

	ABHANDLUNGEN DER GEOLOGISCHEN BUNDESANSTALT				
	Abh. Geol. B.-A.	ISSN 0378-0864	ISBN 3-85316-007-7	Band 56/2	S. 653-668
Geologie ohne Grenzen Festschrift 150 Jahre Geologische Bundesanstalt			Redaktion: Harald Lobitzer & Pavol Greclka		

Some new aspects of the lower boundary of the Egerian stage (Oligocene, chronostratigraphic scale of the Paratethys area)

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With 5 Text-Figures and 2 Plates

Paratethys
Egerian
stratotype
larger foraminifera
molluscs
Pectinidae
sequence stratigraphy

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Abstract

The authors wanted to revise the stratigraphic signals of the Kiscellian/Egerian boundary in the light of new developments and discoveries in the fields of larger foraminifera and molluscs. They intended also to investigate the position of the same boundary in the latest chronostratigraphic time scales and check the correlation with the standard stages, like the Chattian and Aquitanian. There was no change since the definition of Egerian. The low diversity of planktonics and the common mixture of planktonic tests were caused by reworking and by the more or less restricted character of the Central Paratethyan sea-basins.

After the short review of the old definitions (part I by TB), the present field conditions of the stratotypes are treated with special emphasis on the Eger Wind's brickyard holo-stratotype and the Novaj, Nyárjas section (part II – TB). Progress and recent state of taxonomy and stratigraphy are shortly presented in part III (TB and partly GyL). An additional, new Egerian facio-stratotype, the transgressive Csókás section is proposed here, too. New results obtained on larger foraminifera are shown in part IV (GyL). The three analysed Egerian localities of larger foraminifera contain nearly the same, very rich assemblage, that is not endemic, and most closely related to the one from Escornebéou (SW France). The Novaj, Csókás and Budikovany sections can be correlated with the SBZ 23 shallow benthic zone. The Kiscellian/Egerian boundary corresponds to the SBZ 22/23 boundary. In part V (TB) the molluscan assemblages of the boundary zone are discussed. Molluscs of the holostratotype (Wind's brickyard), Novaj and some less known sites from the vicinity of Eger are treated here. The majority of mollusc taxa (74%) are old forms, crossing the Kiscellian/Egerian boundary. 22% of the fauna above the Kiscellian/Egerian boundary is new and spread throughout Europe in Latest Oligocene and Miocene times. Separated from the other molluscs, the *Pectinacea* are treated in part VI (OM). "*Flabelliptectin burdigalensis*" was thought to be an index fossil first appearing at the base of the Egerian. A detailed check of the original material showed that more taxa are represented under this name. These taxa belong to the genus *Amussiopecten* (Sacco, 1897) and the *Chlamys northamptoni* group (ROGER, 1939). In part VII (TB) the author stresses that while the Rupelian/Chattian boundary coincides with the great sea level fall, the 27.1 My old Kiscellian/Egerian boundary is significantly younger. The stage boundaries of the Central Paratethys are often non-coincident with the sequence boundaries because of the strong tectonical overprint.

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Einige neue Aspekte der Egerium – Untergrenze (Oligozän, regionale chronostratigraphische Gliederung der Zentralen Paratethys)

Zusammenfassung

Eine Revision der Kiscellium/Egerium–Grenze wird vorgestellt, basierend auf moderner Literatur und der Neubearbeitung der Großforaminiferen und Mollusken. Die chronostratigraphische Lage dieser Grenze, wie auch ihr Bezug zum Chattium und Aquitanium wird diskutiert. Die Definition der Stufe Egerium aufgrund einer gering diversen, meist aufgearbeiteten, planktonischen Fauna konnte unverändert beibehalten werden. Diese wird in Zusammenhang mit einer regressiven Phase in der Zentral Paratethys gebracht.

Ein kurzer Überblick der bisherigen Definitionen der Kiscellium/Egerium–Grenze ist im Kapitel 1 (TB) gegeben. Es folgt eine Darstellung der Aufschlußverhältnisse der Stratotypen. Eine Sonderstellung nehmen dabei Profil Nyárjas bei Novaj und der Stratotypus: Wind'sche Tongrube in Eger ein (Kapitel 2, TB). Der Stand der stratigraphischen und taxonomischen Forschung wird im nächsten Kapitel dargestellt. Dabei kann Profil Csókás als ein neuer Faziostratotypus fürs Egerium vorgeschlagen werden (Kapitel 3, TB und GyL). Weiters werden drei reiche, nicht endemische Großforaminiferen-Faunen von Novaj, Csókás and Budikovany vorgestellt und mit dem südwestfranzösischen Vorkommen von Escornebéou verglichen, resultierend in einer Korrelation der Probenpunkte mit der flachmarinen Benthoszone SBZ 23. Die Kiscellium/Egerium Grenze wird mit der SBZ 22/23 Grenze korreliert (Kapitel 4, GyL). Im Kapitel 5 (TB) wird die biostratigraphische Aussagekraft der Molluskenvorkommen innerhalb der Kiscellium/Egerium Grenzzone herausgestrichen. Der Schwerpunkt liegt dabei beim Stratotypus und den benachbarten Fundpunkten. Die Auswertung ergab daß 74% der Gesamtf fauna an der Egeriumbasis zu alten, persistierenden Formen gehört und daß nur 22% aus der neuauftretenden und in späten Oligozän und Miozän europäischer Bioprovinzen weitverbreiteten Formen besteht. Die Familie der Pectiniden konnte aufgrund ihrer umstrittener Taxonomie in die Analyse nicht miteinbezogen werden und wurde deswegen getrennt behandelt (Kapitel 6, OM) Eine taxonomische Revision von "*Flabellipecten burdigalensis*", einem Indexfossil der Egeriumbasis, wurde durchgeführt. Dabei zeigte sich, daß die Form in zwei Spezies zu trennen ist welche einerseits der Gattung *Amussipecten* (Sacco, 1897) und andererseits der Gruppe um *Chlamys northamptoni* (Roger, 1939) angehören. Abschließend wird im Kapitel 7 (TB) festgelegt daß die Kiscellium/Egerium-Grenze, mit 27.1 My deutlich jünger ist als die, durch einen signifikanten Meeresspiegelabfall gekennzeichnete, Rupelium/Chatium-Grenze. Das Abweichen der Stufengrenzen der Zentralen Paratethys von globalen Sequenzgrenzen ist auf eine starke regional-tektonische Überprägung zurückzuführen.

Introduction

The first significant isolation of the Paratethys occurred in the Early Oligocene (BÁLDI, 1979, 1986, 1989). The regional chronostratigraphic scale of the Paratethys area, limited earlier to the Neogene, has to be extended on the Oligocene, too. The stage Egerian, obtaining its name after the city of Eger, Hungary, was proposed for the first time in 1968 by some of the stratigraphers, who attended the Bologna congress of the Committee on Mediterranean Neogene Stratigraphy (CMNS, 1967) (SENES, CÍCHA, PAPP, BÁLDI, etc.) [for more details see BÁLDI (1973), BÁLDI & SENES (1975)]. It has been introduced and designated in 1975 [BÁLDI & SENES (1975)]. The underlying stage, named Kiscellian ("Kleinzellian") after the Kiscell (Kleinzell) Plateau in Budapest III. district, Hungary, was first proposed in 1979 (BÁLDI, 1979), and designated, introduced by BÁLDI (1986). The stage Kiscellian, however, had been informally in usage by some Central European stratigraphers since 1975.

