **Nagyharsány Limestone** (which partly overlies the Kimmeridgian and has developped continuously in part from the Aptian) is dated by *Orbitolina beremendensis* Méhes and *Simplorbitolina manasi* Ciry et Rad. as corresponding to the Realy Albian. The macrofaunal content is significant and diversified. The most frequent fossil is the Pachyodonta bivalve (*Toucasia carinata* Matheron, *Agria* aff. *darderi* var. *pyrenaica* Astre), though *Lamellotis hantkeni* Horváth is also present. There are also corals : *Calamophyllia* cf. *stutzi* Koby, *Actinastrea* cf. aff. *konincki* (Edw. et Haime) and gastropods : *Nerinea coquandi* d'Orb., *N. prefleurasi* Delpey, *Ampullina* sp. Microfauna : benthonic Foraminifera : *Orbitolina*, Miliolidae, Textularidae, Rotalidae, Anomalidae, *Cuneolina* sp., Ostracoda.

The flora has so far been found to be represented by *Salpingoporella dinarica* Rad. and *Bacinella irregularis* Rad.

The light grey, bedded limestone is bioclastic-pseudoolithic, with some limestone and dolomite detritus and some quartz sand in the part underlain by Kimmeridgian sediments. The greatest known thickness is 30 m. The fauna has not yet been studied thoroughly and it can only be supposed that a part of the limestones of similar lithology known from numerous boreholes in the Danube-Tisza interfluvial area may belong to the Albian.

The Bisse Marl

Overlying the Nagyharsány Limestone, the Bisse Marl has been dated, by the species *Kossmatella agassiziana* Pictet, as being Middle Albian.

The macrofauna contains a few cephalopods : *Mortoniceras* sp., *Hamites* sp., *Hemiptychoceras*, *Hadrocheilus hungaricus* Strausz, *Akidocheilus cor* Strausz. *Neohibolites* sp. and one or two bivalves.

The greatest part of the microfauna belongs (49 genera embracing 113 species) to the Foraminifera. Specifically, benthonic forms are predominant, while individually this role belongs to the planktonic forms. The most significant stratigraphic indices are the following : *Ticinella roberti* (Gand.), *Hedbergella trocoidea* (Gand.), *H. infracretacea* (Glaessn.), *Spiroplectammina complanata* (Reuss), *Epistomina spinulifera* (Reuss). The character of the fauna is defined, by the following families : Textularidae, Verneuillinidae, Lagenidae, Rotalidae, Globigerinidae, Anomalinidae. The Foraminifera are accompanied by a few representatives of Radiolaria and Ostracoda.

The quantity of nannofossils is also significant : these are in an extremely poor state of preservation. Nevertheless, although only *Discolithus embergeri* Noel and *Nannoconus steinmanni* Kamptner could be determined at the species level, the 45 m thich sequence could be split up into six horizons on the basis of the abundances of the fossils.

The rather rich sporomorph assemblage is characterized by the predominance of fens ; the consistent occurrence of bisaccate coniferous pollen of differentiated structure, of *Cedrus* and *Picea* type and the presence of *Encommiidites troedsonii* Erdtman. Among the fern spores, the representatives of *Cicatricosisporites* and *Ischysporites* are already sporadic in occurrence ; on the contrary, the forms of varied ornament of the genus *Corrugatisporites* (e.g. *C. toratus* Weyl et Greif.), as well as those of *Gleicheniidites* (*G. angulatus*, *G. umbonatus*, *G. latus*), and also *Vadászisporites urkuticus* Deák and *Duplexisporites generalis* Deák, occur frequently.

The Bisse Marl is constituted by yellowish-grey silty marls attaining a maximum of 45 m in thickness. It overlies conformably Albian limestones, without transitions between the two formations. Outside the immediate area of the Villány Mountains, the formation is not known to occur.

Cenomanian

In the **Transdanubian Central Mountains** the Cenomanian includes the upper part of the Pénzeskut Marl already discussed in connection with the Albian sediments. The age determination has been based mainly on the ammonite fauna : *Mantelliceras mantelli* (Sow.), *Hyphoplites* sp., *Calycoceras* sp., *Turrilites tuberculatus* (Sow.), *T. gravesianus* (d'Orb.).

