Newsl. Stratigr.	4 (3)	174–202	3 Figs., 1 Tab.	Berlin · Stuttgart, 29. 3. 1976

Current Oligocene/Miocene biostratigraphic concept of the Central Paratethys (Middle Europe)

by FRITZ STEININGER, FRED RÖGL and ERLEND MARTINI*

with 3 textfigures and 1 table in two parts

IGCP Project 73/I/25: "Stratigraphic Correlation Tethys – Paratethys Neogene"

* Authors' addresses: Doz. Dr. F. STEININGER, Paläontologisches Institut der Universität Wien, Universitätsstr. 7, A-1010 Wien, Austria.

Dr. F. RÖGL, Naturhistorisches Museum Wien, Burgring 7, A-1010 Wien, Austria.

Prof. Dr. E. MARTINI, Geologisch-Paläontologisches Institut der Universität Frankfurt, Senckenberg-Anlage 32–34, D-6000 Frankfurt am Main, Germany.

Abstract: The most important Oligocene and Miocene calcareous nannoplankton, silicoflagellate, planktonic and benthonic foraminifera and mollusk data which are important for defining the biostratigraphic intervals in the marine Oligocene and Miocene of the Central Paratethys are discussed and summarized in Table 1, part I, II, and the Latdorfian and Rupelian and the recently proposed marine late Oligocene/Miocene chronostratigraphic stages (Egerian – Eggenburgian – Ottnangian – Karpatian and Badenian from oldest to younger) of the Central Paratethys (Central Europe) are described. The correlation of some classical mammalian faunas (tab. 1, part II) to this proposed marine stratigraphic sequence is discussed, and the general paleogeographic setting of these areas briefly outlined.

A tentative biostratigraphic correlation of the chronostratigraphic units of the Central Paratethys with the "Cenozoic planktonic time scale" and the classical European stage system is presented.

Zusammenfassung: Die wesentlichen biostratigraphischen Grundlagen (Verbreitung von kalkigem Nannoplankton, Silicoflagellaten, planktonischen und benthonischen Foraminiferen und Mollusken) zur biostratigraphischen Gliederung des marinen Oligozäns und Miozäns in der zentralen Paratethys Mitteleuropas werden diskutiert und sind auf einer zweiteiligen Tabelle zusammenfassend dargestellt. Damit wird der Umfang für Latdorf und Rupel sowie für die in der zentralen Paratethys neu aufgestellten marinen oberoligozänen und miozänen chronostratigraphischen Stufen (Egerien, Eggenburgien, Ottnangien, Karpatien und Badenien) beschrieben.

Für einige der klassischen Säugetierfaunen (tab. 1, part II) dieser Gebiete wird eine verläßliche Korrelation mit der lokalen marinen Abfolge gegeben.

Die Korrelationsmöglichkeiten des Stufenschemas der zentralen Paratethys mit der känozoischen Planktonzonierung und dem klassischen Stufenschema Europas werden aufgezeigt.

1 Introduction

The Paratethys concept – created by LASKAREV (1924) for the classical Oligocene and Neogene sedimentation areas in central Europe – was lately put foreward by the Paratethys working group. SENES (1959, 1960, 1961), SENES et al. (1971), CICHA & SENES (1973) introduced and established the division into a Western, Central and Eastern Paratethys area, each part more or less characterized by its own geodynamic and faunistic development.

The Central Paratethys (Fig. 1) extends from Bavaria, Germany, throughout the foredeep of the Alps and the Carpathians to Rumania and includes the following intramontaneous basins: the Vienna Basin (Fig. 1:1), the Intracarpathian Basin (Fig. 1:2) the Styrian Basin (Fig. 1:3), the Drava/Sava Depression (Fig. 1:4) and the Transsylvanian Basin (Fig. 1:5).

Whereas the faunal development of early and middle Oligocene within the Central Paratethys is still comparable with the Mediterranean and Northern European Bioprovinces, these Central Paratethys areas differentiate in the late Oligocene and increase throughout the Neogene their own bioprovincial character. The different faunal development and the difficulties in the further usage of the classic terms of the European Neogene time scale within the Central Paratethys sedimentation areas (PAPP & STEININGER

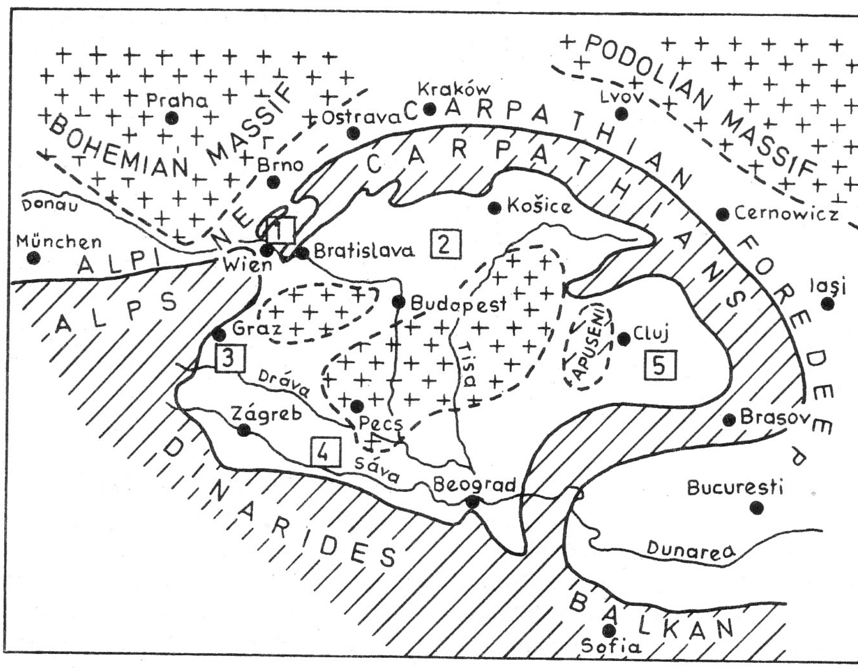


Fig. 1. Oligocene / Neogene Sedimentation Areas of the Central Paratethys: 1 - Vienna Basin; 2 - Intracarpathian Basin; 3 - Styrian Basin; 4 - Drava/Sava Depression; 5 - Transsylvanian Basin (partly after SENES et al. 1971).

1973) gave rise to a new regional chronostratigraphic stage concept (BALDI 1969; CICHA & SENES 1968; PAPP & al. 1968). These regional stages of the Central Paratethys (Egerian, Eggenburgian, Ottnangian, Karpatian, Badenian, Sarmatian, Pannonian, Pontian, Dacian and Romanian from oldest to younger) are based on an "integrated assemblage zone" biostratigraphic concept, which was outlined by STEININGER & SENES (1971) and STEININGER (in press).

The geodynamic evolution of this area is characterized by the uplift and thrustfaulting of the Alpine-Carpathian-, Dinarid and Balcan mountain chains and the subsiding of the intramontane basins (see Fig. 1). This fact was accounted for by SENES & MARINESCU (1974) in developing a model distinguishing three significant steps in the geodynamic evolution of this area: the Eoparatethys (Egerian to Ottnangian), the Mesoparatethys (Karpatian and Badenian) and the Neoparatethys (Sarmatian to Romanian) (Fig. 2, 3).

The present contribution summarizes the biostratigraphic ranges of the most important groups – see Table 1, part I, II – used for a correlation by the way of the "Cenozoic Planktonic Reference Time Scales" – as proposed by BERGGREN (1972, 1973), BERGGREN & v. COUVERING (1974), BLOW (1969), BOLLI (1966) and MARTINI (1971) with the European Oligocene and Neogene stages and other regional stage systems on the one hand and worldwide faunistic and climatic data planes on the other. Therefore it can not be the scope of the present paper to deal with certain areas of the Central Paratethys in detail and to list all species found; only the general development of the calcareous nannoplankton, silicoflagellates, planktonic and benthonic foraminifera, mollusks and marine correlated vertebrate localities within the Central Paratethys will be discussed. The marine sedimentation ends throughout the Central Paratethys with the late middle Miocene; for this reason the paper concentrates on the marine Oligocene and Miocene of the Central Paratethys.

2 Biostratigraphy and Oligocene/Miocene stage concept of the Central Paratethys

Up to the present only a few Latdorfian and Rupelian sections have been studied, as far as their nannoplankton and foraminifera content is concerned. No studies on silicoflagellates and almost no modern work on the mollusk assemblages have been done. But extensive regional studies have been carried out by the Paratethys Working Group on nearly all late Oligocene and Neogene deposits and their biostratigraphically important fossil groups.

Latdorfian

The lower Oligocene nannoplankton zones NP 21 (*Ericsonia subdisticha* zone) and NP 22 (*Helicosphaera reticulata* zone) can be identified easily by the presence of *Cyclococcolithus formosus* and *Reticulofenestra umbilica* (Tab. 1, part I), and were noted in Bavaria (Fischschiefer), Tyrol-Häring (Zementmergel), Moravia (Pausramer Schichten, part), Hungary (transition beds between Ofener Mergel and Fischschiefer), and in Rumania (basal Fusaru-Formation: dunkelbraune Kalkmergel-Schichten) (CICHA, HAGN & MARTINI 1971; MARTINI & LEBENZON 1971; MARTINI & MOISESCU 1974).

The planktonic and benthonic foraminifera fauna is well developed and corresponds in composition and diversity to the Mediterranean area. It ranges from zone P 18 to the lower part of zone P 19. The fauna of zone P 18 is characterized by *Pseudohastigerina, Globigerina officinalis* and the *Globigerina gortanii – G. eocaena – G. corpulenta – G. prasaepis* group of large species. In Zone P 19 the species *Globigerina angiporoides, G. praebulloides* and *Catapsydrax unicavus* are dominant. The stratigraphically important species *Globigerina ampliapertura, G. sellii* and *G. tripartita* have been reported less frequently (Cicha, Hagn & Martini 1971; Rögl 1975) (Tab. 1, part II).

A well developed fauna of benthonic foraminifera yielded a large number of species ranging up from the Eocene and forms with the first appearing in the early Oligocene (Hagn, Hölzl & Hrubesch 1962). Only a few stratigraphically useful groups are discussed. *Uvigerina eocaena* and *U. acutocostata* are both ranging up from the Eocene; intermediate forms between *U. eocaena* and *U. hantkeni* with evolutionary trends of *costata* species have their first occurrence as well as *U. farinosa*. According to Lindenberg (1965) the following *Bolivina* species are characteristic for the early Oligocene in these areas: *Bolivina beyrichi carinata, B. kodymi, B. prion, B. semistriata, B. striatocarinata, B. terquemi* and *B. vaceki bavarica*. Further markers for early Oligocene age are *Bulimina sculptilis* and *Asterigerina rotula haeringensis*. The latest occurrences of small nummulites *(Nummulites bouillei, N.* cf. *boucheri)* were described by Lühr (1962).

This stage has been recorded in the dark, shaly marls, the so called "Zementmergel" in the lower Inn valley (Häring, Tyrol), out of the same facies from the "Fischschiefer" of Bavaria (Marienstein) and in several borehole sections of the Molasse basin (Upper Austria). The same fauna in a better preservation is reported from dark brown, soft marls belonging to the tectonic Pouzdrany unit of the Western Carpathians (Czechoslovakia) (Cicha, Hagn & Martini 1971).

The early Oligocene occurs throughout the Western Carpathians, represented by the *Globigerina postcretacea* zone characterized by a specific plankton fauna, which connects it with the Caucasus area (Samuel & Salaj 1968).

A mollusk fauna of Häring was described by Dreger (1892, 1903) and other faunas from Rumania are mentioned by Moisescu (1972) and Rusu (1972).

Rupelian

Nannoplankton assemblages of Rupelian equivalents in zone NP 23 (*Sphenolithus predistentus* zone) and in the lower part of zone NP 24 (*Sphenolithus distentus* zone) show a decline in species in the lower part with a tendancy to mass-occurrences of *Reticulofenestra ornata,* which have been found in zone NP 23 in Bavaria, Austria and Rumania (Martini & Lebenzon 1971). Information on zone NP 24 is somewhat poor as sphenoliths are generally rare or absent, but the Kiscell Clay (Kleinzeller Ton) of Hungary belongs in zone NP 24 as indicated by the presence of *Helicosphaera recta, Sphenolithus distentus* and *Coccolithus abisectus* (Cicha, Hagn & Martini 1971 and Baldi-Beke 1975) (Tab. 1, part I).

The rich foraminifera fauna of zone P 19 disappears within the Rupelian. In general only small planktonic species survive, indicating a distinct similarity to Northern

European faunal assemblages. Common species are: *Globigerina praebulloides, Globorotalia munda* and *Catapsydrax unicavus*, accompanied by *Globigerina angiporoides, Globorotalia nana* and *Catapsydrax dissimilis. Globorotalia opima opima* has been reported only in the Pouzdrany unit in the Western Carpathians and from central Hungary (Cicha, Hagn & Martini 1971; Kenawy 1968; Rögl 1975) (Tab. 1, part I). The benthonic populations of the Rupelian yielded *Uvigerina hantkeni, U. farinosa* and the first specimens of *U.* cf. *gallowayi.* In the Southern Alpine Molasse (Italy) however the faunal composition is somewhat different yielding *U. eocaena, U. havanensis, U. rustica* and also *U.* cf. *gallowayi*, but lacking *U. hantkeni* (Rögl, Cita, Müller & Hochuli 1975). The arenaceous species *Cyclammina acutidorsata* and *C. rotundidorsata* are common, but ranging up into the Miocene (Cicha & Zapletalova 1963; Cicha, Chmelik, Picha & Stranik 1964). Again a number of biostratigraphically useful *Bolivinas* are noticed (Lindenberg 1964; Hofmann 1967): *Bolivina beyrichi bituminosa, B. koessenensis* and *B. rhomboidalis* are restricted to the early and middle Oligocene.

Some Rupelian mollusk faunas are mentioned by Hagn & Hölzl (1952) and later by Hölzl (1962) from Upper Bavaria, from the Kiscell clay in Hungary by Noszky (1939, 1940) and from Rumania by Meszaros & Marosi (1957), Moisescu (1972) and Rusu (1972).

Egerian

The Egerian stage was proposed as a chronostratigraphic unit of late Oligocene/early Miocene age. The definition and extensive documentation and further literature concerning this stage can be found in Baldi (1966, 1973), Baldi & Senes (1975), Cicha & Senes (1968), Hölzl (1962), Papp et al. (1968), Suraru (1970), Senes et al. (1970) and Steininger (1969, 1975). The stage name was derived from the town of Eger in northern Hungary, where the stratotype section is exposed in the "Wind"-brickyard. Formerly used stratigraphic terms for Egerian within the Central Paratethys: "Chatt", "Aquitan", "Chatt/Aquitan", "Oberes Stampien", "Oberoligozän" etc.