It is time now to revise the old, classic definitions of both stages, considering the long time, elapsed since the definitions. The main goal of the present paper is nothing more than to present and analyse the main paleontologic, geochronologic and stratigraphic aspects of the Kiscellian/Egerian boundary in the context of some new results, discovered since the designation, and description of the two stages. The new results are in connection with those taxa of larger foraminifera and molluscs which were thought to be important indicators of the lower boundary of the Egerian. Furthermore, there are left yet unsolved problems, concerning the absolute ages and the correlation with sequence stratigraphy.

1. Short account of the old definitions

After BÁLDI & SENES (1975): "The Egerian stage has been established in 1968 by T. BÁLDI and J. SENES for that time interval which characterizes by some typical groups and formations the transition from Oligocene to Miocene in Central Europe, i.e. in the area of Central Paratethys. – The base of

the Egerian corresponds chronologically with the first appearance of *Globorotalia opima opima* and *Miogypsinoidea complanata*. Simultaneously with these forms there appear sporadically also the first forms of the *Globigerinoides* genus. As to nannoplankton, in the lower part of the Egerian appears *Sphenolithus ciperoensis* and disappears (?) *Sphenolithus distentus*. *Flabellipecten burdigalensis* and, probably, *Chlamys decussata* appear also close to the base of the Egerian. The Eger profile may be regarded as a boundary stratotype. *Pecten burdigalensis*, with its first appearance indicating the lower boundary of Egerian after the definition of the CMNS working group for Paratethys in Vienna (1970), has been found deepest in this section at 27,6 m, but a juvenile exemplar has been observed even deeper, at 35,2 m, almost exactly where the lithostratigraphic boundary is between the Kiscell Clay and glauconitic sandstone of the Eger Formation. – We are considering as lower limit of the Egerian, the basis of the glauconitic sandstone member of the holostratotype after the first appearance of *Pecten burdigalensis* at this level. The interval between 36–18 m can be held as a gap for the lacking *Miogypsina* [correctly: *Miogypsinoidea*] *complanata* biozone (lowermost taxon of the *Miogypsina* lineage, marking the beginning of Egerian..."[BÁLDI & SENES 1975 (p. 10, 88, 111–112)].

2. Checking the present state of stratotypes in the field

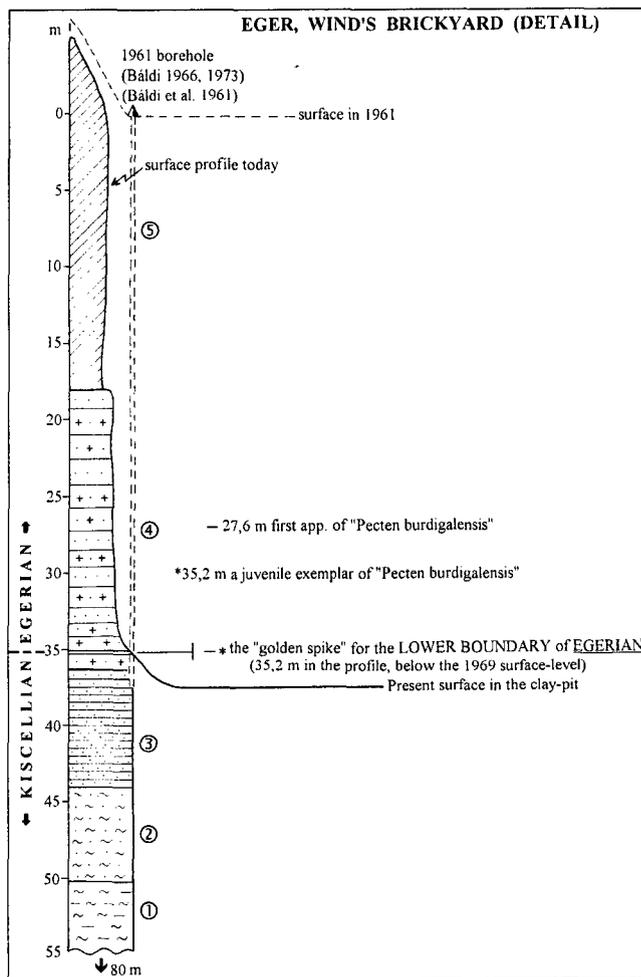
From the above short review it is rather obvious that the stratotype ["holostratotype", as we named it in those times] is designated in Eger (fig. 1), in the well-known classic macrofaunal locality of the clay-pit of the – Wind's brick-yard. The section of the whole locality was figured first by TELEGGI-RÓTH (1914). Regarding the serious changes following that time, it seemed to be necessary both to complete and to revise TELEGGI-RÓTH's profile. This was done by BÁLDI (1966, p. 70, 1973, p. 81). The section of a borehole drilled until the depth 80 m below the then existing surface of the bottom of the clay-pit, has been also included into BÁLDI's section.

Further immense transformations took place during the last decades in the clay-pit of the brickyard. Fig. 2 is a magnified and more detailed part of Báldi's profile referred above. Because of the huge quantity of exploited clay and silt, the bottom of the present pit is in 1998 around at the 35. meter of the borehole of the year 1961. That means that practically the whole Egerian of the stratotype crops out to the surface, – involving the glauconitic sandstone too. All these changes are presented on fig. 2. In the tuffaceous, glauconitic sandstone (Upper Egerian, 4. layer) the following macrofauna was collected from the cores in 1961 (BÁLDI, 1966): "*Pecten burdigalensis*" (common), solitary corals (*Flabellum*, *Trochocyathus*) (common), *Cerithium egerense* GÁBOR, *Babylonia eburnoides umbilicosiformis* TELEGGDI-RÓTH, *Dentalium apenninicum* SACCO, shark teeth. The mollusc clay (5. layer on fig. 2.) has a very diverse, well-preserved, mainly small sized, but shelled mollusc-fauna published by BÁLDI (1966, 1973). In the assemblage the following taxa are dominant: *Hinia schlotheimi*, *Volutilithes permulticostata*, *Cadulus gracilina*, *Costatoleda psammobiaeformis*. The place of the "golden spike" is also presented.

Another surface section, the hill-top of *Nyárjas at Novaj*, on Fig. 3 hardly 7 km-s E of Eger, was designated as one of the "facio-stratotypes" of the Egerian. Faciostratotype, a concept used only by the Paratethys Group of CMNS, has been held coeval with the "holostratotype" (the "true" stratotype) of the stage and served as auxiliary profile of the type-section itself. The Novaj section – after the discovery of LEGÁNYI, – was first described and figured by BÁLDI, KECSKEMÉTI & NYÍRO (1961). Miogypsinids and other larger foraminifera of the outcrop were found, correctly recognized