It is still too early to attempt to draw the boundary between the Albian and Cenomanian on the basis of the microfauna.

Sporomorphs do not point to there being a well-defined devergency between the Early and Late Cenomanian, as the evolution of the flora was contiruous.

In the *Mecsek Mountains belt*, Cenomanian formations could be identified at only three points : one in a rather small outcrop (Vékény Marl) within the mountainous region, one in the borehole Szigetvár-3, immediately west of the mountains, and one in the borehole Kaskantyu-1 in the Danube-Tisza Interfluvial.

The Vékény Marl

The Vékény Marl does not contain macrofossils.

The microfauna is dominated by the foraminifers, with planktonic forms dominating : *Praeglobotruncana helvetica* Bolli, *Praeglobotruncana stephani* (Gandolfi), *Rotalipora appenninica* (Renz), *R. montsalvensis* Mornod, *R. cushmani* Morrow, *Hedbergella saratogensis* Tappan, *Clavihedbergella subdigitata* Carman, *H. infracretacea* Glaessner. Accordingly, the formation represents the *Rotalipora greenhornensi - Rotalipora cushmani* Zone. Moreover, benthonic Foraminifera are numerous.

The nannofossils have not been studied.

Vékény Marl is of a red colour, both the lower and upper boundaries are tectonically controlled. It attains 7 m in thickness. In spite of its yellowish-grey colour, the marl recovered from borehole Szigetvár-3 is also considered to belong to this stratigraphic unit.

Turonian

Thus far, only one Turonian locality is known in Hungary. This is borehole Kerekegyháza-5 in the Danube-Tisza Interfluvial.

The macrofauna is insignificant, only a few fragments of echinoids have been recovered.

The microfauna is represented by Foraminifera and Ostracoda. Among the Foraminifera, it is the planktonic organisms that predominate : *Globotruncana lapparenti* Brotz, *G. lapparenti coronata* Bolli, *G. marginata* (Reuss), *G. sigali* Reichel, *Praeglobotruncana helvetica* Bolli, *P. renzi* Thalmann, *P. delrioensis* (Plumm), *Hedbergella infracretacea* (Glassner), *H. cretacea* (d'Orb.), *Clavihedbergella subdigitata* (Carman), *Globorotalites conicus* (Carsey), *Anomalina ammonoides* (Reuss), *Planulina spissocostata* Cushm., *Heterohelix globulifera* (Reuss), *H. globulosa* (Ehrb.).

The nannofossil content is unknown. Spores and pollen are absent.

The rock is composed of redbrown to greyish-brown argillaceous marls.

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Dépôt du manuscrit : 30 Septembre 1975

SUMMARY

Because of the restricted extent of Middle Cretaceous sediments and of the relative stability in the geological evolution of the time, the Middle Cretaceous formations play a subordinate role in the geological structure of Hungary. The sub-Hercynian—pre-Gosau and Laramian orogenic movements, which were less intensive than in the neighbouring countries, have caused, in agreement with earlier movements of lesser intensity, a zonal arrangement in the structure of the Mesozoic basement. Therefore, it is useful to discuss the Middle Cretaceous formations in relation to their distribution in pre- and post-tectonic belts.

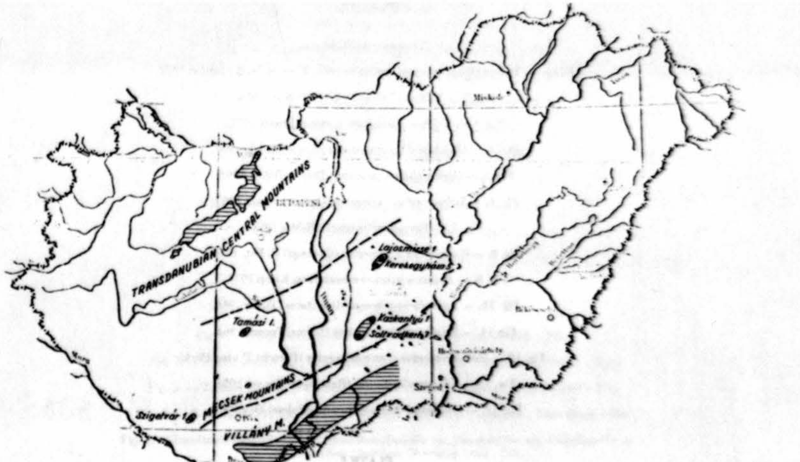
At present, Middle Cretaceous rocks are known to occur in three zones :