Within the Egerian most known nannoplankton assemblages are too poor to place them in a certain zone within the interval NP 24 (*Sphenolithus distentus* zone) to NN 1 (*Triquetrorhabdulus carinatus* zone), but the presence of *Zygrhablithus bijugatus* and *Dictyococcites dictyodus* indicates that most samples from Moravia (wells at Pausram, Lubná, Bućovice and Kyjov) belong to zone NP 24/25. A few samples can be placed definitely in zone NP 25 (*Sphenolithus ciperoensis* zone), as the assemblage contains *Discolithina enormis* (Pectunculus-sands of Hungary, Wallern Parzham No. 21, Unter Rudling, Ebelsberg near Linz — all Upper Austria, and the so-called "Lower Aquitanian" of the subalpine molasse at Wildenwart south of Prien). Baldi-Beke (1975) reported the occurrence of *Triquetrorhabdulus carinatus* and *Sphenolithus delphix* in the Egerian of Hungary, indicating that part of the Egerian belongs to zone NN 1 (zone NN 1 was also indicated for a sample higher up in the section of Wallern/Parzham) (pers. comm. C. Müller to F. Steininger). In Rumania the Fusaru-Formation (Fusaru-Serie) and the Zimbor-Formation (Zimborer Schichten) belong to the combined zones NP 24/25 according to Martini & Lebenzon 1971 and Mészaros et al. 1975 (Tab. 1, part I).

In the Egerian several localities containing silicoflagellates are known in Upper Austria (Wallern, Breitenaich, Weghof, Oberndorf), and were studied in detail especially by BACHMANN (1970). The assemblages are dominated by *Corbisema flexuosa* and varieties of *Dictyocha crux*. Other forms present are *Mesocena apiculata, Dictyocha cannopiloides* and *Cannopilus schultzi*. Of special interest is the fairly common occurrence of *Naviculopsis lata* indicating the presence of the *Naviculopsis lata* zone in the Egerian (Tab. 1, part I).

The foraminifera fauna is more diverse only in the upper part of the Egerian and is dominated, as in the Rupelian, by benthonic forms. The Rupelian/Egerian boundary cannot be drawn by planktonic forms, it is defined by the first appearance of *Cancris turgidus* in the Alpine foredeep of Upper Austria. The most diverse faunas are known from the Western Carpathians and from Hungary. The most common species are *Globigerina praebulloides, G. obesa, G. globularis, G. ciperoensis ciperoensis, Globorotalia opima nana, G. permicra, Globorotaloides suteri, Catapsydrax dissimilis* and *Cassigerinella boudecensis*. Scarce are *Globigerina ciperoensis angulisuturalis, G. venezuelana, Globoquadrina baroemoenensis* and *G. globularis*. In the upper part of the Egerian *Globigerinoides primordius, Globorotalia pseudocontinuosa* and *G. semivera* are found more frequently (CICHA, HAGN & MARTINI 1971; KENAWY 1968; RÖGL 1975) (Tab. 1, part I).

The first occurrence of *Globigerinoides primordius* was found to be worthless as an index to define the Oligocene/Miocene boundary. It is found in Trinidad and Venezuela within the *Globigerinoides ciperoensis ciperoensis* zone (pers. investigations F. RÖGL), in the Western Carpathians even together with *Globorotalia opima opima* (CICHA & al. 1971) and in the Molasse basin of Upper Austria in the nannoplankton zone NN 1 (F. RÖGL & C. MÜLLER, unpublished). The first *Globigerinoides primordius* occur together with *Miogypsina tani* in the Aquitaine (ANGLADA 1971 a; JENKINS 1966) — the Aquitanian stage as defined in the Bordeaux area. In the Carry-le-Rouet section (ANGLADA 1971 b) in levels above the first occurrence of *M. bantamensis* and *M. gunteri*, whereas in the Piedmont basin (Italy), *Globigerinoides primordius* appears together with the first *M. gunteri* (NICORA 1971). With these uncertainties in connection with the unknown upper boundary of the Chattian, the Oligocene/Miocene boundary can be expected to fall into the upper part of the Egerian.

Species of the genus *Miogypsina* are of special importance for the correlation of the Egerian with areas outside the Paratethys. *Miogypsina (M.) complanata* occurs in the lowermost Egerian of the foredeep in Upper Austria (KÜPPER 1966), *M. (M.) septentrionalis* in Eger and Novaj, Hungary (BALDI & al., 1961) and *M. (Miogypsinoides) formosensis* in Plesching, Upper Austria (RÖGL & STEININGER 1970) and in Zagorje, Yugoslavia (PAPP 1954). *M. septentrionalis* and *M. formosensis* have nearly the same time range and give a correlation to the type Chattian at the Doberg (Germany). In Bretka, in the intramontane Slovakian basin (Czechoslovakia) *M. (M.) gunteri* (PAPP 1960) defines the upper parts of the Egerian, thereby correlating with the lower Aquitanian in France (Tab. 1, part I).

The fauna of larger foraminifera with *Miogypsina (M.) septentrionalis* and *M. (Miogypsinoides) formosensis* is accompanied by *Heterostegina* sp., *Operculina complanata,* *Lepidocyclina (Eulepidina) dilatata* and *L. (Nephrolepidina) morgani* (PAPP, in BALDI & SENES 1975). This population of larger foraminifera occurs in a widespread horizon within the Paratethys, from Southern Slovakia to Hungary and Slovenia, and can be compared with similar horizons in the Mediterranean (LORENZ 1972; NICORA 1971).

Within the smaller foraminifera again the uvigerinas are important. The *U.* cf. *gallowayi*-group was subdivided by PAPP (PAPP, in BALDI & SENES 1975). The evolutionary lingeage from *U. hantkeni*, in the Rupelian to *U. posthantkeni*, in the Eggenburgian, was divided into some new species and subspecies. *Bolivina beyrichi carinata, B. crenulata crenulata, B. elongata, B. liebusi, B. reticulata* and *B. versatilis versatilis* are characteristic for the late Rupelian and Egerian (HOFMANN 1967). A good Egerian marker, also for longer distance correlations outside of the Paratethys area is *Almaena osnabrugensis*. A compilation on the variety and occurrences of Egerian benthonic populations is given in BALDI & SENES (1975).

The most diverse Egerian mollusk faunas (BALDI & SENES 1975) are known from Bavaria (Thalberg-fauna – HÖLZL 1952), Upper Austria (Plesching-fauna, near Linz), southern Slovakia (Kovacov-fauna), northern Hungary (Eger) and Rumania (Buzas/Zimbor – S. Mihać/Almas).

The Upper Austrian and Hungarian faunas are associated with *Miogypsina (M.) formosensis, M. septentrionalis* and nannoplankton associations of the zones NP 24 / NP 25. This was pointed out also by MARTINI & LEBENZON (1971) and MESZAROS & al. (1975) for the Zimbor beds in Rumania. Characteristic is the first or last occurrence and/or the total range (Tab. 1, part II) of some of the following most frequent taxa: *Chlamys decussata, Chl. incomparabilis, Chl. hertlei, Chl. csepreghy-meznericsae, Chl. northamptoni, Flabellipecten burdigalensis, Fl. carryensis, Mytilus aquitanicus, Cardium heeri, C. egerense, Pitar beyrichi, Glycymeris latiradiata, Turritella beyrichi, T. venus, Protoma cathedralis, Aporrhais callosa* and *Rostellaria dentata.*

The most characteristic feature of Egerian mollusk faunas is their composition of "Oligocene" and "Miocene" taxa, the later prevailing towards the upper part of the stage. The mollusk fauna, especially the pectinid fauna, correlates well with the type Chattian in northern Germany. *Flabellipecten carryensis* occurs together with *Miogypsina gunteri* and is known only from uppermost Egerian levels at Bretka and ties in with the Aquitanian neostratotype section at Carry-le-Rouet (CATZIGRAS & al. 1972).

The large mammal fauna (RABEDER 1975 and RABEDER & STEININGER 1975) known from the "Linzer Sande" in Upper Austria (Tab. 1, part II) is associated with *Miogypsina (M.) formosensis* and the typical "Plesching"-mollusk fauna. In terms of the European mammalian local fauna stratigraphic concept this large mammal fauna of Linz can be correlated approximately with local faunas like that of Corderet. As far as the marine vertebrate fauna of the Egerian is concerned, the selachian fauna demonstrates an Oligocene/Miocene transitional character; the occurrence of the genus *Halitherium* is remarkable.

The area covered by the Egerian sea is shown in Fig. 2 (Egerian & Eggenburgian). According to the faunal development of the early Egerian we have to assume an active connection throughout the western parts of the Alpine foredeep with the Mediterranean

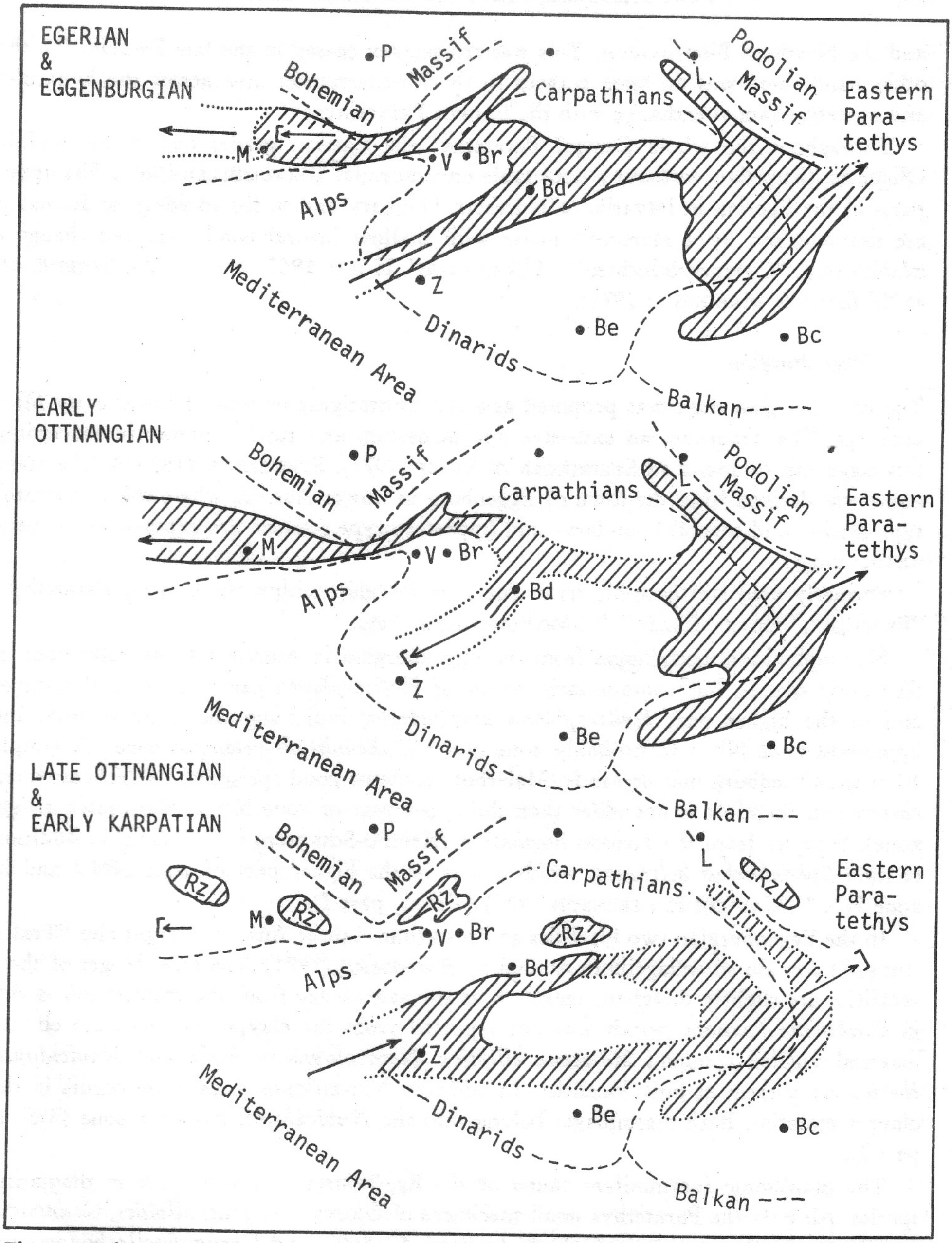


Fig. 2. Paleogeographic setting of: Egerian and Eggenburgian; early Ottnangian and late Ottnangian and early Karpatian (partly after SENES & CICHA 1973). Explanation: diagonal hatching – areas covered by marine sediments; Rz - Rzehakia = "Oncophora"-sea; ← = seaway open; [← = seaway closed; Be - Beograd, Br - Bratislava, Bd - Budapest, L - Lvov, M - Munich, P - Praha, V - Vienna, Z - Zagreb. Ca. B. - Caspian Basin, Da. B. - Dacian Basin, Eu. B. - Euxinian Basin, Pa. B. - Pannonian Basin.

and the Northern Bioprovinces. This western seaway ceased in the late Egerian. On the other hand there was an open seaway to the Mediterranean area across the Dinarides and an active faunal exchange with the Eastern Paratethys.

Throughout the whole Central Paratethys the Egerian grades out of the middle Oligocene (Rupelian) without a detactable unconformity (BRAUMÜLLER 1961). The upper parts of the Egerian in Bavaria, in Northern Hungary and in the foredeep of Rumania are characterized by a regressive phase with shallow littoral conditions and changing salinity (e.g. "Cyrenen-Schichten", "Flözmolasse", HÖLZL 1962; BALDI 1973; SENES & al. 1970; SENES & MARINESCU 1974).

Eggenburgian

The Eggenburgian stage was proposed as a chronostratigraphic unit of lower early Miocene age. The definition, an extensive documentation and further literature concerning this stage can be found in STEININGER & SENES (1971), STEININGER (1975 b). The stage name was derived from the town of Eggenburg in Lower Austria, where the unit stratotype section and several boundary- and hypostratotype sections are exposed in the near surroundings.

Formerly used stratigraphic terms for Eggenburgian within the Central Paratethys: "Burdigal", "Unter-Miozän", "I. Mediterranstufe" etc.