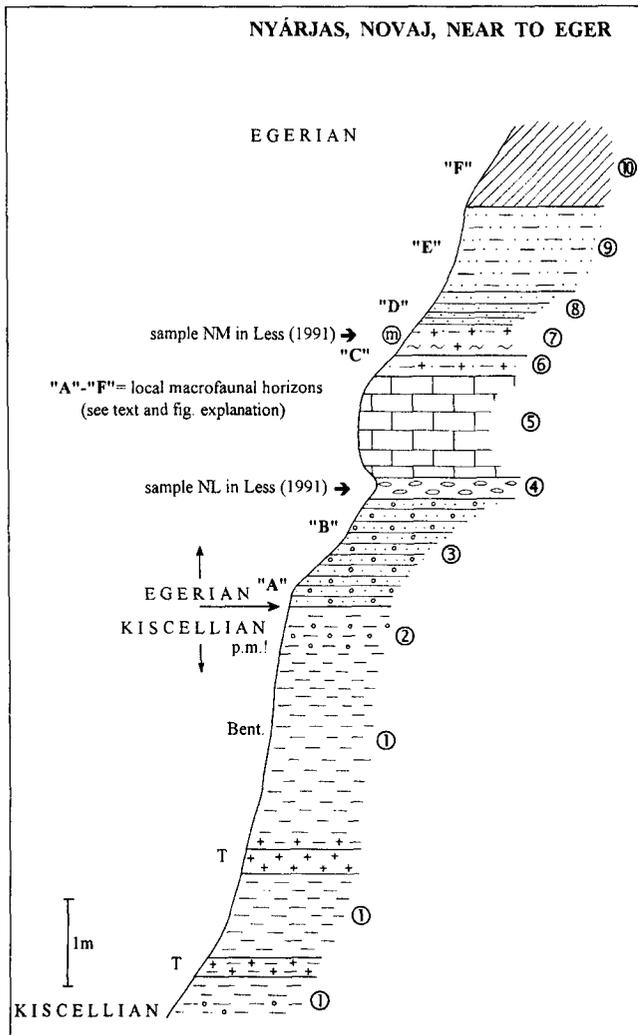
Text-Fig. 1. A sketch-map of North Hungary and South Slovakia, showing the topographic position of localities, treated in the present text. 1. Lower Egerian, 2. Upper Egerian. The locality Eger, Wintner's School, is known from Lörenthey's collection originating still prior to World War I. Presently not available in the field because the glauconitic layers and its fauna came from a well-digging.



Text-Fig. 2. An up-to-date profile of the clay pit of the Wind's brick-yard in Eger. This is only a detail of BÁLDI's earlier section from 1966 and 1973. Note the huge deepening of the pit by the large scale exploitation during the last decades. The recent surface of the bottom of the pit has reached the 35–37 m niveau of the borehole, drilled in 1961. Until this depth, now the whole section crops out to the surface, though much cleaning is still necessary before studies. 1. marl, marly clay (Kiscell Clay, Kiscellian). 2. fine sandy, silty marl, slightly glauconitic (Kiscell Clay, Kiscellian). 3. glauconitic, fine grained sandstone (Kiscell Clay, Kiscellian). 4. tuffaceous, glauconitic sandstone (Eger Formation, Egerian). Its fauna was collected from the cores. 5. mollusc clay (Eger Formation, Egerian) with its rich and characteristic marine macrofauna. The place of the "golden spike" is also presented.

and published in the same time by DROGER (1961), and connected with other data by BÁLDI, KECSKEMÉTI, NYÍRO & DROGER (1961). It has been treated later by BÁLDI (1973) and BÁLDI & SENES (1975). In 1972 a 60 m long trench was dugged across the sequence, making available several new details and increased number of data including many new macrofaunal finds. The results were published by BÁLDI-BEKE & BÁLDI (1974a and 1974b). Important new data on larger foraminifera were recognized and published by LESS (1991). A new species, the *Nummulites kecskeméti* Less was described (see further results of Gy. LESS on larger foraminifera in a following, separate section of the present paper. Fig. 3. about the Novaj, Nyárjas section presents in a more accurate and more detailed form the geological and paleontological observations, obtained here following the 1972, and a much later, 1985 digging work.

On fig. 3. the lower half of the Novaj section belongs to the Kiscell Clay of the Kiscellian. The whole Kiscellian is mostly strongly tuffaceous and bentonitic clay, yielding no macrofauna. It is interesting that in the uppermost layers of Kiscellian, one can observe a thin "pebbly mudstone" intercalation, very close to the Kiscellian/Egerian boundary. The pebbly mudstone can be the slight indication of a rather dis-



Text-Fig. 3.

An up-to-date section of the Novaj, Nyárjas hill-top with the Kiscellian/Egerian boundary. It is largely based on section published by BÁLDI-BEKE & BÁLDI (1974). The figure is, however, more detailed, more precise than the one published earlier. Therefore it is new. 1. Kiscell Clay, more or less tuffaceous, bentonitic (Bent.) (Kiscellian). T = tuff or clayey tuff intercalation in the Kiscell Clay 2. pebbly mudstone in the uppermost portion of the Kiscellian. (Indicates submarine gravitational mass movement.) 3. glauconitic coarse sand, with dispersed pebbles, and with rich, but not well preserved macrofauna. In the lowermost layer of No. 3., the "A", a little higher the "B" macrofaunal, local zone was studied (Eger Formation, Egerian). 4. Oil-grey lepidocyclina marl, lepidocyclinas in almost rockbuilding quantity (Eger Formation, Egerian). 5. lithothamnian limestone with sporadic glauconitic grains, in upper part with more Lepidocyclinae and less Corallinaceae (Egerian). 6. tuffaceous sandy clay. 7. slightly glauconitic, tuffaceous marl, sandy silt. (Eger Formation, Egerian). Both the 6. and 7. layers are richest in miogypsinids. The "C" macrofauna was collected from this horizon. m = miogypsinids are common. 8. glauconitic fine sandstone (macrofauna level "D") (Eger Form., Egerian). 9. clayey, marly, glauconitic, fine sandstone, silt (macrofaunal horizon "E") (Egerian). 10. molluscan clay member (Eger Formation, Egerian). "F" macrofaunal horizon. For further explanation see text.

tant submarine fan and some gravitational mass movement on the sea-bottom sediment (BÁLDI, 1986, 1983 and for sedimentological grounds see CROWELL, 1957). The fan itself, and other convincing, large scale marks of the same submarine gravity mass-movement have been recognized around Noszvaj, 5–6 km N of Novaj-Nyárjas and they can be followed laterally along the Southern foot-hills of the Bükk Mts. as far as Miskolc (BÁLDI & SZTANÓ in press, Földt. Közl., 1999). It is everywhere in the same stratigraphic position: in uppermost Kiscellian and at places perhaps also in the lowermost Egerian, always underlying the glauconitic sandstone member. In the present paper we have not the possibility to treat in details that newly found, important turbiditic event which occurred in the type area near to the turn of Kiscellian/Egerian.

The upper half of the Novaj section is Egerian. It is built up of coarse glauconitic sandstone, marly, glauconitic silts and a one meter thick lithothamnian limestone, – a real rarity in Paratethyan realm. The succession of the above lithofacies is shown on fig. 3. The macrofauna of the Egerian of the outcrop is diverse. The lowermost level of the glauconitic sandstone contains the very common shells of "*Flabellipecten burdigalensis* LAM.". The first occurrence of this taxon has been found to be the best marker of the Egerian lower boundary in the stratotype section (Wind's brickyard, Eger). Most abundant fossils are: other pectinids, some molluscs (only imprints and steinkerns), solitary, ahermatypic corals, and larger foraminifera in some layers in rockbuilding quantity: Lepidocyclinae, Heterosteginae, Operculinae, Miogypsinidae, Nummulites, etc. Separate sections of the present paper treat the larger foraminifera and the pectinids. The glauconitic member is overlain by the molluscan clay, the same that we found in the Wind's brickyard, Eger. This member can be traced throughout N Hungary: from Esztergom until Miskolc with hardly changing thickness, and with the same characteristic macrofauna [BÁLDI & NAGY-GELLAI (1990)]. In the Egerian part of the Novaj section, local macrofaunal horizons have been designated ("A", "B", etc.), as seen on fig. 3. The macrofauna will be presented in a separate chapter.