the Transdanubian Central Mountains belt,
the Mecsek Mountains belt and
the Villány Mountains belt.

The formations of this age vary largely in distribution and in degree of exploration in the various belts. The most diversified geological features (palustral, littoral, pelagic sediments : variegated clays, various types of limestones, glauconitic marls, etc.) and the most advanced studies are characteristic of the Transdanubian Central Mountains belt. In the Villány Mountains belt, only Albian shallow-water (littoral to sublittoral) limestones and marls of slight thickness and surface extent are known to occur. The Mecsek Mountains belt is least well known, as Middle Cretaceous formations are only known from deep boreholes, apart from one small outcrop. These sedements are all, without any exception, of marine origin, being formed of red, variegated or grey sedimentary deposits, mainly marls ; sandstones, limestone breccias and even basic volcanic rocks of the same age are also known.

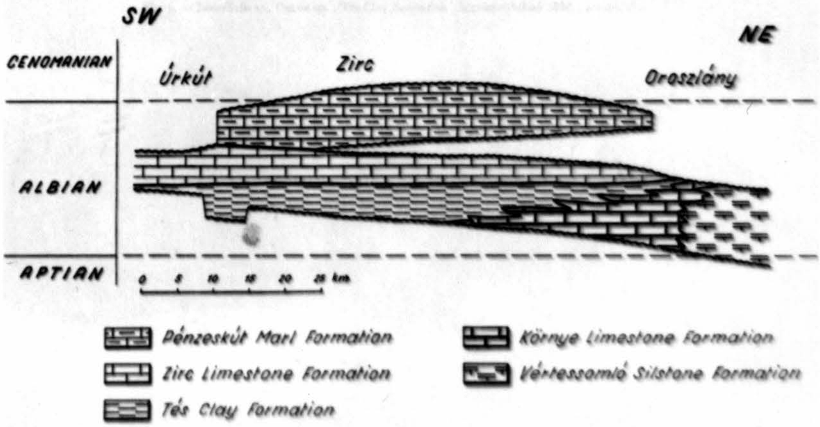
Thus, the Hungarian Middle Cretaceous is represented primarily by marls which are rich in microfossils, but mostly poor in macrofossils. In spite of this fact, a satisfactory and reliable ammonite scheme has been established for one formation, the Pénzeskut Marl. The second richest rock type is a marine limestone, notably, a limestone of shallow-water origin, frequently of reef character. A typical feature of this formation is the richness of the macrofauna in relation to the microfauna. On account of the character of the fauna, these formations can be subdivided only on a local basis. There is only one, albeit not fully, marine formation, a sediment of dessicatory lagoonal origin, with palustrial features (the Tés Clay) ; in this formation, brackish-water and marine episodes frequently intervene. The zonal schemes that could be established for this formation cannot be extrapolated beyond the limits of subbasins.

The fauna of the majority of the formations bears witness to South-Alpine-Dinaric affinities, though there are also examples of North Alpine-Carpathian influence.



Supplement 1 Middle Cretaceous of Hungary

MIDDLE CRETACEOUS FORMATIONS OF THE TRANSDANUBIAN CENTRAL MONTAINS



Supplement 2

PLATE 3
Pénzeskut Marl

Fig. 1. — Vadaszisporites sacali Deák et Combaz 1967.

Fig. 2. — Camarozonosporites cerniidites (Ross) W. Kr. 1959.

Fig. 3. — Duplexisporites generalis Deák 1962.

Fig. 4. — Trilites (Bikolisporites) toratus baconicus Juhász 1972.