Nannoplankton assemblages from the Eggenburgian in Austria are generally poor in diagnostic species, but contain early forms of *Helicosphaera carteri* in several samples and in the higher part *Helicosphaera ampliaperta*, indicating the interval from the uppermost zone NN 1 to probably zone NN 3 (*Sphenolithus belemnos* zone). A sample from the Ortenburg marine sands (Maierhof) contains good specimens of *Helicosphaera carteri* and therefore is not older than the upper part of zone NN 2 (*Discoaster druggi* zone). Samples from the Krosno-Formation (Krosno-Schichten) in Rumania in addition contain *Sphenolithus belemnos*, which occurs in the higher part of zone NN 2 and in zone NN 3 (MARTINI & LEBENZON 1971) (Tab. 1, part I).

In the Eggenburgian two localities at Ernstbrunn, Lower Austria (claypit and "Trafostation") contain silicoflagellates studied by BACHMANN (1971). The assemblages of these localities are slightly different, inasmuch as the assemblage from the trafostation is rich in *Corbisema flexuosa*, which was not reported from the claypit, whereas the claypit material yielded common *Mesocena elliptica*. *Naviculopsis navicula* and *Naviculopsis iberica* are present at both localities. In addition *Naviculopsis quadratum* occurs in the claypit material. Both assemblages belong into the *Naviculopsis navicula* zone (Tab. 1, part I).

The planktonic foraminifera fauna of the Eggenburgian is very poor in diagnostic species. All over the Paratethys small specimens of *Globigerina praebulloides*, *G. angustiumbilicata*, *G.* cf. *ciperoensis*, *G. bollii lentiana*, *G. dubia* and *Cassigerinella boudecensis* are dominant. The lower boundary of this stage coincides with the appearance of *Globigerinoides trilobus* which is as rare as *Globorotalia siakensis* and *Globoquadrina* ssp. in the Paratethys area (CICHA, HAGN & MARTINI 1971; RÖGL 1975) (Tab. 1, part I).

The fauna of benthonic foraminifera is well developed. *Uvigerina posthantkeni*, *U.*

parviformis, *Cibicidoides budayi* and *Cyclammina praecancellata* are stratigraphically important (CICHA & al. in STEININGER & SENES 1971). *Bolivina concinna*, *B. dilatata dilatata*, *B. rottensis* and *B. scalprata retiformis* show their first appearance (CICHA 1970; CICHA & ZAPLETALOVA 1961; HOFMANN 1967). In the shallow water facies *Elphidium subcarinatum*, *E. ortenburgense*, *E. felsense* and *Cribrononion cryptostomum* are restricted to the Eggenburgian (PAPP 1963).

Miogypsina intermedia mentioned from the Haller Schlier in Upper Austria (PAPP 1960) occurs in a stratigraphic position not in agreement with the time range of the Eggenburgian. In the Mediterranean *M. intermedia* is reported from the later Burdigalian (about N 7 or NN 3 pp. – NN 4).

The base of the Eggenburgian stage is defined by a most distinctive and diverse mollusk fauna, widespread throughout the whole Central- and Eastern Paratethys (=Tschernobaevka-Fm. and Sakaraulian stage). The best mollusk faunas (STEININGER & SENES 1971) have been described from Upper-(Kaltenbachgraben) and Lower Bavaria (Mairhof) (HÖLZL 1958, 1973), from the surroundings of Eggenburg in Lower Austria, the surroundings of Budapest and the Corus- and Chechis-beds (SURARU 1967, 1968) in Rumania.

Characteristic and most frequent taxa are (Tab. 1, part II): *Pecten pseudobeudanti*, *Chlamys gigas*, *Chl. opercularis*, *Chl. varia*, *Anadara fichteli*, *Glycymeris fichteli*, *Laevicardium kübecki*, *Pitar lilacinoides*, *Arctica girondica*, *Crassostrea gingensis*, *Cr. crassissima*, *Ocinebrina crassilabiata*, *Diloma (P.) amedei*, *Turritella terebralis*, *T. t. gradata*, *T. eryna* s. l., *T. vermicularis*, *T. turris*. In the upper part we find in addition to the mentioned forms the following taxa: *Pecten hornensis*, *P. beudanti*, *Chlamys palmata crestensis*, *Chl. holgeri*, *Chl. scabrella*, *Chl. praescabriuscula*, *Hinnites brussoni* etc.

The most remarkable fact is the explosive and diverse occurrence of abundant "giant" taxa within different groups of molluska (e.g.: *Arcidae*, *Glycymeridae*, *Mytilidae*, *Pectinidae*, *Ostreidae*, *Cardiidae*, *Glossidae*, *Veneridae*, *Turritellidae*, *Ficidae* etc.). Some of these evolve out of the Egerian mollusk fauna, others have their first appearance by migration.

This fact of a first peak of abundant "giant" mollusk taxa is not restricted to the Paratethys; it can be seen in the upper Aquitanian and lowermost parts of the Burdigalian in the Mediterranean region, in the Carribean region by the acceleration of the evolution of turritellids (MACSOTAY 1971; MACSOTAY & SCHERER 1972) and in California in the upper Zemorrian to lowermost Saucesian – "Vaqueros" – mollusk-stage (ADDICOTT 1970, 1972, 1974; BANDY 1971, BANDY & ARNAL 1969).

It is most interesting to note that the sirenid genus: *Metaxytherium* appears within this event in the early Miocene in the Central Paratethys and Baja California (STEININGER & SENES 1971; DOWNING 1972). In contrast to the Egerian selachian fauna, the Eggenburgian fauna is characterized by typical worldwide Miocene species (e.g. *Carcharodon m. megalodon*, *C. m. chubutensis*, *Isurus desorii* etc.).

Together with the characteristic Eggenburgian mollusk faunas the first remains of *Brachyodus onoideus* are frequently reported (DAXNER-HÖCK 1971; RABEDER & STEININGER 1975) (Tab. 1, part II).

This first appearance of *Brachyodus onoideus* together with *Anchitherium* is noted in terms of the European mammalian local fauna stratigraphic concept in faunas like Chitenay, Wintershof-West and Estrepouy.

The area covered by the Eggenburgian sea was nearly the same as in the Egerian – Fig. 2 (Egerian & Eggenburgian). The active seaway to the West was still closed in early Eggenburgian time. An active connection must be assumed primarily towards the Southeast to the Mediterranean area in the South.

An unconformity is noted below the Eggenburgian stage nearly throughout the whole Paratethys and it lies transgressively upon the Egerian; only within the central parts of the Intracarpatian basin in Hungary and the Transsylvanian basin in Rumania the Eggenburgian might grade out conformably of the Egerian (SENES & MARINESCU 1974).

Ottnangian

The Ottnangian stage was proposed as a chronostratigraphic unit of late early Miocene age. The definition, an extensive documentation and further literature concerning this stage can be found in PAPP, RÖGL & SENES (1973) and RÖGL (1975 b). The stage name was derived from the village of Ottnang in Upper Austria, where the unitstratotype section is exposed.

Formerly used stratigraphic terms for Ottnangian within the Central Paratethys: "Ober-Burdigal", "Helvet", "Unter-Helvet", "I. Mediterranstufe" pp.

Calcareous nannoplankton assemblages from the type Ottnangian and equivalent strata in Austria show a low diversity in species, but contain good specimens of *Helicosphaera carteri* and *Helicosphaera ampliaperta* (CICHA, HAGN & MARTINI 1971; MARTINI & MÜLLER 1975). As *Sphenolithus belemnos* which is poorly known in the Paratethys, has not yet been found in Ottnangian samples, zone NN 3 pp (*Sphenolithus belemnos* zone) and/or NN 4 (*Helicosphaera ampliaperta* zone) may be present (Tab. 1, part I). The silicoflagellate assemblage at Ottnang does not contain representatives of the genus *Naviculopsis*, which has its last occurrences in zone NN 3, indicating that a correlation with zone NN 4 seems more realistic.

Silicoflagellates from the type Ottnangian are described by BACHMANN (1973) and extensive lists of synonyma for species found were presented. Most of these species or forms are also present in samples from Limberg (STRADNER 1961) and Oberdürnbach, Lower Austria (MARTINI & MÜLLER 1975). The assemblages are dominated by short-spined forms of *Dictyocha crux* (*D. crux parva* in BACHMANN), outnumbering by far all other species. *Corbisema flexuosa* is very rare at Ottnang and representatives of the genus *Naviculopsis* are not present in the stratotypes as well as in equivalent strata, but were reported from the underlying Eggenburgian (Tab. 1, part I). Therefore the silicoflagellate assemblages belong to a zone above the *Naviculopsis navicula* zone and seem to represent the lower part of the *Dictyocha triacantha* zone in a local assemblage.

The planktonic foraminifera fauna contains no species useful in the sense of the planktonic foraminifera zones. The faunal composition is more or less the same as recorded from the Eggenburgian with one dominant form: *Globigerina ciperoensis ottnangiensis*.

Other common forms are: *Globigerina bollii lentiana, G. angustiumbilicata, Cassigerinella boudecensis* and *C. globulosa;* scarce occurrences of *Globigerinoides trilobus, Globoquadrina langhiana, Globorotalia acrostoma* and *Catapsydrax* ex gr. *unicavus* are mentioned (RÖGL 1969; CICHA & al. in PAPP, RÖGL & SENES 1973). The later authors give a compilation of planktonic and benthonic species from the Ottnangian of the Central Paratethys; characteristic benthonic species are *Bolivina scitula, Caucasina* aff. *schischkinskayae, C. cylindrica, Lenticulina* ex gr. *melvilli, Semivulvulina pectinata, Sigmoilopsis ottnangensis, Stilostomella ottnangensis.* After HOFMANN (1967) *Bolivina matejkai, B.* cf. *scalprata miocenica* and *B. scitula.* A fair number of dominant species of the Eggenburgian are lacking in the Ottnangian: e.g.: *Cyclammina praecancellata, C. rotundidorsata, Bulimina arndti, Uvigerina posthantkeni, U. parviformis.* On the other hand the Uvigerinas: *Uvigerina* cf. *acuminata, U. bononiensis primiformis* and *U. parkeri breviformis* have their first occurrence in the Ottnangian.

The richest mollusk faunas known so far come from Upper- and Lower Bavaria and Upper Austria on the one hand and from Rumania on the other. Still not quite solved is the stratigraphic and bioprovincial position of the Bantapuszta formation mollusk fauna in Hungary (KÓKAY 1973). While the Bavarian, Austrian and Czechoslovakian marine faunas seem to have had a closer connection with the western foredeep, and the Rumanian probably with the Eastern Paratethys, the Bantapuszta faunal elements must be traced from the Mediterranean region.

In general the marine mollusk fauna can be derived from the Eggenburgian fauna (STEININGER & al. 1973); the described associations represent two different environments: infra- to circalittoral sandy environments and circalittoral to (upper) bathyal, so-called "Schlier", environments.

Some of the biostratigraphically important species listed are: *Flabellipecten hermannseni, Pecten fotensis, P. subbenedictus, P. helvetiensis, Chlamys tournali, Chl. albina, Chl. malvinae, Pitar islandicoides, Megacardita jouanetti, Turritella spirata, T. doublieri* (Tab. 1, part II).

Taking into account this characteristic mollusk fauna it was demonstrated that the lower marine part of the type section of the Helvetian at Imihubel near Bern, Switzerland is correlative with the lower Ottnangian (PAPP & STEININGER 1973).

Within the upper Ottnangian a marginal regressive brackish to freshwater facies is widespread in the foredeep of the Central Paratethys and the Eastern Paratethys (= Kozachurian stage). Most characteristic is a mollusk association made up of *Rzehakia socialis, Limnopagetia* and *Congeria.*

The mammal-bearing calcareous sands of Orechov in Moravia (CICHA, FAHLBUSCH & FEJFAR 1972) (Tab. 1, part II) are directly overlain by *Rzehakia*-beds. According to the European mammalian local fauna stratigraphic concept this fauna corresponds to the local faunas of La Romieu-Vieux Collonges.

During the late Eggenburgian – early Ottnangian – Fig. 2 (early Ottnangian) the western seaway across the Alpine foredeep into the Rhone valley and the Mediterranean area must have been reactivated, whereas a connection between the western and eastern parts of the Central Paratethys is questionable. The seaway to the Mediterranean in the South seems to be closed. A regressive phase in late Ottnangian time – Fig. 2 (late Ottnangian & early Karpatian) brings the so-called Rzehakia – "Oncophora" – sea into existence. The connection with western Alpine foredeep and the Rhone valley was interrupted and the western Paratethys started to dry up.

The Ottnangian follows without any traceable unconformity above the Eggenburgian throughout the whole Central Paratethys. With the upper Ottnangian the marine sedimentation ends within the Western Alpine foredeep (SENES et al. 1970). Egerian, Eggenburgian and Ottnangian make up the so-called "Eoparatethys" according to SENES & MARINESCU (1974).

Karpatian

The Karpatian stage was proposed as a chronostratigraphic unit of latest early Miocene age. The definition, an extensive documentation and further literature concerning this stage can be found in CICHA, SENES & TEJKAL (1967) and CICHA, SENES & STEININGER (1975). The stage name was derived from the Carpathian foredeep, where the unitstratotype is located in the brickyard of the town Slup in Czechoslovakia.

Formerly used stratigraphic terms for Karpatian within the Central Paratethys: "Oberhelvet", "Untertorton", "Torton", "Vindobon pp.", "II. Mediterranstufe".

Nannoplankton samples from the Karpatian in Austria (Laa a. d. Thaya, Retznei – underlying "Steirischer Schlier") as well as from a well in Moravia (Rataje 1) contain *Helicosphaera ampliaperta* and *Reticulofenestra pseudoumbilica* among others. A sample from the claypit at Wagna (Styria) on the other hand lacks *H. ampliaperta*, but contains *Sphenolithus heteromorphus*, good specimens of which are not present in the earlier samples (MARTINI & MÜLLER 1975) (Tab. 1, part I). On the basis of these assemblages the Karpatian belongs in the upper part of zone NN 4 and the lower part of zone NN 5 (*Sphenolithus heteromorphus* zone). It is interesting to note that *Sphenolithus heteromorphus* seems to invade the Paratethys in late Karpatian time, despite the fact that in the open oceans it has a concurrent range with *Helicosphaera ampliaperta* in the whole zone NN 4.