3. Progress in taxonomy and stratigraphy since the designation of the Egerian

3. 1. No big change occurred in field conditions. Both Eger, Wind's brick-yard and Novaj, Nyárjas remained available for anybody. Because of the intensive exploitation, the outcrop of the Wind's brick-yard changed very much in shape, size and depth. The presently outcropping rocks are not so fossiliferous. The Kiscellian/Egerian boundary, the place of the "golden spike" got to the surface in the last years.

3. 2. However, in the last years a new important section, Csókás, near Miskolc (fig. 4) has been discovered that was ranged – first of all by its larger foraminiferal content – earlier (BALOGH, 1964) into the Upper Eocene. Even JÁMBOR-KNESS (1988) in her monograph on the larger foraminifera of Hungary put it at the Eocene/Oligocene boundary (she calls the locality as Sólomkút – Puits de Faucon). LESS (1991) was the first who elaborated the section and its larger foraminiferal fauna (more details see in Chapter 4) that proved to be almost identical with that of the Novaj, Nyárjas section. The age (Lower Egerian) was confirmed by the calcareous nannoplankton studied by M. BÁLDI-BEKE and A. NAGY-MAROSY, too. The peculiarity of the section is that the Lower Egerian in this isolated locality lies transgressively upon the Triassic rocks of the Bükk Mts. The thickness of the whole

3. 6. K/E B takes place in the lower part of the **Upper Oligocene**.

3. 7. It is, however, younger than the Rupelian/Chattian boundary of 28,5 My old. The difference is 1,4 My. This position is very correctly figured on tables published by both STEININGER and RÖGL.

3. 8. *Globorotalia* [correctly: *Paragloborotalia*] *opima* s. l. occurs mainly in Upper Kiscellian (in the Kiscell Clay). Its presence in the Lower Egerian is rather dubious. The more so, since after the table of BERGGREN et al. (1995), *Pgr. opima* disappears exactly at 27,1 My. No better and more updated data are at our disposal on planktonic foraminifera of the Egerian type-area now than in 1975. Therefore I can not modify with full assurance the original definition of the K/EB. [In the original definition the **first appearance** of the *Pgr. opima* s. l. is described as signal of the lower boundary of the Egerian. It is a nonsense!] Anyway, this part of the original definition can be considered tentatively, as erroneous. The disappearance of *Pgr. opima* at the K/E B is very probable.

3. 9. The 27,1 My time-horizon intersects the lowermost part of the calcareous nannofossil zone NP 25 (sensu MARTINI, 1971). The major and lower part of the Egerian belongs to this biozone, while the uppermost, Miocene portion of this stage would correlate to NN 1 and in some authors' opinion, also to the lower NN 2 [RÖGL, 1998, p. 283; STEININGER et al., 1996].

3. 10. It is interesting, but not incorrect that contradicting to the original definition of 1975, the upper part of zone NP 24 has not been included into the range of Egerian. This nannozone will indicate only the Upper Kiscellian in the future. NP 24 correlates to Upper Kiscellian only.

3. 11. Any discussion on the problem of separation of NP 24 from NP 25 is, however, a futile. In the region of the Central Paratethys a reliable separation of these zones is in most cases impossible, as BÁLDI-BEKE (1984 and earlier) has been stressing it. About the relationship of K/E B and zone NP 25 our statement has been based only on indirect correlations [by the help of BERGGREN et al. (1995)]. Though MARTINI (1971) refers to some European examples too, these zones (NP 24 and 25) are based mainly on sphenolithes, preferring the waters of open oceans. Last occurrence (LO) levels are often used to characterize zone-boundaries. The majority of the nannofossil zones were described from materials of bottom boring cores, drilled in the sea-floor of open, tropical oceans. Certain nannoplanktonic, stratigraphic units therefore can not be reliably recognized or separate from each other, originating from sediments of rather closed and temperate marine basins, located on higher latitudes and in the centre of orogenic belts. Here the lower diversity nannofossil assemblages are made even more confusing by the additions of older taxa, washed out, transported and resedimented repeatedly, as a consequence of repeated tectonical activities above and below sea level.

3. 12. Keeping in mind the difficulties mentioned under point 11., one has to admit that zonal boundaries only defined by FO-s can be really convincing and recognizable. In this respect NP 24 can be better utilized, since its lower boundary is marked by the FO of *Sphenolithus ciperoensis* (and there are other events at this boundary useful in higher latitudes too: FO of *Helicosphaera recta* and FO of *Cyclicargolithus abisectus*). The Tard Clay and Kiscell Clay (Lower and Upper Kiscellian) were always well separable by means of nannofossils, even if facies similarities persisted in some cases. [The Tard Clay is not extending beyond the upper boundary of NP 23.]

3. 13. The situation of the zone NP 25 is different. Both boundaries are defined by LO-s (MARTINI, 1971). This way

NP 25 remains an uncertain unit over large areas of the Central Paratethys. One can state definitely only that the lower and – in time – longer portion of the Egerian correlates to the NP 25 zone.

3. 14. The zone NN 1 is distinguishable from NP 24–25 only with LO-s of more species. It is correlated with the upper and – in time – shorter part of the Egerian which belongs to the Miocene.

3. 15. Very well recognizable datum-level is the FO of *Discoaster druggii*. This event is regarded usually as the upper boundary of Egerian in Hungary (equally self-evidently with the lower boundary of the Eggenburgian) (E/EB in the following). The first appearance of *D. druggii* signals the Lower Boundary (LB in the following) of zone NN 2 of MARTINI (1971). After MARTINI's original definition, it is the "Interval from the first occurrence of *Discoaster druggii*...." (MARTINI, 1971, p. 764). Its equivalent is BUKRY'S CN1C sub-zone. The stratigraphers are rather divided in the question of the age of this zone. An age about 23,2 My-s is attributed to the FO of *D. druggii* and this way to the LB of NN 2 by BERGGREN et al. (1995). They correlate this event with the magnetostratigraphic polarity chronozone C6Br. [The age of the anomaly 6 was originally calculated to 20–22 My by RYAN, CITA, POORE and others still in 1975–1980.] The Chron 6Br is the time of the FO of *D. druggii* (23,2 My). On the other hand YOUNG et al. (1994), HAQ et al. (1987, 1988), HAQ (1991) have thought to appear the *D. druggii* much later, at 20,8 My, consequently the basis of NN 2 would be the same age too (20,8 My). The difference is coming probably from different correlations with the magnetostratigraphic scale. YOUNG et al., HAQ, and others correlate the FO of *D. druggii* with the boundary of C6/C6A chron (20,5 My). BERGGREN and others correlate the same event with C6Br (23,3 My). RÖGL (1998) and STEININGER et al. (1996) took over BERGGREN's et al. version in the question of the NN 2 LB. The whole confusion was caused by "...a misinterpretation of the magnetic polarity stratigraphy in Hole 522 (Poore and others)", as it has been explained by AUBRY (in: BERGGREN et al., 1995, p. 193).

3. 16. Anyhow, to declare an opinion on our part in the above question (point 15.), would exceed our aims and capabilities far beyond the frames of the present work. We are engaged here first of all in the **l o w e r** boundary of the Egerian. The outcome of this discussion, however, will effect the Paratethyan stratigraphy. If we maintain keeping the Egerian UB at the base of zone NN 2 (23,2 My), the difference would amount to 2,1 My-s. The E/EB has been drawn by RÖGL (1998) and STEININGER et al. (1996) at the 20,5 My level. The latter one intersects in the middle the NN 2 nanno-zone. While they acknowledge the chronological position of NN 2 after the version of BERGGREN et al. (1995), they do not link it with the E/EB. Their intention might be to connect E/EB with the 20,5 My old Aquitanian/Burdigalian boundary horizon.