Fig. 5. — Acritosporites triangularis (Bolch.) Obonizkaja 1964.

Fig. 6. — Costatoperforosporites triangulatus Deák 1962.

Fig. 7. — Nodosisporites costatus Deák 1964.

Fig. 8. — Cicatricosisporites mediostriatus (Bolch.) Pocock 1964.

Fig. 9. — Classoidites glandis van Ameron 1965.

Fig. 10-13. — Angiosperm pollen.

PLATE 4

Fig. 1. — Praeoglobotruncana div. sp. borehole Kerekegyháza-5 ; 22x.

Fig. 2. — Rotalipora div. sp., Hedbergella sp. ; Vékény Marl Formation ; Vékény ; 38x.

Fig. 3. — Tritaxia div. sp. ; Pénzeskut Marl Formation ; borehole Pusztavám-980 ; 27x.

Fig. 4. — Hedbergella div. sp. ; Ticinella div. sp. ; Bisse Marl Formation ; Tenkeshegy ; 48x.

Fig. 5. — Involutina hungarica (Sidó), Ammobaculites div. sp., Reophax div. sp., Flabellamina sp. ;
Tés Clay Formation ; borehole Oroszlány-1825 ; 20x.

Fig. 6. — Choffatella decipiens Schlum., Lenticulina div. sp., Ostracoda div. sp. ;
Tés Clay Formation ; borehole Csehbánya-5 ; 20x.

Fig. 7. — Chara oogonium, Munieria baconica Deecke ; Tés Clay Formation ; borehole Csehbánya-5 ; 35x.

Fig. 8. — Hedbergella div. sp., Euguttulina sp., Reophax sp., Gavelinella sp., Dorothia sp. ;
Vértessomló Siltstone Formation ; borehole Tatabánya-1462 ; 20x.

PLATE 5

Fig. 1. — Toucasia carinata (Math.) ; Zirc Limestone Formation ; Lókut ; natural size.

Fig. 2. — Pseudotoucasia santanderensis (Douvillé) ; Zirc Limestone Formation ; Bakonybél, Feketehegy ; natural size.

Fig. 3. — Lopha rectangularis (Roemer) ; Tés Clay Formation ; borehole Oroszlány-1822 ; natural size.

Fig. 4. — Adiozoptyxis coquandiana d'Orb. ; Tés Clay Formation ; borehole Oroszlány-1822 ; natural size.

Fig. 5. — Nerinella algarbiense Choffat, Nerinea (Plesioptyxis) prefleuraui (delpey) ;
Tés Clay Formation ; borehole Bokod-1828 ; natural size.

Fig. 6. — Lamellotis sp., Ostrea sp. ; Tés Clay Formation ; borehole Bokod-1828 ; natural size.

PLATE 1.

Vértesomló Siltstone

Fig. 1. — Trilites (Bikolisporites) toratus toratus (Weyl. et Greif.) Juhász 1972.

Fig. 2. — Trilites (Trilites) triangulus Kds. 1964.

Fig. 3. — Trilites (Pereisporites) minor Juhász 1972.

Fig. 4. — Gleicheniidites umbonatus (Bolch.) Bolch. 1968.

Fig. 5. — Gleicheniidites carinatus (Bolch.) Bolch. 1968.

Fig. 6. — Ischyosporites variegatus (Couper) Schulz 1967.

Fig. 7. — Foveosporites canalis Balme 1957.

Fig. 8. — Neoraistrickia truncatus (Cookson) R. Pot. 1956.

Fig. 9. — Appendicisporites concentricus Kemp 1971.

Fig. 10. — Appendicisporites parviangulatus Döring 1966.

Fig. 11. — Staplinisporites caminus (Balme) Pocock 1964.

Fig. 12. — Rotverrusporites obscurilaesuratus (Pocock) Döring 1964.

Fig. 13. — Classopollis torosus (Reissinger) Couper 1958.

Fig. 14. — Callialasporites segmentatus (Balme) Dev 1961.

PLATE 2

Tés Clay

Fig. 1. — Plicatella trichacantha Malj. 1949.

Fig. 2. — Trilobosporites gibberulus (K.-M.) Pocock 1964.