Information on Karpatian silicoflagellate assemblages is rather poor. BACHMANN & PAPP (1968) reported the presence of common *Dictyocha mutabilis* and *Mesocena elliptica* and rare specimens of representatives of the genus *Cannopilus* from Altruppersdorf, Lower Austria. This and some other localities mentioned in BACHMANN (1970) need detailed study and documentation. As these localities belong to strata intermediate between the Ottnangian (Ottnang) and lower Badenian (Frättingsdorf), the later certainly belongs to the *Dictyocha triacantha* zone; therefore the Karpatian must be placed in the *Dictyocha triacantha* zone.

The number of planktonic foraminifera increases within the Karpatian. In the lower part of the stage they are still similar to the Ottnangian: *Globigerina praebulloides*, *G.* cf. *concinna*, *G. obesa*, together with *Globigerinoides trilobus*, *Hastigerinella clavacella* and *Cassigerinella boudecensis* are common. In the upper part of the stage the faunal composition is more related to the Badenian stage. New forms like *Globigerinoides sicanus*, *G. subsacculifer*, *Globorotalia acrostoma*, *G. bykovae* and *Globoquadrina dehiscens* have their first occurrence.

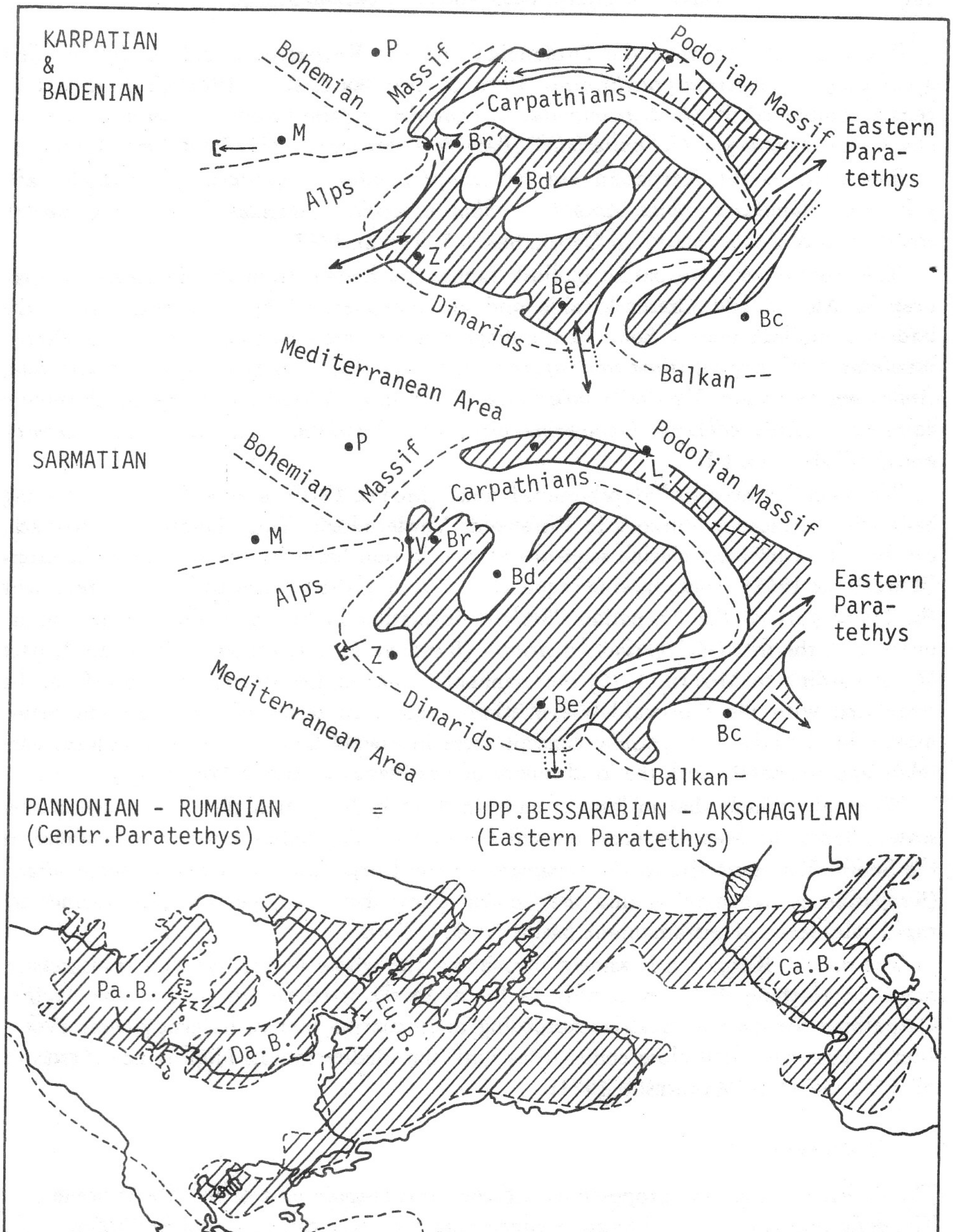


Fig. 3. Paleogeographic setting of: Karpatian and Badenian; Sarmatian and Pannonian – Rumanian = Upper Bessarabian – Akschagylian (partly after SENES & CICHA 1973). Explanation see Fig. 2.

The boundary between the Ottnangian and the Karpatian is defined by the first occurrence of *Uvigerina graciliformis* (Papp, Steininger & Rögl 1971) (Tab. 1, part I). It is accompanied by *U.* cf. *acuminata, U. bononiensis primiformis, U. parkeri breviformis, U. semiornata* and *U. "uniserialis"* (Papp & Turnovsky 1953; Papp 1963, 1966).

Restricted to the Karpatian are *Reticulophragmium carpaticum, Schenckiella* aff. *primaeva, Planularia inflata, Amphimorphina miocenica, Cibicides slovenicus, C. vortex* etc. (Cicha & Zapletalova in Cicha, Senes & Tejkal 1967).

The most diverse Karpatian mollusk faunas are known from the northeastern foredeep in Austria and Czechoslovakia and are characterized by close relations to the Badenian mollusk faunas. Some of the diagnostic and most common species are: *Pecten revolutus, Chlamys latissima nodosiformis, Chl. kautskyi, Chl. gentoni, Chl. fasciculata, Amussium felsineum, Turritella bicarinata, T. erronea, T. badensis, T. eryna, Dorsanum echinatum, Hinia edlaueri, Ocinebrina orientalis, O. striata, Pirenella bicincta turritogracilis* (Tab. 1, part II).

The so-called Styrian "Hyotherium-fauna" (Mottl 1970), known from coal-bearing beds with tuffaceous horizons in Eibiswald, Vorderndorf, Wies, Zangtal and Köflach, can be traced into the marine sequence of the Styrian basin by the tuffaceous horizons (Kollmann 1965). These marine sequences containing the tuffaceous horizons represent the lower part of the Karpatian "Schlier"-formation in Styria, which contains in its upper part the first *Globigerinoides sicanus* (Rabeder & Steininger 1975) (Tab. 1, part II). According to Mottl (1970) the mammal faunas of Leoben and Fohnsdorf can be correlated with the Eibiswald-Wies-Köflach faunas. In terms of the European mammalian local fauna stratigraphic concept these Eibiswald-Leoben faunal complexes correlate approximately with the local faunas of Las Planas IV B and Pont Levoy.

We might assume that in late Ottnangian & early Karpatian time – Fig. 2 – a new seaway from the Mediterranean toward the Central Paratethys came into existence in the South. This gave rise to the expansion of the Karpatian and Badenian sea – Fig. 3 (Karpatian & Badenian) within the Central Paratethys area; characterized further by rapid subsidence of intramontane basins (Figs. 1, 2, 3).

The marine Karpatian is known throughout the whole Paratethys as a transgressive sequence, reaching to the west only as far as to the northeastern part of the Alpine-Carpathian foredeep in Austria. According to its marine faunas, its geodynamic evolution it must have had close connections with the Mediterranean bioprovince (Senes & al. 1970, Senes & Marinescu 1974).

Badenian

The Badenian stage was proposed as a chronostratigraphic unit of middle Miocene age. The definition and further literature concerning this stage can be found in Cicha, Papp, Senes & Steininger (1975). The stage name was derived from the town of Baden in Lower Austria where the unitstratotype and several boundary- and hypostratotypes are exposed in the close surroundings.

Formerly used stratigraphic terms for Badenian within the Central Paratethys: "Torton", "Torton im Wiener Becken", "Vindobon pp.", "II. Mediterranstufe" etc.

In the lower Badenian (the Lagenid-zone at: Frättingsdorf and Sooss in Austria and the Dej-Formation at Hoja in Rumania) *Sphenolithus heteromorphus* is still present together with rare *Discoaster exilis* and *Cyclococcolithus rotula,* indicating the presence of nannoplankton zone NN 5 (Cicha, Hagn & Martini 1971 and Martini & Moisescu 1974). The range of *Discoaster musicus,* which occurs at Breznita (Rumania) and is very rare at Frättingsdorf and which may represent a local species, is still incompletely known and cannot be taken as a marker species yet. In the upper Badenian (Walbersdorf in Austria and Valea Morilor in Rumania) the calcareous nannoplankton lack index-species commonly used in the open oceans and correlations become less reliable. In a recent investigation Müller (1974) places samples from Walbersdorf tentatively in zone NN 7 (*Discoaster kugleri* zone) and NN 8 (*Catinaster coalitus* zone) on the basis of the presence of *Triquetrorhabdulus rugosus, Rhabdosphaera poculi* and *Helicosphaera walbersdorfensis* and their occurrence elsewhere (Tab. 1, part I).

Silicoflagellates from the lower Badenian were reported by Bachmann from a few localities in Lower Austria, including the better known locality of Frättingsdorf. The assemblages are dominated by *Dictyocha crux* and *Mesocena elliptica.* Also fairly common are species of the genus *Cannopilus* and specimens of *Dictyocha ausonia* and *Dictyocha rhombica. Mesocena apiculata* is still present but rare. The occurrence of *Dictyocha triacantha* indicates the presence of the *Dictyocha triacantha* zone in the lower part of the Badenian (Tab. 1, part I). The upper Badenian silicoflagellate assemblages are dominated by representatives of the *Dictyocha crux*-group *(D. crux, D. crux longispina, D. schauinslandi).* Other forms like *Dictyocha speculum, D. cannopiloides* and *Mesocena polyactis,* which seem to be restricted to the upper Badenian-Sarmatian interval, are rare, and *Dictyocha triacantha* is missing. These assemblages are known from Walbersdorf, Austria (Bachmann 1971) and from the Intracarpathian basin in Rumania, and seem to represent a local development of the *Dictyocha rhombica* zone (Tab. 1, part I).

The lower boundary of the Badenian stage is defined by the first occurrence of *Praeorbulina.* Planktonic foraminifera are well developed, with increasing frequencies of *Globigerinoides, Globorotalia* and *Globoquadrina.* Missing are the most important *Globorotalia* of the *G. fohsi*-lineage, which are restricted to the tropical-subtropical area. Common are *Globorotalia siakensis, G. acrostoma,* and the endemic species *G. bykovae* and *G. transsylvanica.* The occurrence of *Globorotalia peripheroronda* and *peripheroacuta* is described from Slovakia and Rumania. In the upper part of the Badenian the evolution of *Globigerina decoraperta* and *G. druryi* group is significant. *G. druryi* is highly developed and resembles *G. "pseudonepenthes"* of the Mediterranean region. For this reason *G. nepenthes* has sometimes been mentioned from the Paratethys. The correlation to N 13 at the end of marine sedimentation in this area is indicated by these species. The new planktonic genus *Velapertina,* connected with the *Orbulina* lineage, will be of further stratigraphic value in the later Badenian. This form is also known from the Mediterranean but not documented in its range (I. Premoli Silva, pers. comm.) (Tab. 1, part I).

Within the Vienna Basin and the Central Paratethys the stratigraphical subdivision of the Badenian and Sarmatian can be based on the ecologic changes of the benthonic foraminifera fauna (Grill 1941, 1943; Papp & Turnovsky 1953). Within the Badenian this subdivision is supported by the two Uvigerina lineages ranging from triserial to biserial forms (Papp & Turnovsky 1953; Papp 1963, 1966; Papp & Schmid 1971). The first costate group is represented by *Uvigerina macrocarinata, U. grilli, U. venusta venusta* and *U. venusta liesingensis* arranged according to their stratigraphic appearance (see Tab. 1, part I); a slightly costate to smooth test is developed in the *U. semiornata semiornata, U. semiornata urnula, U. semiornata brunnensis* and *U. semiornata karreri* lineage. *Heterostegina* were also known to be useful for biostratigraphy within the Badenian (Papp & Küpper 1954).

A correlation of the mentioned ecologic zonation to the standard plankton zones is somewhat difficult. The so-called early Lagenid-zone corresponds to N 8 pp. – the *Praeorbulina glomoerosa* zone; the late Lagenid-zone begins with *Orbulina suturalis* and corresponds therefore to N 9 and ranges into N 10, by correlation over nannoplankton determinations of NN 5. The zone with arenaceous foraminifera falls within NN 5 and NN 7, and therefore might be correlated to the foraminifera zones N 11 – N 12 pp. The Bulimina-Bolivina-zone and the zone with an impoverished fauna can be correlated with the nannoplankton zones NN 7 to NN 8 pp. This corresponds to N 12 pp. – N 13, as it is shown by the first occurrence of *Globigerina druryi,* which characterizes N 13.

The Badenian stage mollusk fauna is, besides the Eggenburgian fauna, the most characteristic widespread and diverse fauna known in the Central Paratethys. Some of the most diagnostic taxa are: *Flabellipecten besseri, F. lejthayanus, F. koheni, Chlamys solarium, Chl. elegans, Chl. seniensis, Chl. scissa, Chl. elini, Chl. spinulosa, Pecten aduncus, Amussium cristatum badense, Venus basteroti, Trinoclea marginata, Megacardita jouanneti leviplana, Ostrea digitalina, Pycnodonta leopolitana, P. squarrosa, P. pedemontana, Turritella partschi, T. subangulata* s. l., *T. tricincta, T. archimedes dertoniator, T. hoernesi, T. biplicata, Ocinebrina credneri, Diloma orientalis* (Tab. 1, part II).

This mollusk fauna marks a world-wide northward shift of a warm water regime within the range of the *Praeorbulina-Orbulina* datum level, which is known too from the Langhian and lower Serravallian stage in the Mediterranean region and is pointed out by Addicott (1970 a, b) within the uppermost Saucesian/Relizian Stage ("Temblor"-mollusk-stage – Addicott 1972) of the Pacific coast Neogene.