3. 17. Among the advantages of the 23,2 My E/EB one can enumerate a.o. the possibility of easy recognition throughout the sedimentary basins in Hungary, Slovakia, etc. by the help of the recording of the FO of *Discoaster druggii*. There would remain "plenty of time" for the Eggenburgian (about 4 My), while the Egerian would have still always a considerable duration (27,1–23,2 My, almost 4 My). As disadvantage can be recorded the too short duration of NN 1 (only 0,5 My).

3. 18. Therefore it became a usage to describe the longer, Oligocene part of the stage, as Lower Egerian. The Upper, much shorter Miocene part has been treated often under the name "Upper Egerian". NP 25 is correlated with the L.Egerian (LE), while NN 1 (and only this one!) with the UE.

3. 19. The boundary between LE and UE can be best defined a. o. by the FO of *Miogypsina gunteri*. In Aquitania

(SW-France) this member of the Mio. lineage marks convincingly the lower edge of the Miocene, Aquitanian. The FO of *Mio. gunteri* was at 23,8 My. Only half a million year would remain for the Upper Egerian which is, however, enough, considering the generally less significant thickness and distribution of the rocks included in this sub-unit.

3. 20. Presently we are already in the pleasant position of having the description of the stratotype of the Paleogene/Neogene (= Oligocene/Miocene = Chattian/Aquitian) boundary, carefully and elaborately chosen, depicted, examined and published by Steininger and his Working Group (STEININGER, 1994). This is the Lemme-Carrosio section. The level of the "golden spike" designated here, intersects the time-interval of the Egerian at the horizon treated already (18. and 19. points).

3. 21. Because of the problems with planktonic fossils, and of the richness in the same time in molluscs, Pectinids and other macrofaunal taxa received special attention in 1975, at the definition of the K/EB (Kiscellian/Egerian Boundary). "*Pecten* [= *Flabellipecten*] *burdigalensis*" was promoted among the most important index fossils of the Egerian, when we regarded this taxon as a signal of the LB of the Egerian. The boundary was designated even in the stratotype itself at the first occurrence of this species. Latest it became clear that there are serious taxonomic problems around this form. One of the authors of the present paper, discoverer of these anomalies, O. MANDIĆ is treating the details in a separate section of this article. Another author (BALDI) tries to find some more index-fossils for the recognition of the K/EB by comparing older and younger macrofaunal lists recorded from the type area and Dejčár.

3. 22. Just for the sake of experiment, BALDI tries in a separate section to correlate the K/EB with sequence stratigraphic levels.

4. Larger foraminifera as tools for the chronostratigraphic correlation of the Kiscellian/Egerian boundary

Larger foraminifera play an important role in correlating the shallow water deposits of the Tethyan Oligocene and Lower Miocene. The correlation is based on two principles: firstly on the successive appearance (and subordinately on the disappearance) of different genera and also of different evolutionary lineages inside particular genera; and secondly on the rapid evolution of some evolutionary lineages that provides to subdivide them into successive, artificially delimited chronospecies. Unlike the Eocene forms, the Oligocene-Lower Miocene genera and the evolutionary lineages are very well distinguishable from each other, and also the segregation of the evolutionary lineages is based on numerically defined limits. As a result, the Oligocene-Lower Miocene larger foraminifera are mostly very well determinable by using the morphometric method, circumscribed above and, therefore, recently there are not too much pitfalls in their taxonomy.

This recent clear situation is mostly due to C. W. DROOGER's life-activity. He (DROOGER, 1952, 1963) and the so-called Utrecht School under his leadership (e.g. de MULDER, 1975; LAAGLAND, 1990) step by step made clear the evolution of miogypsinids, lepidocyclinids and of the genus *Cycloclypeus* by applying biometrics and elaborating their results statistically by populations. The outcome of these works has been summarized by DROOGER (1993).

Simultaneously, DROOGER & LAAGLAND (1986) established the first larger foraminiferal zonation of the Oligocene by

using the genera *Miogypsinoides*, *Miogypsina*, *Lepidocyclina*, *Cycloclypeus* and *Nummulites*. At the same time they correlated this zonation with two versions of the planktonic zonation published by HARDENBOL & BERGGREN (1978) and BERGGREN et al. (1985), respectively. This correlation was later modified by LAAGLAND (1990) who chose only the BERGGREN et al. (1985) scale as a base. The most recent zonation of larger foraminifera (by CAHUZAC & POIGNANT, 1997) mostly adopts the results of DROOGER & LAAGLAND (1986) but it includes more new genera (mostly the operculinid and porcellaneous forms), extends towards the Miocene and uses the newest BERGGREN et al. (1995) magnetobiostratigraphic scale for correlation. In the framework of the EXXON-project "Mesozoic-Cenozoic sequence stratigraphy of western European basins" CAHUZAC & POIGNANT (1997) established six shallow benthic zones (SBZ 21-26) for the Oligo-Miocene continuing the SBZ 1-20 zones of SERRA-KIEL et al. (1998) for the Paleocene and Eocene. Three of their six zones cover the whole Oligocene, their correlation with the planktonic zonations and with the larger foraminiferal zonations of the Dutch authors is shown in Fig. 5.

Despite the small differences between the three above mentioned zonations the succession of the main larger foraminiferal events is the same in all of them. These are:

4. 1. The extinction of all the orthophragminids (*Discocyclina*, *Asterocyclina* and *Orbitoclypeus*) and several nummulitids at the Eocene/Oligocene boundary (SBZ 20/21 zone boundary in CAHUZAC & POIGNANT, 1997, *fabianii/fichteli* zone-limit at the Dutch authors).