Fig. 3. — Matonisporites major Deák 1964.

Fig. 4. — Ischyosporites estherae Deák 1964.

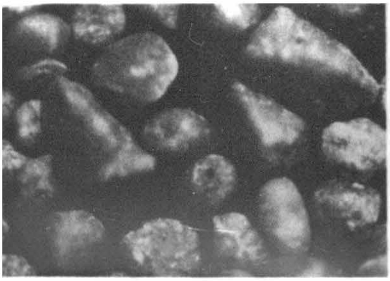
Fig. 5. — Vadaszisporites pseudofoveolatus (Deák) Deák et Combaz 1967.

Fig. 6. — Purgatisporites purus Deák 1964.

Fig. 7. — Inaperturopollenites undulatus Weyl. et Greif. 1953.

Fig. 8. — Ephedripites dudarensis Deák 1964.

Fig. 9-11. — Angiosperm pollen.



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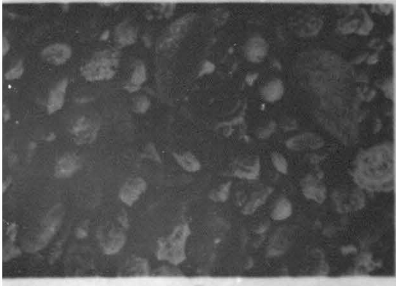

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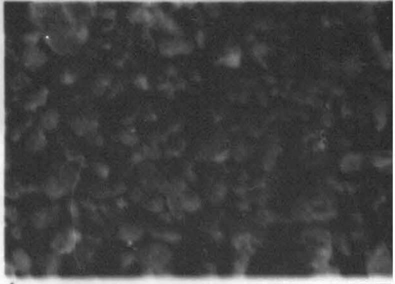