An important mammal fauna is known from the fissure fillings I and II of Devinska Nova Ves (Neudorf a. d. March) near Bratislava (Thenius 1959; Cicha, Fahlbusch & Fejfar 1972) (Tab. 1, part II), which correlates in terms of the European mammalian local fauna stratigraphic concept approximately with local faunas like Sansan. These fissure fillings are overlain by marine sediments of middle Badenian age (zone with arenaceous foraminifera), which correlate to the plankton zone N 11 / N 12 pp. Because of paleogeographic reasons and the evolutionary level of the mammalian fauna recovered in the fissures, this fauna must be correlated to the upper Karpatian/lower Badenian.

Out of marine middle Badenian sediments from the so-called "sand-hill" locality in Devinska Nova Ves (Neudorf a. d. March-Sandberg) (Tab. 1, part II) a typical "Conohyus"-Fauna with the first appearance of *Dryopithecus, Heteroprox, Listriodon* and *Tragoceros* within the Central Paratethys is known (Thenius 1952, 1959). This fauna can be correlated approximately with the plankton zones N 11 / N 12 pp. (RABEDER & STEININGER 1975).

During the high standing of the Badenian we find an active seaway to the Mediterranean in the South and to the Eastern Paratethys. In general the sea did not reach the Alpine foredeep west of the Vienna Basin and it is still questionable if the two arms of the Carpathian foredeep had an active connection. The progressive movements and uplifts of the Alps and Carpathians, the Dinarides and the Balcan mountain chains during upper, middle and late Miocene subsequently cut off the marine seaways of the Paratethys from the open oceanic realms and is followed, from west to east, by a progressively advancing regressive phase of sedimentation.

Within the southern and eastern areas as well as in the central parts of the basins of the Central Paratethys the Badenian stage follows without any traceable unconformity above Karpatian sediments. Otherwise especially the lower and middle Badenian covers transgressively much larger areas than the Karpatian (SENES & CICHA 1973). The marine sedimentation ends within the Central Paratethys in the upper Badenian. Karpatian and Badenian make up the so-called "Mesoparatethys" according to SENES & MARINESCU (1974).

Sarmatian – Pannonian – Pontian

The Sarmatian – Pannonian and Pontian stages of the Central Paratethys are characterized by nonmarine endemic invertebrate faunas. A tentative correlation to the marine "planktonic reference scales" can only be implied by linking mammal faunas.

The **Sarmatian** s. str. was proposed as a stratigraphic unit in the sense of a stage by SUESS (1866). In his original paper SUESS also indicated the stratigraphic range of the Sarmatian s. str., which is used in his sense in the Central Paratethys. Within the Eastern Paratethys the Sarmatian s. l. has a wider stratigraphic range and is divided into the Volhynian, Bessarabian and Chersonian substages. Only the Volhynian and the lower Bessarabian are equivalents of the Sarmatian s. str. in the sense of SUESS. The upper Bessarabian, Chersonian and Mäotian must be correlated to the Pannonian stage of the Central Paratethys. The definition, an extensive documentation and further literature concerning the Sarmatian stage s. str. can be found in PAPP, MARINESCU & SENES (1974), PAPP & STEININGER (1975) and PARAMONOVA (1975).

The calcareous nannoplankton assemblages of the Sarmatian in Austria (Walbersdorf, wells Laxenburg and Himberg) are dominated by *Braarudosphaera bigelowi*, as already noted by STRADNER (1960), and contain otherwise nondiagnostic species like *Coccolithus pelagicus, Helicosphaera carteri, Discolithina multipora* and *Micrantholithus* cf. *vesper*. A correlation to the standard nannoplankton zonation is still less reliable than that of the upper Badenian, but on the range chart (Tab. 1, part I) the Sarmatian assemblages are placed tentatively in zone NN 9 (*Discoaster hamatus* zone).

At Walbersdorf upper Badenian and Sarmatian is present at the claypit and adjacent areas. The area is currently reinvestigated, and it seems that the silicoflagellate assemblage from Walbersdorf described by BACHMANN (1971) may already belong to the Sarmatian. In the assemblage of BACHMANN's sample "C" from Walbersdorf aberrant forms are fairly common, indicating abnormal conditions. It is the youngest silicoflagellate assemblage at present known from the Paratethys (Tab. 1, part II).

Within the Sarmatian the endemic development of benthonic foraminifera, ostracods and mollusks allow a good regional subdivision and correlation of Sarmatian deposits (Grill 1941, 1943; Papp 1956; Papp & Senes 1974 in Papp, Marinescu & Senes 1974). *Elphidiidae, Nonionidae* and *Miliolidae* (Tab. 1 part I) are the last representatives of foraminifera in the central Paratethys Neogene.

The endemic mollusk fauna of the Sarmatian is characterized by some few stratigraphically important genera (e. g. *Calliostoma, Mohrnsternia, Pirenella, Bittium, Cerithium, Dorsanum, Acteocina, Cerastoderma, Mactra, Ervilia, Congeria* and *Irus*) (Tab. 1, part II). These genera have a rapid evolution and are useful for a precise regional correlation within the Central- and with the Eastern Paratethys.

It is essential and significant to point out that vertebrate faunas (e. g. St. Stefan i. L., Vienna, Nexing, Sauerbrunn — Thenius 1959; Thenius & Steininger 1965) (Tab. 1, part II) which are embedded in, and well correlatable with, the endemic biostratigraphic units of the Sarmatian sensu Suess are *all lacking Hipparion*. According to the European mammalian local fauna stratigraphic concept they can be correlated with faunas like Steinheim and Anwil. De Bruijn & Meulenkamp (1972) demonstrated in the Mediterranean area that similar faunas are of pre-Tortonian age.

The transgressive migrational event of the *first appearance of Hipparion* marks the lower **Pannonian** stage (Papp & Steininger 1975) in the Central Paratethys (Thenius 1974). The mammal faunas correlate to the faunas of Eppelsheim, Höwenegg in Germany and Can Llobateres (Vallesian stage) in Spain. By the somewhat younger Kastellios-hill mammal fauna (Greece) described by de Bruijn, Sondaar & Zachariasse (1971) such faunas might be linked to the plankton scale, approximately with zone N 16.

Sediments with an endemic invertebrate fauna of lower **Pontian** yielded the rich local vertebrate faunas of Eichkogel (Daxner-Höck 1970, 1972 a, 1972 b; Papp 1951; Rabeder 1970, 1973) and Kohfidisch (Bachmayer & Wilson 1970; Bachmayer & Zapfe 1969, 1972). These faunas correlate well to the spanish mammal localities of Aspe = Crevillente 1—3. The spanish section is underlain and intercalates with marine sediments of late Miocene age (Bizon, Bizon & Montenat 1972).

During the Sarmatian — Fig. 3 (Sarmatian) — a huge sea, the isolated remain of the former marine phase of the Paratethys sea — with rapidly changing salinity came into existence in the Central- and the Eastern Paratethys.

Within the upper late Miocene and Pliocene — Fig. 3 (Pannonian — Rumanian) — this intracontinental sea diminished, forming small local basins, which in turn evolved into the so-called "Caspian" brackish lakes and ended the existence of the Paratethys.

Sarmatian, Pannonian, Pontian, Dacian and Rumanian make up the so-called "Neoparatethys" according to Senes & Marinescu (1975).

3 Radiometric dates of the Central Paratethys

The "planktonic reference scale" of range Table 1 (part I and II) is based on radiometric time scales given by Berggren (1972, 1973), Berggren & v. Couvering (1974), OPDYKE & al. (1974) and THEYER & HAMMOND (1974 a, b) and is not always in accordance with radiometric dates obtained in the Central Paratethys.

The radiometric dates obtained in the Central Paratethys are known from different biostratigraphic positions from Egerian up to Sarmatian age. Whereas the Rupelian, Egerian and Eggenburgian dates are calculated on glauconites, all dates from the Ottnangian and younger stages are calculated on volcanic rocks.

The following dates are taken from ODIN (1973, 1975), calculated and recalculated by the western decay constant $\lambda_\varepsilon = 0{,}584$. It is essential to point out that in the original publications of VASS, BAGDASARJAN & KONECNY (1970) and VASS, BAGDASARJAN & SLAVIK (1974) the eastern decay constant $\lambda_\varepsilon = 0{,}557$ is used.

Egerian

Glauconites out of the type section of the Egerian in Eger (Hungary) and a section in the close neighbourhood with *Miogypsina septentrionalis* and *M. formosensis* were dated by ODIN (1975) in two samples:

G 229 = 20,2 ± 1,2 M.Y.B.P.
G 469 = 21,5 ± 1,1 M.Y.B.P.

Eggenburgian

Glauconites out of the Chechis formation near Briglez, surroundings of Cluj, Transsylvanian Basin (Rumania), which contains a typical Eggenburgian benthonic foraminifera fauna and which directly overlies the rich Eggenburgian mollusk fauna of the Corus formation, were dated by ODIN (1975) in two samples:

G 422 = 18,0 ± 1,1 M.Y.B.P.
G 470 = (17,6 ± 1,6) M.Y.B.P.

The last date was put in parenthesis by ODIN because of poor glauconite quality.

EVERNDEN & al. (1961) gave a radiometric date (24,8 ± 1 M.Y.B.P.) for glauconites from the Eggenburgian of Upper Austria. According to ODIN (1975) this date was recalculated by OBRADOVICH in 1964 and he gave an age of

18,8 M.Y.B.P.

As demonstrated in Table 1 (part I and II) the Eggenburgian correlates to the late Aquitanian and early Burdigalian. Glauconite dates published by ODIN (1975) gave an age of: 20,2 ± 1,3 M.Y.B.P. for the Aquitanian in Southern France (ALVINERIE et al. 1974) and an age of 18,1 ± 1,1 and 18,2 ± 0,9 for the Piedmont basin: Aquitaniano with *Gl. trilobus*. These dates are in good accordance with the Eggenburgian radiometric and biostratigraphic ages.

Ottnangian

The only date (A.V. 24) from a rhyolitic tuff horizon near Kaldona, Southern Slovakia (see: VASS et al. 1970) which discordantly overlies fossiliferous Eggenburgian sediments and is overlain by fossiliferous Ottnangian "Rzehakia"-beds was recalculated by ODIN (1973)

22,0 ± 2,0 M.Y.B.P.

The quality of the sample is discussed by ODIN (1975), the biostratigraphic position of this date is not clear.

Karpatian

The only date (A.V. 2) from a rhyolitic tuff horizon near Kleňany, Southern Slovakia (see: VASS et al. 1970) which is intercalated and interfingers with marine sediments containing a Karpatian uvigerinid- and "Schlier"-type-mollusk-fauna and which lies below the first occurrence of *Globigerinoides sicanus* was recalculated by ODIN (1973):

20,7 ± 1,2 M.Y.B.P.

There is no accordance between the biostratigraphic position of the Karpatian and the obtained radiometric date.

Badenian

Three samples (A.V. 12; A.V. 13) from andesitic tuff horizons near Hrušov, Southern Slovakia (see: VASS et al. 1970) which are intercalated and can be traced into marine beds with *Praeorbulina* and *Orbulina*, were recalculated by ODIN (1973):

A.V. 12 = 17,75 ± 0,9 M.Y.B.P.
A.V. 13 = 15,35 ± 0,7 M.Y.B.P.

Recently two whole rock dates from basaltic rocks from Styria (Austria) which overlie marine beds with *Praeorbulina* and are intercalated with marine beds of lower and middle Badenian age (KOLLMANN 1965) were given by Dr. BAGDASARJAN (pers. comm. to F. STEININGER):

A.V.R.-1: quarry Weitendorf, lower level: 16,8 ± 0,75 M.Y.B.P.
A.V.R.-2: quarry Weitendorf, upper level: 16,0 ± 0,3 M.Y.B.P.
A.V.R.-3: quarry Gleichenberg Klause: lower level: 16,3 ± 0,9 M.Y.B.P.
A.V.R.-4: quarry Gleichenberg Klause: upper level: 15,3 ± 0,1 M.Y.B.P.

Lately also LIPPOLT & al. (1975) published whole rock dates of the basaltic trachyandesites from the quarry in Weitendorf:

ST W 12 B = 15,2 ± 0,9 M.Y.B.P.

and a preliminary date from the quarry in Gleichenberg/Klause:

14,6 M.Y.B.P.

Similar dates are given for a basaltic andesite without biostratigraphic control from Kollnitz in Carinthia:

ST SP A 2 = 14,9 ± 0,9 M.Y.B.P.

Sarmatian

Several samples from andesitic tuff horizons near Nizna-Mysla, Eastern Slovakia, and Sazdice, Southern Slovakia (see: Vass et al. 1970, 1972) with typical Sarmatian mollusk faunas were recalculated by Odin (1973):

Lower Sarmatian: A.V. 18 = 13,2 ± 2,1 M.Y.B.P.
Lower Sarmatian: A.V. 4 = 12,7 ± 2,1 M.Y.B.P.

4 Conclusions

Current investigations on the Oligocene and Neogene calcareous nannoplankton, silicoflagellate, planktonic and benthonic foraminifera, ostracode and mollusk faunas of the Central Paratethys (Middle Europe) (Fig. 1) resulted in the definition of the following local late Oligocene/Neogene chronostratigraphic stages:

Egerian, Eggenburgian, Ottnangian, Karpatian, Badenian, Sarmatian, Pannonian, Pontian, Dacian and Rumanian from oldest to younger. Whereas the marine early and middle Oligocene (Latdorfian and Rupelian) shows affinities to the Mediterranean and Northern European bioprovinces, the late Oligocene and the Neogene (Egerian to Rumanian) belongs to a new – independant – Paratethys bioprovince.

The most important biostratigraphic data are summarized – in Table 1, part I–II – for the marine Oligocene and marine Miocene sequences and the definition and a tentative correlation of the proposed marine late Oligocene and Miocene stages (Egerian to Badenian) is given:

Egerian: late Oligocene to lowermost early Miocene (Chattian or Bormidian and lower Aquitanian); upper part of NP 24 to NN 1; upper P 21 to N 4.

Eggenburgian: lower to middle early Miocene (upper Aquitanian to lower Burdigalian); NN 2 to the uppermost part of NN 3; N 5 and the upper part of N 6.

Ottnangian: upper early Miocene (approximately middle to upper part of Burdigalian); uppermost part of NN 3 and lower part of NN 4; upper part of N 6 and lower part of N 7.

Karpatian: uppermost early Miocene (uppermost Burdigalian); upper part of NN 4 and lower part of NN 5; upper part of N 7 and lower part of N 8 till to the first appearance of *Praeorbulina.*

Badenian: lower to upper parts of middle Miocene (Langhian and Serravallian); NN 5 to lowermost parts of NN 8; first appearance of *Praeorbulina* = upper part of N 8 to N 13.