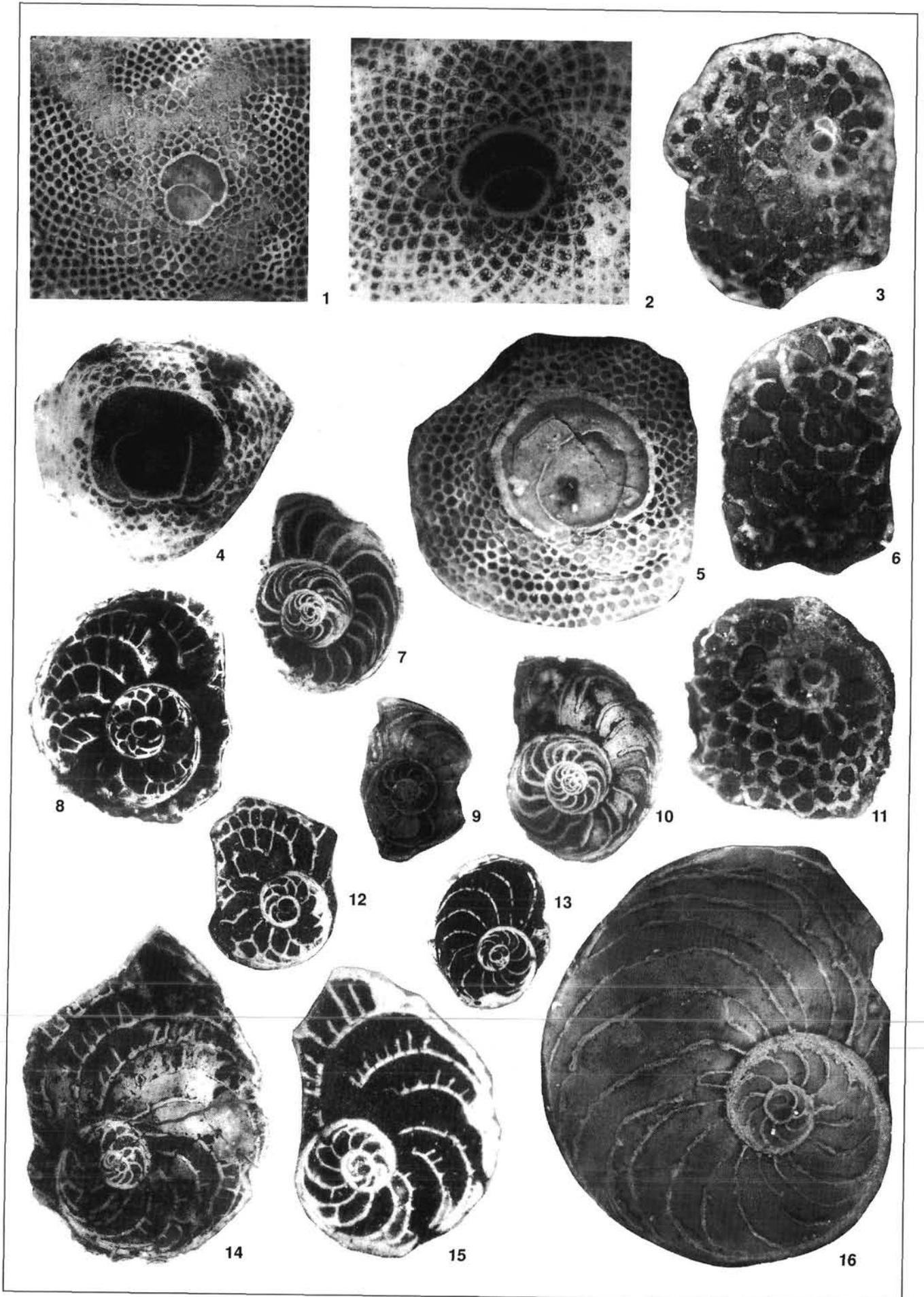
4. 2. The appearance of lepidocyclinids (both *Nephrolepidina* and *Eulepidina*) having migrated from the American bioprovince (SBZ 21/22 zone-boundary in CAHUZAC & POIGNANT, 1997, *fichteli/praemarginata* zone-limit at the Dutch authors).

4. 3. The appearance of *Cycloclypeus* (SBZ 22 A/B subzone-boundary in CAHUZAC & POIGNANT, 1997, *praemarginata/Cycloclypeus* zone-limit at the Dutch authors).

4. 4. The appearance of miogypsinids nearly simultaneously with the extinction of two surviving from the Eocene *Nummulites*-lineages (*N. incrassatus-vascus* and *N. fabianii-fichteli*) and with that of the *Cycloclypeus droogeri-mediterraneus*-lineage (the boundary of the SBZ 22/23 zones in CAHUZAC & POIGNANT, 1997, the *Cycloclypeus/Miogypsinoides* zone-limit after the Dutch authors).

4. 5. The appearance of *Miogypsina gunteri* simultaneously with the disappearance of the last Nummulites, involute *Heterostegina* (*Grzybowskaia* in CAHUZAC & POIGNANT, 1997) and *Spiroclypeus* at the Oligocene/Miocene boundary (SBZ 23/24 zone-boundary in CAHUZAC & POIGNANT, 1997; *Miogypsinoides/gunteri* zone-limit after the Dutch authors).

In order to correlate the larger foraminifera that can be found at the vicinity of the Kiscellian/Egerian boundary in the Paratethyan realm to the larger foraminiferal zonations listed above we can use only those data that have been obtained by adopting the morphometric methods of the Utrecht School. There are only three such papers. The first one has been published by DROOGER (1961) who identified *Miogypsina septentrionalis* from Novaj, Nyárjas (from the *Miogypsina* Clay) and definitively settled with this the long-lasting, so-called "Chattian-Aquitian dispute" about the age of the Egerian type fauna for the favour of the Chattian. The second paper is written by VANOVA (1975) dealing with the lepidocyclinids and miogypsinids from Budikovany and Breka in Slovakia (the latter locality belongs already to the Miocene part of the Egerian. The third paper is published by LESS (1991) who described the complete larger foraminiferal fauna from the two levels of Novaj, Nyárjas (sample NL comes from the *Lepidocyclina* Marls while sample NM repre-



sents the *Miogypsina* Clay) and also from the new locality of Csókás (sample C3 and sample C4, about 10 m above C3). From the PAPP (1975) data we can use only the operculinids figured from Budikovany because his species concept was rather typological than populational, being the latter crucial in applying the Utrecht methods. Moreover, he cites *Miogypsinoides formosensis* YABE & HANZAWA from both Novaj and Budikovany that was not found either by DROOGER or VANOVA or LESS. So, the analysis of the larger foraminiferal fauna of the basal Egerian is based on five layers of three localities (Novaj, samples NL and NM, Csókás, samples C3 and C4 and Budikovany).

Miogypsina septentrionalis DROOGER (pl. 1, figs. 3, 6, 11): It is known only from Novaj, mainly in the *Miogypsina* clays (sample NM) but one single specimen was already found in the *Lepidocyclina* marls (sample NL), too. It is worth noting that VANOVA (1975) did not find any miogypsinids in Budikovany that are mentioned by PAPP (1975). In all the three larger foraminiferal scales (see above) this species, being the most primitive true *Miogypsina* with lateral chambers, is placed above the appearance of *Miogypsinoides* with no lateral chambers, into the upper half of the SBZ 23 zone or of the *Miogypsinoides*-zone, respectively. It is worth noting that the most primitive *Miogypsinoides* – *M. complanata* SCHLUMBERGER – is described by KÜPPER (1975) from the Puchkirchen beds in Austria belonging also to the Egerian.

Lepidocyclina (Nephrolepidina) morgani LEMOINE & R. DOUVILLÉ (pl. 1, figs. 1–2.): It is known from all samples. If we applied rigorously the principle of the embryonic acceleration, the Novaj populations would be more primitive than the Csókás and Budikovany ones. However, this chronospecies that follows his short-living ancestor, the *L. (N.) praemarginata* (characteristic for the SBZ 22 zone) is relatively long-lived and can be followed from the top of the SBZ 22 zone up to the middle of the SBZ 25 (Burdigalian) zone. Moreover, the Bretka population of this species (with *Miogypsina gunteri* – VANOVA, 1975) coming already from the Aquitanian is more similar to the Novaj populations than to those from Csókás and Budikovany. The offspring of *L. (N.) morgani*, the *L. (N.) tournoueri* (SBZ 25 zone) is again short-living. These data reflect that the evolution of the *Nephrolepidina*-lineage in its middle part is more complicated than it is usual for the Oligo-Miocene larger foraminiferal lineages.

Lepidocyclina (Eulepidina) dilatata (MICHELOTTI) (pl. 1, figs. 4–5.): In four samples (Csókás, samples C3 and C4, Budikovany and Novaj, sample NL from the *Lepidocyclina* Marls) it is abundant but is missing in the *Miogypsina* Clays of Novaj. The *Eulepidina*-lineage is much less studied than the *Nephrolepidinae*, however, this species – that follows its ancestor, the *L. (E.) formosoides* (characteristic for the SBZ 22A subzone) – clearly marks the Chattian (SBZ 22B and 23

zones) and maybe also some parts of the Aquitanian, too. By following the main evolutionary trends of the larger foraminifera (embryonic acceleration and size-increase of the embryo) a Csókás-Budikovany-Novaj younging trend can be concluded.