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Plate 4
Compiled by M. Sidó

XI. 13

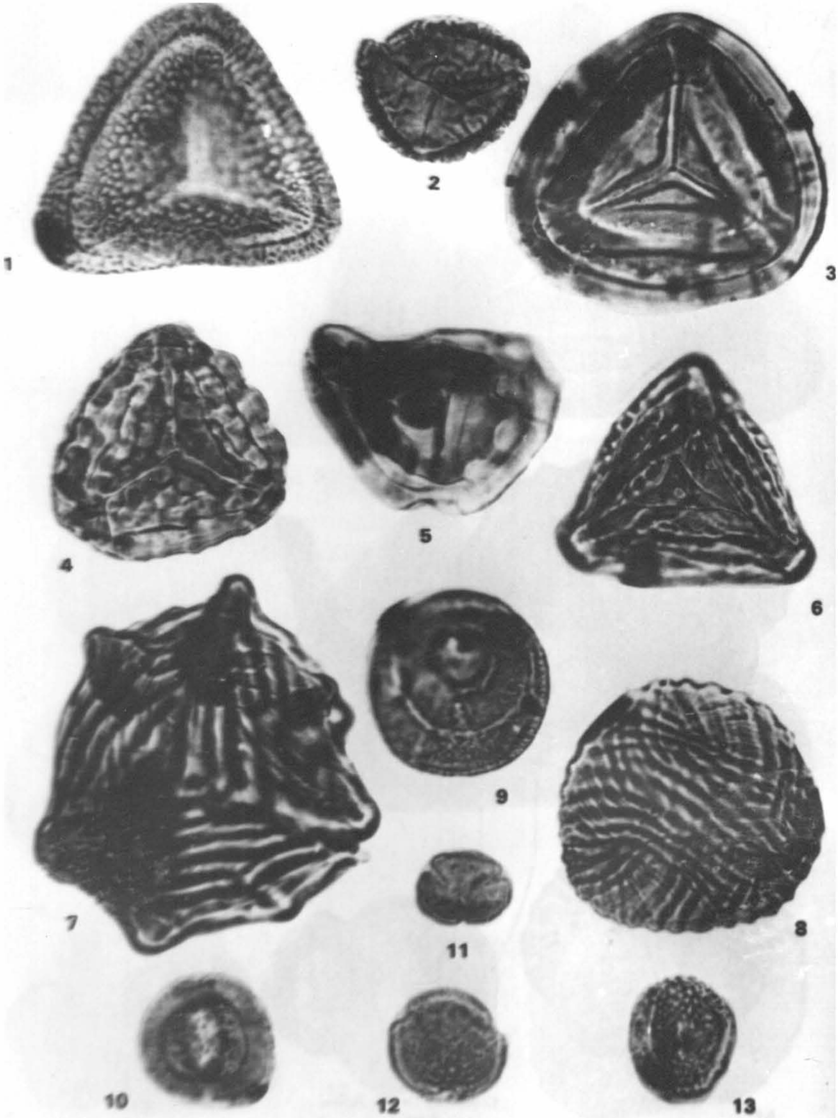

Plate 3
Compiled by Dr. M. Juhász

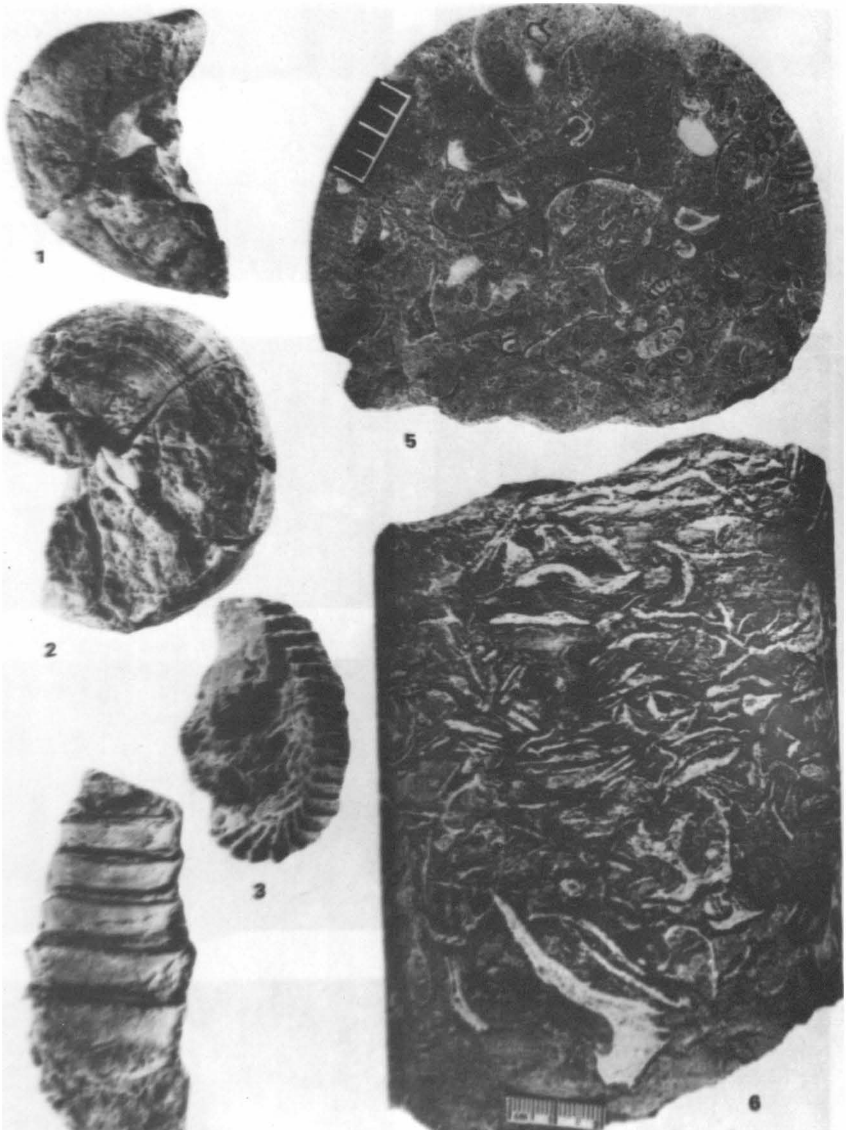

Plate 5
Compiled by Móráné L. Czabalay