Sarmatian: uppermost middle to lower late Miocene; **Pannonian** and **Pontian** (late Miocene) can only be correlated tentatively over intercalated mammal faunas with the marine planktonic scale.

Some of the classical mammal faunas could be correlated with the marine sequence: Linz, Melk, Zagorje (upper Egerian), Eggenburg (lower Eggenburgian), Orechov (Ottnangian), Eibiswald-Leoben (Karpatian), Devinska Nova Ves (= Neudorf a. d. March) – fissures I, II (Karpatian/Badenian), Devinska Nova Ves; sandhill (middle Badenian), Göriach (middle to upper Badenian).

The general paleogeographic setting of this area (Fig. 2, 3) and some regional and interregional time equivalent climatic, evolutionary and faunal migrational events are discussed and briefly outlined.

Radiometric dates with biostratigraphic control obtained in the Central Paratethys area within the last few years are briefly discussed. Glauconite dates are available for the Egerian (20,2 ± 1,2 and 21,5 ± 1,1) and the Eggenburgian (18,0 ± 1,1 and 18,8); dates on volcanic rocks for the Ottnangian (22,0 ± 2,0 with questionable biostratigraphy), Karpatian (20,7 ± 1,2 – not in accordance with the biostratigraphic position of the Karpatian), Badenian (17,75 ± 0,9; 16,8 ± 0,75; 16,0 ± 0,3, 16,3 ± 0,9, 15,3 ± 0,1 and 15,35 ± 0,7) and the Sarmatian (13,2 ± 2,1 and 12,7 ± 2,1).

Acknowledgements. We are greatly indepted to A. Bachmann, G. P. Bagdasarjan, T. Baldi, O. Hölzl, C. Müller, G. S. Odin, A. Papp and to all members of the Paratethys Working Group for valuable unpublished informations and advices which made it possible to write this summarizing paper. Ph. Kern and H. Hohenegger critically read the manuscript, and made a number of valuable suggestions. For technical assistence in typing and drafting we would like to thank Mrs. Margarethe Tschugguel and Mrs. Emy Neubauer.

References

Addicott, W. O. (1970): Tertiary paleoclimatic trends in the San Joaquin basin, California. – U.S. Geol. Survey Prof. Pap. **644-D**: D 1 – D 19, Washington.

– (1972): Provincial middle and late Tertiary molluscan stages, Temblor Range, California. – Proc. Pacific Coast Miocene Biostrat. Symp.: 1–22, pls. 1–4, Bakersfield.

– (1974): Giant Pectinids of the Eastern North Pacific Margin: Significance in Neogene Zoogeography and Chronostratigraphy. – J. Paleontol. **48**: 180–194, 2 pls., Tulsa, Oklahoma.

Alvinerie, J. et al. (1974): Sur l'âge Radiométrique des Glauconites Miocènes d'Aquitaine. – Bull. Inst. Géol. Bassin d'Aquitaine, **16**: 159–166, Talence.

Anglada, R. (1971 a): Sur la position du datum à Globigerinoides (Foraminiferida) la zone N 4 (Blow 1967) et la limite oligo-miocène en Méditerranée. – C. R. Acad. Sci. Paris **272 (D)**: 1067–1070, Paris.

– (1971 b): Sur la limite Aquitanien – Burdigalien, sa place dans l'echelle des Foraminifères planktoniques et sa signification dans le Sud-Est de la France. – C. R. Acad. Sci. Paris **272** (D): 1948–1951, Paris.

Bachmann, A. (1970 a): Flagellata (Silicoflagellata). – Catalogus Fossilium Austriae **1 b**: 1–128, Wien.

– (1970 b): Silicoflagellaten aus dem oberösterreichischen Egerien (Oberoligozän). – Verh. Geol. Bundesanst. Jg. 1970 (2): 275–305, 3 textfigs., 1 tab., pls. 1–7, Wien.

– (1971 a): Silicoflagellaten aus dem Eggenburgien von Ernstbrunn (Niederösterreich). – Verh. Geol. Bundesanst. Jg. 1971 (3): 552–569, 2 tab., pls. 1–3, Wien.

– (1971 b): Silicoflagellaten aus dem oberen Badenien von Walbersdorf, Burgenland. – Sitz. *Ber. Österr. Akad. Wiss., math.-nat. w. Kl., Abt. I, 179 (1/4): 55–72, 3 textfigs., pls. 1–10,* Wien.

– (1973): Die Silicoflagellaten aus dem Stratotypus des Ottnangien. – In: Papp et al.: M_2 – Ottnangien. Die Innviertler, Salgótarjáner, Bántapusztaer Schichtengruppe und die Rzehakia-Formation. – Chronostrat. & Neostratotypen. Miozän der zentralen Paratethys **3**: 275–295, pls. 1–3, Bratislava.

Bachmann, A. & A. Papp, 1968: Vorkommen und Verbreitung der Silicoflagellaten im Neogen Österreichs. – Gior. Geol. (2) **35**, Fasc. II: 117–126, pl. 3, tab. 1, Bologna.

BACHMANN, A., A. PAPP & H. STRADNER (1963): Mipropaläontologische Studien im „Badener Tegel" von Frättingsdorf, N. Ö. – Mitt. Geol. Ges. Wien **56** (1): 117–211, 3 textfigs., pls. 1–24, Wien.

BACHMAYER, F. & R. W. WILSON (1970): Die Fauna der altpliozänen Höhlen- und Spaltenfüllung bei Kohfidisch, Burgenland (Österreich). A Pliocene Fauna of Small Mammals (Insectivora, Chiroptera, Lagomorpha, Rodentia) from the Kohfidisch Fissures of Burgenland, Austria. – Ann. Nat. hist. Mus. Wien **74**: 533–587, 13 pls., Wien.

BACHMAYER, F. & H. ZAPFE (1969): Die Fauna der altpliozänen Höhlen- und Spaltenfüllung bei Kohfidisch, Burgenland (Österreich). Geologische und biostratinomische Verhältnisse der Fundstelle, Ausgrabungen. – Ann. Nat. hist. Mus. Wien **73**: 123–139, 2 textfigs., 5 pls., Wien.

– – (1972): Die Fauna der altpliozänen Höhlen- und Spaltenfüllung bei Kohfidisch, Burgenland (Österreich). Proboscidea. – Ann. Nat. hist. Mus. Wien **76**: 19–27, Wien.

BALDI, T. (1966): Die oberoligozäne Molluskenfauna von Eger und die Neuuntersuchung der Schichtfolge. – Ann. Mus. Nat. Hist. Hung. **58**: 69–101, 2 textfigs., 2 tab., 4 pls., Budapest.

– (1969): On the Oligocene Miocene Stages of the Central Paratethys and on the Formations of the Egerian in Hungary. – Ann. Univ. Sc. Budapestinensis, Sect. Geol. **12**: 19–28, Budapest.

– (1973): Mollusc fauna of the Hungarian Upper Oligocene (Egerian). – 511, 55 textfigs., 4 tab., 51 pls., Akad. Kiado, Budapest.

BALDI, T. & J. SENES (1975): OM-Egerian. – Chronostrat. & Neostratotypen. Miozän der Zentralen Paratethys, **5**, Bratislava (in print).

BALDI, T., T. KECSKEMETI, M. R. NYIRO & C. W. DROOGER (1961): Neue Angaben zur Grenzziehung zwischen Chatt und Aquitan in der Umgebung von Eger (Nordungarn). – Ann. Hist. Natur. Mus. Nat. Hung. **53**: 67–132, Budapest.

BALDI-BEKE, M. (1975): Lower boundary and vertical range of the Egerian on the basis of the nannoplankton. – Proc. 6. Congr. Neogene Mediterranean, **1**: 237–239, Bratislava.

BANDY, O. (1971): Neogene Planktonic Foraminiferal Zones, California, and some Geologic Implications. – Paleogeogr., Paleoclimatol., Paleoecol. **12**: 131–150, Amsterdam.

BANDY, O. & R. E. ARNAL (1969): Middle Tertiary Development San Joaquin Valley, California. – Geol. Soc. America Bull. **80**: 783–820, 27 figs., 1 pl., Boulder, Colorado.

BERGGREN, W. A. (1969): Cenozoic chronostratigraphy, planktonic foraminiferal zonation and the radiometric time scale. – Nature **224** (5224): 1072–1075, London.

– (1972): A Cenozoic time-scale – some implications for regional geology and paleobiogeography. – Lethaia **5**: 195–215, Oslo.

– (1973): The Pliocene time-scale. – Calibration of planktonic foraminiferal and calcareous nannoplankton zones. – Nature **243**: 391–397, London.

BERGGREN, W. A. & M. AMDURER (1973): Late Paleogene (Oligocene) and Neogene planktonic foraminiferal biostratigraphy of the Atlantic Ocean (Lat. 30° N to Lat. 30° S). – Riv. Ital. Paleont. 79 (3): 337–392, Milano.

BERGGREN, W. A. & J. v. COUVERING (1974): The Late Neogene: Biostratigraphy, Geochronology and Paleoclimatology of marine and continental stratigraphies for the past 15 million years. – Palaeogeogr., Palaeoclimat., Palaeoecol. **16**: 1–216, 16 textfigs., Amsterdam.

BIZON, G., J. J. BIZON & CH. MONTENAT (1972): Le Miocène Terminal dans le Levant Espagnole (Provinces d'Alicante et de Murcia). – Rev. Inst. Français Petr. **6**: 831–857, Paris.

BLOW, W. H. (1969): Late Middle Eocene to Recent planktonic foraminiferal biostratigraphy. – Proc. 1st Int. Conf. Plankt. Microfoss., Geneva 1967, **1**: 199–422, Leiden.

BOLLI, H. M. (1966): Zonation of Cretaceous to Pliocene marine sediments based on planktonic foraminifera. – Bol. inform. Asoc. Venez. Geol. Min. Petrol. **9** (1): 2–32, Caracas.

– (1970): The foraminifera of Sites 23–31, Leg 4. – Init. Repts. Deep Sea Drill. Proj. **4**: 577–643, Washington.

– (1973): Oligocene to Recent planktonic foraminifera and stratigraphy of the Leg 15 Sites in the Caribbean Sea. – Init. Repts. Deep Sea Drill. Proj. **15**: 475–497, Washington.

BRAUMÜLLER, E. (1961): Die paläogeographische Entwicklung des Molassebeckens in Oberösterreich und Salzburg. – Erdoel-Z. **77**: 3–14, pls. 1–2, Wien - Hamburg.

DE BRUIJN, H. & J. E. MEULENKAMP (1972): Late Miocene Rodents from the Pandanassa Formation (Prov. Rethymnon), Creta, Greece. – Koninkl. Nederl. Akad. Wetensch., Proc. Ser. B **75**: 54–60, 1 pl., Amsterdam.

DE BRUIJN, H., P. Y. SONDAAR & W. J. ZACHARIASSE (1971): Mammalia and Foraminifera from the Neogene of the Kastellios Hill (Crete), a Correlation of Continental and Marine Biozones. – Koninkl. Nederl. Akad. Wetensch. Proc. Ser. B **74**: 1–22, 4 pls., Amsterdam.

CATZIGRAS, F., CH. GLINTZBOECKEL et al. (1972): Contribution à l'étude de l'Aquitanien. La coupe de Carry-le-Rouet (Bouches-du-Rhône, France). – Bull. Bur. Rech. Géol. & Min., 2. sér., No. 4: 135 pp., Paris.
CICHA, I. (1970): Stratigraphical problems of the Miocene in Europe. — Rozpr. Ust. Ust. Geol. 35: 134 pp., 12 pls., Praha.
CICHA, I., F. CHMELIK, F. PICHA & Z. STRANIK (1964): Übersicht über den heutigen Stand der Forschungen in der Molassezone, Zdanicer und Pouzdraner Einheit Süd-Mährens. – Mitt. Geol. Ges. Wien **56** (1963): 445–468, Wien.
CICHA, I., V. FAHLBUSCH & O. FEJFAR (1972): Biostratigraphic Correlation of some Late Tertiary vertebrate faunas in Central Europe. – N. Jb. Paläont. Abh. **140**: 129–145, Stuttgart.
CICHA, I., H. HAGN & E. MARTINI (1971): Das Oligozän und Miozän der Alpen und der Karpaten. Ein Vergleich mit Hilfe planktonischer Organismen. – Mitt. Bayer. Staatssamml. Paläont. hist. Geol. **11**: 279–293, 1 tab., München.
CICHA, I., A. PAPP, J. SENES & F. STEININGER (1975): Badenian. – In: STEININGER, F. & L. NEVESSKAJA (eds.): Stratotypes of Mediterranean Neogene Stages, **2**: 43–49, Fig. 10, Bratislava.
CICHA, I. & J. SENES (1968): Sur la Position du Miocène de la Paratethys Centrale dans le cadre du Tertiaire de l'Europe. – Geol. Zbornik Slov. Akad. Vied **19**: 95–116, 4 figs., 2 tab., Bratislava.
– – (1973): Neogene of the West Carpatian Mountains. – 10. Congr. Carpath.-Balkan. Geol. Assoc. Excursion-Guide F: 46 pp., 7 figs., Bratislava.
CICHA, I., J. SENES & F. STEININGER (1975): Karpatian. – In: STEININGER, F. & L. NEVESSKAJA (eds.): Stratotypes of the Mediterranean Neogene Stages, **2**: 93–100, Figs. 22–23, Bratislava.
CICHA, I., J. SENES & I. TEJKAL (1967): M_3 – Karpatien. – Die Karpatische Serie und ihr Stratotypus. – Chronostrat. & Neostrat. **1**: 312 pp., 57 pls., Bratislava.
CICHA, I. & I. ZAPLETALOVA (1963 a): Die Vertreter der Gattung *Bolivina* (Foraminifera – Protozoa) im Miozän der Westkarpaten. – Sborn. U. U. Geol., Paleont. **28** (1961): 115–183, Praha.
– – (1963 b): Wichtige Vertreter der Familie Lituolidae REUSS, 1861 (Foraminifera) aus dem Miozän der Westkarpaten. – Sborn. Geol. Ved, Paleont. **1**: 75–121, Praha.
CITA, M. (1971): Definition and use of the Bormidian stage. A critical review. – Newsl. Stratigr. **1** (4): 29–43, Leiden.
DAXNER-HÖCK, G. (1970): Die Wirbeltierfauna aus dem Alt-Pliozän (O-Pannon) vom Eichkogel bei Mödling (N. Ö.). III. Rodentia. – Ann. Nat. Hist. Mus. Wien **74**: 597–606, Wien.
– (1971): Vertebrata (excl. Pisces) der Eggenburger Schichtengruppe. – In: STEININGER, F. & J. SENES: M_1 – Eggenburgien. – Chronostrat. & Neostrat. **2**: 761–769, 4 pls., Bratislava.
– (1972 a): Cricetinae aus dem Alt-Pliozän vom Eichkogel bei Mödling (Niederösterreich) und von Vösendorf bei Wien. – Paläont. Z. **46**: 133–150, pls. 21–22, 3 textfigs., Stuttgart.
– (1972 b): Die Wirbeltierfauna aus dem Alt-Pliozän (Pont) vom Eichkogel bei Mödling (Niederösterreich). IV. Gerbillinae (Rodentia, Mammalia). – Ann. Nat. Hist. Mus. Wien **76**: 143–160, 4 textfigs., 1 pl., Wien.
DOMNIG, D. P. (1972): Sirenias and Desmnostylians in West Coast Miocene Stratigraphy. – Proc. Pacific Coast Mioc. Biostrat. Symp.: 146–149, Bakersfield.
DREGER, J. (1892): Die Gastropoden von Häring bei Kirchbichel in Tirol. – Ann. Nat. hist. Mus. Wien **7**: 11–34, pls. 1–4, Wien.
– (1903): Die Lamellibranchiaten von Häring bei Kirchbichel in Tirol. – Jb. Geol. Reichsanst. **53**: 253–284, pls. 11–13, Wien.
DROOGER, C. W. (1966): Miogypsinidae of Europe and North Africa. – CMNS Proc. 3rd Sess. Berne 1964: 51–54, Leiden.
GHEORGHIAN, M. D. (1970): Contribution à la connaissance de certaines espèces de Globorotaliidae, d'âge Tortonien, de la Roumanie. – Dari Seama Sedint. **55** (1967–68): 151–160, Bucuresti.
– (1971): Sur quelques affleurements de dépôts Ottnangiens de Roumanie et sur leur continu microfaunique. – Mem. Inst. Geol. Roman. **14**: 103–121, Bucuresti.
GRILL, R. (1941): Stratigraphische Untersuchungen mit Hilfe von Mikrofaunen im Wiener Becken und den benachbarten Molasse-Anteilen. – Öl & Kohle **37**: 595–602, 18 textfigs., Wien.
– (1943): Über mikropaläontologische Gliederungsmöglichkeiten im Miozän des Wiener Beckens. – Mitt. Reichsamt Bodenf. Wien **6**: 33–44, Wien.
HAGN, H. (1960 a): Die stratigraphischen, paläogeographischen und tektonischen Beziehungen zwischen Molasse und Helvetikum im östlichen Oberbayern. – Geol. Bavarica **44**: 3–208, München.