Nummulites kecskemetii LESS (pl. 1, figs. 7, 9–10): This interesting form can be found in the two samples of Csókás and in the *Miogypsina* Clays of Novaj. Very probably it is present also in Budikovany but it was not observed because of its great external similarity to the *Operculina* for that not too much attention was paid there. It is synonymic with the forms described as *N. bouillei* from Escornebœu by BUTT (1966), DROOGER et al. (1971) and CAHUZAC & POIGNANT (1997) but clearly different from the topotypical *N. bouillei* from Biarritz, rocher de la Vierge (Rupelian, SBZ 21 zone with *N. fichteli* and *N. vascus*), therefore a new name had to be erected for these forms. It is discussed in details in LESS (1999) where he supposed that the Priabonian *N. budensis* became extinct in the Tethys but survived in the American bioprovince. Where we can find the very similar *N. panamensis* in the lower part of the Oligocene. Very likely this form migrated back to the Tethys in the Chattian. By the biometrical analysis in progress, *N. budensis*, *N. panamensis* and *N. kecskemetii* can be successive chronospecies. As a result, *N. kecskemetii* can be a characteristic form for the (Upper?) Chattian of the Tethys. The differences between our particular populations are of ecological origin.

Operculina complanata (DEFRANCE) (pl. 1, figs. 13, 16): This species is known from all samples of all our three localities (from Budikovany see PAPP, 1975, pl. 1, fig. 1.). However, its biostratigraphic potential is probably the lowest of all our larger foraminifera. Both HOTTINGER (1977) and CAHUZAC & POIGNANT (1997) range it from the bottom of the Oligocene at least up to the top of the Burdigalian. Our detailed biometric analysis (LESS, 1991) developed also two morphotypes (“X” and “Y”, compare figs. 13. and 16. in our pl. 1.) within the taxon that can somehow explain its long stratigraphic range.

Operculina heterostegina SILVESTRI (pl. 1, figs. 14–15): This form is missing only in the *Lepidocyclina* Marls of Novaj, in sample NL (for Budikovany see PAPP, 1975, pl. 1, fig. 2.). Very little is known about its stratigraphical range: HOTTINGER (1977, text-fig. 41A-B) cites it from Morocco and from Israel (Ramleh, the locality that is ranged by DROOGER & LAAGLAND (1986) into the upper part of their *Cycloclypeus* zone = the upper part of the SBZ 22B subzone of CAHUZAC & POIGNANT, 1997). This same form is figured also by BUTT (1966, pl. 8, figs. 7–8) from Escornebœu (SBZ 23 zone with *Miogypsinoides complanata*). In Csókás and Novaj this taxon demonstrates a very rapid nepionic acceleration measured on the decreasing number of the operculinid (secondarily non-subdivided) chambers and shows a C3-C4-NM younging suc-

Plate 1

- 1–2. *Lepidocyclina (Nephrolepidina) morgani* LEMOINE & R. DOUVILLÉ A-form, equatorial section, x40. 1. Novaj, sample NL, O. 435, 2. Csókás, sample C3, O. 427.
 3, 6, 11. *Miogypsina septentrionalis* DROOGER A-form, equatorial section, Novaj, sample NM, x40. 3. O. 443, 6. O. 442, 11. O. 441.
 4–5. *Lepidocyclina (Eulepidina) dilatata* (MICHELOTTI) A-form, equatorial section, x20. 4. Csókás, sample C3, O. 421, 5. Novaj, sample NL, O. 423.
 7, 9–10. *Nummulites kecskemetii* LESS A-form, equatorial section, x20. 7. Csókás, sample C3, O. 400, 9. holotype, Novaj, sample NM, O. 396, 10. Csókás, sample C3, O. 401.
 8, 12. *Heterostegina assilinoidea* BLANCKENHORN A-form, equatorial section, Csókás, sample C4, x20. 8. O. 416, 12. O. 415.
 13, 16. *Operculina complanata* (DEFRANCE) A-form, equatorial section, x20. 13. Csókás, sample C4, O. 407, 16. Novaj, sample NL, O. 403.
 14–15. *Operculina heterostegina* Silvestri A-form, equatorial section, Csókás, x20. 14. morphotype “Y”, sample C3, O. 412, 15. morphotype “X”, sample C4, O. 409.

All specimens are deposited at the Oligocene (O.) collection of the Geological Museum of Hungary (formerly the Museum of the Geological Institute of Hungary).

cession. We think that this species has a promising biostratigraphic potential. However, some nomenclatural questions must be cleared (see its synonymic list in LESS, 1991, p. 442).

Heterostegina assilinoidea BLANCKENHORN (pl. 1, figs. 8, 12): This taxon is common in Csókás but only in sample C4. In sample C3 and in the *Miogypsina* Clays of Novaj it can be found only occasionally. By HOTTINGER (1977) it is characteristic for all the Oligocene but CAHUZAC & POIGNANT (1997) marks it for sure only in the SBZ 23 zone.

Four successive conclusions can be drawn by summarizing the above data:

1. The analysed three localities contain nearly the same larger foraminiferal assemblage. The most important difference between them is the presence or absence of miogypsinids (in Budikovany it is questionable – see remarks earlier). A very slight younging tendency from Csókás through Budikovany to Novaj can be guessed but the time-difference between the oldest (C3) and youngest (NM) assemblage is probably not more than some hundred-thousand years.

2. Our larger foraminiferal assemblages are not endemic, all the taxa are well-known from other localities in Europe. The most similar assemblage is described by BUTT (1966) from Escornebéou (SW Aquitaine). The only difference is that it contains *Miogypsina* (*Miogypsinoides*) *complanata* instead of *Miogypsina septentrionalis*. Therefore, our Paratethyan assemblages can be very well correlated with the other European faunas.

3. By the presence of *Miogypsina septentrionalis* the Novaj assemblages (both from the *Lepidocyclina* Marls and from the *Miogypsina* Clays) can be placed into the upper part of the SBZ 23 zone. Being a little bit older (see point 1), but at the same time very similar to the Escornebéou assemblage, the Csókás and Budikovany faunas can be correlated with the lower part of the SBZ 23 zone. This is supported also by the absence of the forms having become extinct at the SBZ 22/23 boundary (*Nummulites fichteli*, *N. vascus* and the *Cycloclypeus droogeri-mediterraneus* lineage). The glauconitic sandstone indicating a very slow sedimentation at the base of the Egerian in Novaj, Nyárjas, the lower boundary stratotype of the Egerian, may very probably correspond to the lower part of the SBZ 23 zone.

4. The Kiscellian/Egerian boundary can be correlated most probably with the SBZ 22/23 zone-boundary that corresponds to the appearance of the miogypsinids that is stated in the original definition of the Egerian (CICHA, PAPP & SENES, 1975). However, in this case the Kiscellian/Egerian boundary is not equivalent with the Rupelian/Chattian boundary but is younger than that and it must be placed at the first third of the Chattian.

5. Use of molluscs for markers of the Kiscellian/Egerian boundary

A general revision is needed for the whole mollusc fauna found along the K/EB. The fulfilment of this process has begun now with the examination of the *Pectinacea* (O. MANDIC, next chapter). Preliminary, within this chapter, the old nomenclature is still in use referred to in quotation marks.