HAGN, H. (1960 b): Die Gliederung der bayerischen Miozän-Molasse mit Hilfe von Kleinforaminiferen. – Mitt. Geol. Ges. Wien **52** (1959): 133–141, Wien.

– (1967): Das Alttertiär der Bayerischen Alpen und ihres Vorlandes. – Mitt. Bayer. Staatssamml. Paläont. hist. Geol. **7:** 245–320, München.

HAGN, H. & O. HÖLZL (1952): Geologisch-Paläontologische Untersuchungen in der subalpinen Molasse des östlichen Oberbayerns zwischen Prien und Sur mit Berücksichtigung des im Süden anschließenden Helvetikums. – Geol. Bavarica **10:** 208 pp., 7 textfigs., 8 pls., München.

HAGN, H., O. HÖLZL & K. HRUBESCH (1962): Zur Gliederung des Oligozäns im östlichen Oberbayern und in Nordtirol. – N. Jb. Geol. Paläont. Mh. 1962 (8): 423–447, Stuttgart.

HÖLZL, O. (1958): Die Molluskenfauna des oberbayerischen Burdigals. – Geol. Bavarica **38:** 348 pp., 6 textfigs., 22 pls., München.

– (1962): Die Molluskenfauna der oberbayerischen marinen Oligozänmolasse zwischen Isar und Inn und ihre stratigraphische Auswertung. – Geol. Bavarica **50:** 275 pp., 13 textfigs., 12 pls., München.

– (1973): 2. Faziostratotypus: Kaltenbachgraben, Landkreis Miesbach-Aibling, Oberbayern, Bundesrepublik Deutschland (Profil der Gerner, Alber und Kirchberger Schichtenfolge). – In: PAPP, A., F. RÖGL & J. SENES: M_2 – Ottnangien. – Chronostrat. & Neostrat. **3:** 155–196, textfig. 22, 23, tab. 4., Bratislava.

HOFMANN, W. (1967): Untersuchungen an der Gattung *Bolivina* (Foraminifera) im Oligozän und Miozän der ostbayerischen Molasse. – Geol. Bavarica **57:** 121–204, München.

JENKINS, D. (1966): Planktonic foraminifera from the type Aquitanian – Burdigalian of France. – Cushm. Found. Foram. Res., Contr. **17:** 1–15, Ithaca, N.Y.

KENAWY, A. L. (1968): Planktonic foraminifera from the Oligocene and Lower Miocene of Hungary. – Ann. Univ. Sci. Budapest., Sect. geol. **11:** 133–201, Budapest.

KOKAY, J. (1973): 6. Faziostratotypus: Bantapuszta, Transdanubien, Ungarn. – In: PAPP, A., F. RÖGL & J. SENES: M_2 – Ottnangien. – Chronostrat. & Neostrat., **3:** 227–236, textfig. 33, Bratislava.

KOLLMANN, K. (1965): Jungtertiär im Steirischen Becken. – Mitt. Geol. Ges. Wien **57:** 479–632, 6 pls., Wien.

KÜPPER, I. (1966): Vorkommen von *Miogypsina (Miogypsinoides) complanata* SCHLUMBERGER im Chatt der Tiefbohrung Kirchham 1 (Molassezone, Oberösterreich). – Erdöl-Erdgas-Z. **82:** 295–297, Wien - Hamburg.

LASKAREV, V. (1924): Sur les équivalents du Sarmatien Supérieur en Serbie. – Rec. Trav. M. I. Cvijic, Belgrade: 1–5, Belgrad.

LINDENBERG, H. G. (1965): Die Bolivinen (Foram.) der Häringer Schichten. Mikropaläontologische Untersuchungen im Alttertiär des Unterinntal-Gebietes. – Boll. Soc. Paleont. Ital. **4** (1): 64–160, Modena.

LIPPOLT, J., I. BARANYI & W. TODT (1975): Das Kalium-Argon-Alter des Basaltes vom Lavant-Tal in Kärnten. – Der Aufschluß, Jg. **26** (6): 218–242, Heidelberg.

LORENZ, C. (1972): Etude des Lepidocaclines et Miogypsines. – In: Contr. étude l'Aquit. La coupe de Carry-le-Rouet. – Bull. B. R. G. M., 2. sér. sect. 1, **4:** 37–44, Paris.

LUCZKOWSKA, E. (1971): A new zone with *Praeorbulina indigena* (Foraminiferida, Globigerinidae) in the Upper Badenian (Tortonian s. s.) of Central Paratethys. – Rocz. Pol. Tow. Geol. **40** (1970): 445–448, Krakow.

LÜHR, H. (1962): Geologisch und mikropaläontologische Untersuchungen im Alttertiär von Häring/Tirol. – Inaug. Diss. Naturwiss. Fak., Ludwig-Max-Univ. München, 174 pp., Isny i. A.

MACSOTAY, O. (1971): Zonacion del Post Eoceno de la Paleoprovincia Caribe-Antillana a base de Taxa de Turritella (Molusco: Gastropodo). – Bol. Inform. Asoc. Venezolana Geol. Min. Petroleo **14:** 18–63.

MACSOTAY, O. & W. SCHERER (1972): Classificacion Numerica de las Turritellidae (Moluscos) del Oligoceno al Holocene. Corespondientes a la Paleo-Provincia del Caribe. – Mem. Iv. Congr. Geol. Venezolanao, v. 3, Bol. Geol. Publ. Esp. No. 5: 1715–1734.

MARTINI, E. (1971): Standard Tertiary and Quaternary calcareous nannoplankton zonation. – Proc. II. Planktonic Conf., Roma 1970, 2: 739–785, 6 tab., pls. 1–4, Rome.

– (1972): Silicoflagellate zones in the late Oligocene and early Miocene of Europe. – Senckenbergiana lethaea **53** (1/2): 119–122, 4 textfigs., Frankfurt a. M.

MARTINI, E. & C. LEBENZON (1971): Nannoplankton-Untersuchungen im oberen Tal des Tarcau (Ostkarpaten, Rumänien) und stratigraphische Ergebnisse. – N. Jb. Geol. Paläont., Mh. 1971 (9): 552–565, 8 textfigs., 1 tab., Stuttgart.

MARTINI, E. & V. MOISESCU (1974): Nannoplankton-Untersuchungen in oligozänen Ablagerungen zwischen Cluj und Huedin (NW Siebenbürgisches Becken, Rumänien). – N. Jb. Geol. Paläont., Mh. 1974 (1): 18–37, 5 textfigs., Stuttgart.

MARTINI, E. & C. MÜLLER (1975): Calcareous nannoplankton and silicoflagellates from the type Ottnangian and equivalent strata in Austria (Lower Miocene). – Proc. 6. Congr. Neogene Mediterran. **1:** 121–124, Tab. 17, Bratislava.

– – (1975): Calcareous nannoplankton from the Karpatian in Austria (Middle Miocene). – Proc. 6. Congr. Neogene Mediterran. **1:** 125–128, Tab. 18, Bratislava.

MÉSZAROS, N., C. LEBENZON, N. SURARU & G. IANOLIU (1975): Die mit Hilfe des Nannoplanktons durchgeführte Abgrenzung des Oligozäns im Tale des Almas (Nord-Westen des Siebenbürgischen Beckens, Rumänien). – Proc. 6. Congr. Neogene Mediterran. **1:** 129–137, pls. 2–4, Bratislava.

MÉSZAROS, N. & M. MAROSI (1957): Raspindirea speciei Variamussium fallax in interiorne arcului Carpatic. – Anal. Rom. Sor. geol.-geogr. **1,** Bucuresti.

MOISESCU, V. (1972): Mollusques et Echinides Stampiens et Egeriens de la Region de Cluj – Huedin – Romanasi (Nord-Ouest de la Transsylvanie). – Inst. Geol. Mem. **16:** 152 pp., 38 pls., Bucuresti.

MOTTL, M. (1970): Die jungtertiären Säugetierfaunen der Steiermark, Südost-Österreich. – Mitt. Mus. Bergbau, Geol. & Techn. Landesmus. Joanneum, Graz **31:** 79–168, 7 textfigs., Graz.

MÜLLER, C. (1974): Nannoplankton aus dem Mittel-Miozän von Walbersdorf (Burgenland). – Senckenbergiana lethaea **55** (1/4): 389–405, pls. 1–4, Frankfurt a. M.

NICORA, A. (1971): Biostratigrafia del limite Oligocene-Miocene nelle Langhe (Piemonte). – Riv. Ital. Paleont. **77** (2): 157–262, Milano.

NOSZKY, J., sen. (1939/1940): A Kiscelli agyag Molluszka faunaja. (Mollusc fauna of the Kiscell Clay.) I. Lamellibranchiata. – Ann. Mus. Nat. Hung. **32,** pars Min. Geol. Pal.: 19–146. – II. Loricata, Gastropoda, Scaphopoda. – Ann. Mus. Nat. Hung., **33,** pars Min. Geol. Pal.: 1–80, Budapest.

ODIN, G. S. (1973): Sur les datations radiométriques du Miocène de la Paratethys. – Bull. Soc. Géol. France (7), **15:** 2 pp., Paris.

– (1975): Les Glauconites. Constitution, Formation, Age. – These Doct. Etat Sc. Nat. Univ. Paris, C. N. R. S., A. O. 10611: 245 pp., Paris.

OPDYKE, N. D. et al. (1974): The extension of the magnetic time scale in sediments of the central Pacific Ocean. – Earth & Plan. Sci. Lett. **22:** 300–306.

PAPP, A. (1951): Das Pannon des Wiener Beckens. – Mitt. Geol. Ges. Wien **39–41:** 99–193, 7 textfigs., 4 pls., Wien.

– (1956): Fazies und Gliederung des Sarmats im Wiener Becken. – Mitt. Geol. Gesien **47** (1954): 35–98, 3 tab., Wien.

– (1959): Tertiär. 1. Pt. Grundzüge Regionaler Stratigraphie. – Handb. Strat. Geol., v. 3/1: 411 pp., 89 figs., 63 tab., Stuttgart.

– (1960): Das Vorkommen von Miogypsina in Mitteleuropa und dessen Bedeutung für die Tertiärstratigraphie. – Mitt. Geol. Ges. Wien **51** (1958): 219–228, Wien.

– (1963): Die biostratigraphische Gliederung des Neogens im Wiener Becken. – Mitt. Geol. Ges. Wien **56:** 225–317, Wien.

– (1966): Evolution von Nannoplankton und Foraminiferen im mittleren Neogen Mitteleuropas. – CMNS Proc. 3rd Sess. Berne 1964: 70–77, Leiden.

PAPP, A. et al. (1968): Nomenclature of the Neogene of Austria. – Verh. Geol. Bundesanst. Jg. 1968: 9–27, 1 tab., Wien.

PAPP, A. & K. KÜPPER (1954): The genus *Heterostegina* in the Upper Tertiary of Europe. – Contr. Cushm. Found. Foram. Res. **5** (3): 108–127, Bridgwater, Mass.

PAPP, A., F. RÖGL & J. SENES (1973): M_2 – Ottnangien. – Chronostrat. & Neostrat. **3:** 841 pp., 44 textfigs., 82 pls., Bratislava.

PAPP, A. & M. F. SCHMID (1971): Zur Entwicklung der Uvigerinen im Badenian des Wiener Bekkens. – Verh. Geol. Bundesanst. Jg. 1971: 47–58, Wien.

PAPP, A., J. SENES & F. MARINESCU (1974): M_5 – Sarmatien. – Chronostrat. & Neostrat. **4:** 707 pp., 87 pls., 75 textfigs., Bratislava.

PAPP, A. & F. STEININGER (1973 a): Die stratigraphischen Grundlagen des Miozäns der zentralen Paratethys und die Korrelationsmöglichkeiten mit dem Neogen Europas. – Verh. Geol. Bundesanst.: 59–65, Wien.

– – (1973 b): Die Stellung des Ottnangien zum Typusprofil des Helvetien. – In: PAPP, A., F. RÖGL & J. SENES: M_2 – Ottnangien. – Chronostrat. & Neostrat. **3:** 29–32, Bratislava.

PAPP, A. & F. STEININGER (1975 a): Sarmatian. – In: STEININGER, F. & L. NEVESSKAJA (eds.): Mediterranean Neogene Stages 2: 139–148, Figs. 33–36, Bratislava.

– – (1975 b): Pannonian. – Ibidem, 2: 121–126, Figs. 29–30, Bratislava.

PAPP, A. & K. TURNOVSKY (1953): Die Entwicklung der Uvigerinen im Vindobon (Helvet und Torton) des Wiener Beckens. – Jb. Geol. Bundesanst. 96: 117–142, Wien.

PARAMONOVA, N. P. (1975): Sarmatian sensu lato (BARBOT DE MARNY 1866). – In: STEININGER, F. & L. NEVESSKAJA (eds.): Stratotypes of Mediterranean Neogene Stages 2: 185–186, Bratislava.

POPESCU, G. (1969): Some new Globigerina (Foraminifera) from the Upper Tortonian of the Transsylvanian Basin and the Subcarpathians. – Rev. Rouman. Geol. Geophys. Geogr., ser. Geol. 13 (1): 103–106, Bucuresti.

– (1970 a): Planktonic foraminiferal zonation in the Dej Tuff Complex. – Rev. Rouman. Geol. Geophys. Geogr., ser. Geol. 14 (2): 189–203, Bucuresti.

– (1970 b): The planktonic foraminifera from the Hida Beds. – Stud. Cercet. Geol. Geofiz. Geogr., ser. Geol. 15 (1): 239–253, Bucuresti.

RABEDER, G. (1970): Die Wirbeltierfauna aus dem Alt-Pliozän (O-Pannon) vom Eichkogel bei Mödling (N. Ö.). I. Allgemeines, II. Insectivora. – Ann. Nat. Hist. Mus. Wien 74: 589–594, Wien.

– (1973): Galerix und Lanthanotherium (Erinaceidae) aus dem Pannon des Wiener Beckens. – – N. Jb. Geol. Paläont., Mh., Jg. 1973: 429–446, 5 textfigs., 3 tab., Stuttgart.

– (1975): Die Wirbeltierreste (excl. Pisces) aus dem Egerien von Österreich. – In: BALDI, T. & J. SENES: OM-Egerien. – Chronostrat. & Neostrat. 5: 437–455, Bratislava.

RABEDER, G. & F. STEININGER (1975): Die direkten biostratigraphischen Korrelationsmöglichkeiten von Säugetierfaunen aus dem Oligo/Miozän der Zentralen Paratethys. – Proc. 6th Congr. CMNS 1975, 177–183, Bratislava.

RÖGL, F. (1969): Die Foraminiferenfauna aus den Phosphoritsanden von Plesching bei Linz (Oberösterreich) – Ottnangien (Untermiozän). – Naturkd. Jb. Stadt Linz 1969: 213–234, Linz.

– (1969): Die miozäne Foraminiferenfauna von Laa und der Thaya in der Molassezone von Niederösterreich. – Mitt. Geol. Ges. Wien 61 (1968): 63–123, Wien.

– (1975): Die planktonischen Foraminiferen der Zentralen Paratethys. – Proc. 6th Congr. CMNS 1: 113–120, Tab. 16, Bratislava.

– (1975): Ottnangien. – In: STEININGER, F. & L. NEVESSKAJA (eds.): Stratotypes of the Mediterranean Neogene Stages 2: 101–120, Figs. 24–28, Bratislava.

RÖGL, F., M. B. CITA, C. MÜLLER & P. HOCHULI (1975): The biostratigraphic age of conglomerate bearing Molasse sediments near Como (Italy). – Riv. Ital. Paleont. 81: 57–88, Milano.

RÖGL, F. & F. STEININGER (1970): *Miogypsina (Miogypsinoides) formosensis* YABE & HANZAWA, 1928 (Foraminiferida) aus den Linzer Sanden (Egerien-Oberoligozän) von Plesching bei Linz, Oberösterreich. – Mitt. Geol. Ges. Wien 62 (1969): 46–54, Wien.

RUSU, A. (1972): Aperçu sur l'Egérien et l'Eggenburgien du Nord-Ouest de la Transsylvanie. – In: MOTAS & al. (eds.): Guide de l'excursion de la V^e Réunion du Groupe de Travail pour la Paratéthys. – Inst. Geol. Guide Ex. 9: 17–22, Bucuresti.

SAMUEL, O. & J. SALAJ (1968): Miobiostratigraphy and foraminifera of the Slovak Carpathian Paleogene. – 232 pp., 31 pls., Geol. Ustav D. Stura, Bratislava.

SCHMID, M. E. (1971): Eine neue Uvigerina aus der Oberen Lagenidenzone (Badenien) des Wiener Beckens (Foraminifera, Uvigerinidae). – Verh. Geol. Bundesanst., Jg. 1971: 43–46, Wien.

SENES, J. (1960): Entwicklungsphasen der Paratethys. – Mitt. Geol. Ges. Wien 52: 181–187, Wien.

– (1961): Paläogeographie des Westkarpatischen Raumes in Beziehung zur übrigen Paratethys im Miozän. – Geol. Prace 60: 159–195, Bratislava.

SENES, J. et al. (1971): Korrelation des Miozäns der Zentralen Paratethys. – Geol. Sbornik 22: pp. 3–9, 5 tab., Bratislava.

SENES, J. & FL. MARINESCU (1974): Cartes paléogéographiques du Néogène de la Paratéthys centrale. – Mém. B. R. G. M. 78: 785–792, 7 pls., Paris.

STEININGER, F. (1969): Das Tertiär des Linzer Raumes. – In: STEININGER, F. & W. PODZEIT (eds.): Geologie und Paläontologie des Linzer Raumes: 35–53, 14 pls., Linz.

STEININGER, F. F. (1975 a): Egerian. – In: STEININGER, F. & L. NEVESSKAJA (eds.): Stratotypes of Mediterranean Neogene Stages, 2: 71–81, Figs. 17–19, Bratislava.

– (1975 b): Eggenburgian. – Ibidem 2: 83–91, Figs. 20–21, Bratislava.

STEININGER, F. F.: Integrated Assemblage Zone Biostratigraphy at Marine – Nonmarine Boundaries: an example from the Neogene of Centrale Europe. – In: KAUFFMAN, E. G. & J. E. HAZEL (eds.): Concepts and Methods of Biostratigraphy (in print).

STEININGER, F. et al. (1973): Die Molluskenfaunen des Ottnangien. – In: PAPP. A., F. RÖGL & J. SENES: M_2 – Ottnangien. – Chronostrat. & Neostrat. **3**: 380–554, 30 pls., Bratislava.

STEININGER, F. & J. SENES (1971): M_1 – Eggenburgien. – Chronostrat. & Neostrat. **2**: 827 pp., 112 pls., Bratislava.

STEININGER, F. & E. THENIUS (1965): Eine Wirbeltierfauna aus dem Sarmat (Ober-Miozän) von Sauerbrunn (Burgenland). – Mitt. Geol. Ges. Wien **57**: 449–467, Wien.

STRADNER, H. (1960): Über Nannoplankton-Invasionen im Sarmat des Wiener Beckens. – Erdoel.-Z. **76**: 430–432, 2 Abb., Wien.

– (1961): Über fossile Silicoflagellaten und die Möglichkeit ihrer Verwendung in der Erdölstratigraphie. – Erdöl u. Kohle, Erdgas, Petrochemie **14**, 87–92, 1 Abb., Taf. 1–3, Hamburg.

SUESS, E. (1866): Untersuchungen über den Charakter der österreichischen Tertiärablagerungen. II. Über den Charakter der brackischen Stufe oder der Cerithienschichten. – Sitz. Ber. Österr. Akad. Wiss., math.-naturwiss. Kl. **54**: 218–357, Wien.

SURARU, N. (1967): Beiträge zur Kenntnis des Burdigals im nordwestlichen Teil des Siebenbürger Beckens zwischen Cluj und Surduc (Rumänien). – N. Jb. Geol. Paläont., Mh. **1967/8**: 489–497, 2 textfigs., Stuttgart.

– (1968): Contributie la cunosterea macrofaunei argilelor de Chechis. – Stud. Univ. "Babes-Bolyai", ser. geol.-geogr. **2**: 47–58, 1 tab., Cluj.

– (1969): Über eine vollmarine Fauna der Zimborer Schichten im unteren Becken des Almas-Tales (I). – Stud. Univ. "Babes-Bolyai", ser. geol.-geogr., fasc. **2**: 45–56, 2 textfigs., 1 tab., Cluj.

– (1970): Über eine vollmarine Fauna der Zimborer Schichten im unteren Becken des Almas-Tales (II). – Stud. Univ. "Babes-Bolyai", ser. geol.-miner. **2**: 33–46, 2 pls., Cluj.

THENIUS, E. (1952): Die Säugetierfauna des Torton von Neudorf a. d. March (ČSSR). – N. Jb. Geol. Paläont. Abh. **96**: 27–136, Stuttgart.

– (1959): Tertiär. 2. Pt. Wirbeltierfaunen. – Handb. Strat. Geol. **3** (2): 328 pp., 32 tab., 10 pls., Stuttgart.

– (1974): Die Säugetierfauna des Alt-Pliozäns (Pannon und Pont) in Österreich. – Mem. B.R.G.M. **78**: 253–258, 2 tab., Paris.

THEYER, F. & S. R. HAMMOND (1974 a): Cenozoic Magnetic Time Scale in Deep-Sea Cores: Completion of the Neogene. – Geol.: 487–492.

– – (1974 b): Paleomagnetic Polarity sequence and radiolarian zones, Brunhes to Epoch 20. – Earth & Planet. Sci. Lett. **22**: 306–319, 1 tab., 7 figs., Amsterdam.

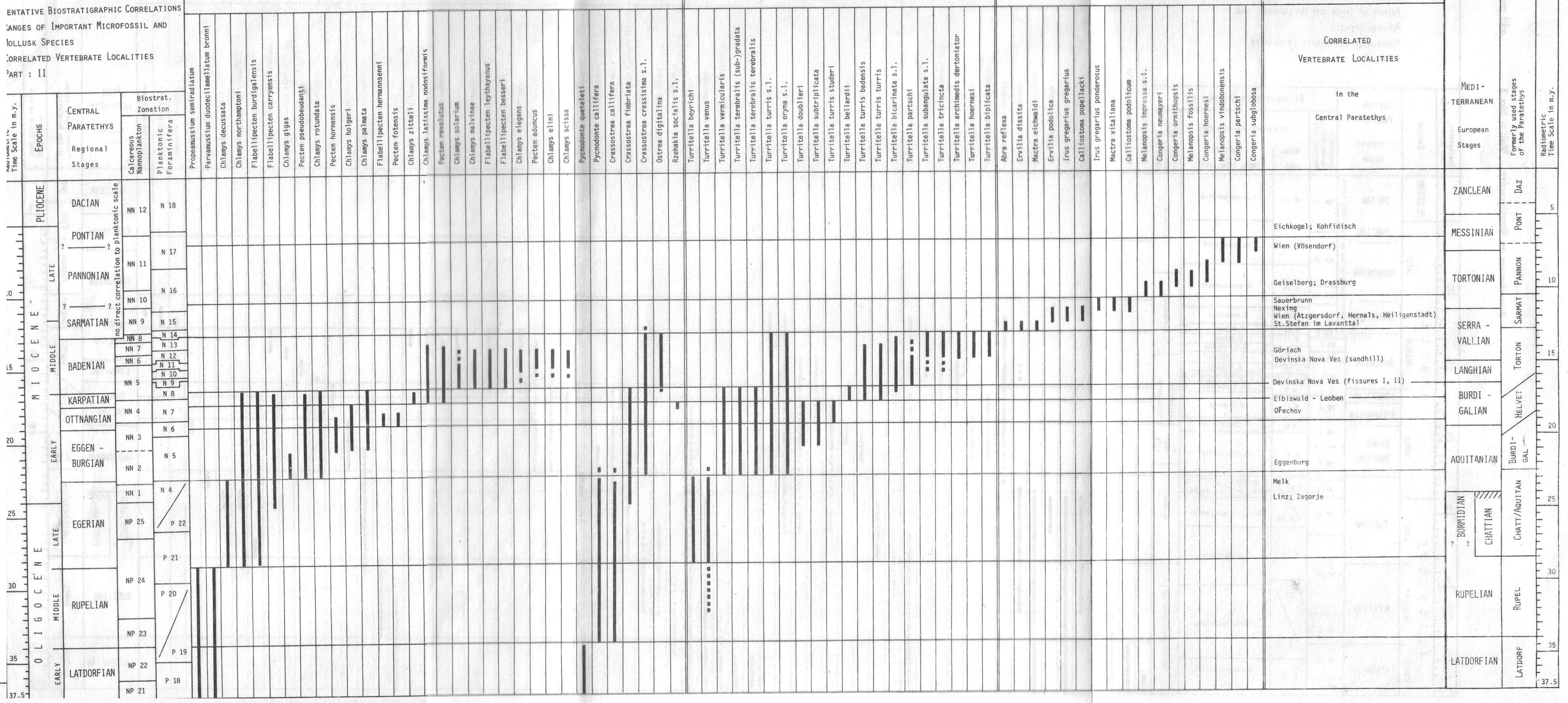
VASS, D., G. P. BAGDASARJAN & V. KONECNY (1970): Absolute Age of Several Stages of the West-Carpathian Miocene. – Geol. Prace **51**: 71–97, 3 tab., Bratislava.

VASS, D., G. P. BAGDASARJAN & J. SLAVIK (1974): Absolute Datierungen aus dem Sarmatien s. str. – In: PAPP, A., F. MARINESCU & J. SENES: M_5 – Sarmatien (sensu E. SUESS, 1866). – Chronostrat. & Neostrat. **4**: 45–53, Bratislava.

Typescript received 25th June 1975

Table 1, part II

OLIGOCENE - MIOCENE BIOSTRATIGRAPHY OF THE CENTRAL PARATETHYS



Newsletters on Stratigraphy Vol. 4, No. 3 add page 192

Table 1, part I

OLIGOCENE - MIOCENE BIOSTRATIGRAPHY OF THE CENTRAL PARATETHYS