There was plenty of material in different collections already at the time of the designation of the K/EB, in 1975. Yet, some of those materials were not properly investigated in that time, and new materials were collected and added to the older ones since 1975. Though the major part of the taxa was described by BÁLDI (1973).

The molluscs of the boundary zone grouped after localities (and when it has been possible after layers within the locali-

ty) are composed of the following taxa (the abundance of taxa is marked by the number of "!").

a) Stratotype, Eger, Wind's brickyard: glauconitic sandstone: "*Pecten burdigalensis*", *Cerithium egerense*, *Babylonia eburnoides umbilicosiformis*, *Dentalium apenninicum*, solitary corals, as *Flabellum*, *Trochocyathus*!

b) Faciostratotype: Novaj, Nyárjas: glauconitic sandstone. The taxa are grouped into horizons (see Fig. 3):

"A" "*Flabellipecten burdigalensis* LAM." (very common in the lowermost part of layer 2. on Fig. 3., Novaj section. Indicates the lower edge of the Egerian, as in the Eger stratotype), "*Flabellipecten telegdirothi* Cs.-MEZN." !!, "*Chlamys* (*Aequipecten*) *biarritzensis novajensis* BÁLDI" !! "*Ch. (Ae.) deleta csepregheznericsae* BÁLDI" !!, *Cardiocardita laurae* BRONGNIART !!! *Loripes ex aff. dentatus* DEFR., bryozoa, *Trochocyathus* cf. *plicatus* MICHELOTTI !!! (solitary coral).

"B" *Nucula nucleus* L., *Glycymeris dispar obliqua* SCHAUROTH, "*Flabellipecten burdigalensis* Lam." !!, "*Chlamys* (*Flexopecten*) *boucheri* DOLLFUS" [= an "*Ch. agriensis* Cs.-MEZN."], *Eucrassatella carcarenis* MIGHT. !!!, *Isocardia subtransversa abbreviata* SACCO !!, *Cardiocardita laurae* BRONGN. !!, *Pecchiolia* cf. *argentea* MARITI !!, *Loripes ex aff. dentatus* DEFR., *Laevicardium* cf. *peracutum* ROVERETO, *Venus* sp., *Pitar polytropa* ANDERSON, *Thracia* sp., *Bolma* sp. ex aff. *prohenica* SACCO, *Architectonica* cf. *carocollata* LAM., *Cerithium* sp., [= an *C. ex gr. egerense* GÁBOR], *Cypraea* sp., *Lyria graniformis gardonyii* NOSZKY, *Volutilithes multicostata* BELLARDI, *Lithoconus ineditus* MIGHT. ---- larger foraminifera: *Lepidocyclina* (sporadically), *Heterostegina* !!, --- solitary corals: *Trochocyathus* cf. *plicatus* MIGHT. !!, *Balanophyllia* cf. *cylindrica* MIGHT., *Flabellum* sp. indet. --- sharks: *Odontaspis* sp. "C" *Crassatina bosqueti* KOENEN !!, "*Anisocardia*" *sacci* PHILIPPI, *Cardiocardita laurae* BRONGN. !!, *Cyclocardia orbicularis subparvocostata* BÁLDI !, *Lucinoma borealis* L., *Loripes* sp., *Acanthocardia* sp., *Corbula gibba* OLIVI, ---- larger foraminifera: *Lepidocyclina* !, *Heterostegina* ! ---- corals: *Flabellum* sp.

"D" "*Chlamys* (*Aequipecten*) *multistriata antiquata* ROVERETO" !, "*Chlamys* cf. *oblitaquensis* SACCO", *Cyclocardia orbicularis subparvocostata* BÁLDI!, *C. cf. scalaris* SOW., *Gryphaea transiens* SACCO, *Macoma elliptica* BROCC., ---- *Lepidocyclina* !, *Heterostegina* !!!, ---- *Acanthocyathus vinobonensis* REUSS, *Caryophyllia inops* REUSS, *Aplocyathus* [= "*Odontocyathus*"] *armatus* MIGHT. !!!

"E" "*Chlamys* (*Aequipecten*) *biarritzensis novajensis* BÁLDI !, *Crassatina bosqueti* KOEN. *Cyclocardia orbicularis subparvocostata* BÁLDI !, *Megacardita* cf. *arduini* BRONGN., *Turritella* cf. *venus* D'ORB., *Turricula* sp. indet., *Dentalium apenninicum* SACCO

"F" (molluscan clay) [its fauna has been described in BÁLDI et al. (1961), BÁLDI (1973)] *Crassatina bosqueti* KOEN. !!!, *Cadulus gracilina* SACCO !!, *Nuculana* (*Costatoleda*) *psammobiaeformis* TELEGGI-RÓTH, *Hinia schlottheimi* BEYRICH, *Turris coronata* MÜST., *Turricula regularis* DE KONINCK, *Athleta ficulina* LAM., *Conus dujardini egerensis* NOSZKY, *Turritella venus margarethae* GAÁL, *Corbula gibba* OLIVI, etc. are among the most common taxa in this profile.

Out of the Novaj, Nyárjas section, still 16 so called "faciostratotypes" were described in the volume, edited by BÁLDI & SENES (1975). Two of them are located in Hungary (Budafok-2. borehole, Máriahalom sand-pit). The others are in Austria, Slovakia, Croatia, Romania (Transylvania). There are, however, still further outcrops of the Lower Egerian glauconitic sandstone in the close vicinity of Eger, namely in the type-area, which were not regarded as faciostratotypes, though they would have added several important aspects to the recognition of the Egerian's lower boundary. Sedimentologic

problems, as e. g. the unravelling of the turbiditic nature of these layers, were delaying the complete understanding of these interesting sections and their fauna (the first paper on these problems is now in press, Földt. Közl., 1999 by BÁLDI and SZTANÓ).

Not regarded, as “faciostratotype”, but a rather famous locality was the **yard of the Eger Vintner's School**, where, in a newly deepened well, the glauconitic sandstone became available. Here the sandstone contained a rich macrofauna which was donated to the collection of the Paleontological Institute of the Budapest University (today ELTE) still before World War I. The locality itself functioned as a well and after our knowledge any further collecting work has been made impossible. [The Vintner's school, later under the name Institute for Viticulture, is in the city of Eger, about 1 km WSW of the Wind's brick-yard.]. BÁLDI (1973) gave a short description of this locality, but – unfortunately – the macrofaunal taxa have been published scattered in a huge table, rather “hidden” among the mollusc faunas of 41 other localities. Therefore it would be useful to present this important fauna separately in the present paper, based on the determinations published in 1973. The “Vintner's School” molluscauna: *Glycymeris pilosa lunulata* NYST, *G. latiradiata subfichteli* BÁLDI, *G. latiradiata obovatoidea* BÁLDI, *Modiolus dunkeri* KOENEN, “*Flabellipecten angustiformis* BÁLDI”, “*Chlamys schreteri* NOSZKY”, “*Camptonectes incomparabilis* RISSO”, *Ostrea gigantea callifera* LAM., *Eucrassatella carcarenensis* MICHT., *Crassatina bosqueti* KOENEN, “*Cardita*” *monilifera* DUJ., *Megacardita arduini* BRONGN., *Arctica* [= “*Cyprina*”] *rotundata* AGASS., *Lucinoma borealis* L., *Laevicardium cyprium* BROCC., *L. tenuisulcatum* [= *cingulatum*] NYST, *Thyasira vara angusta* BÁLDI, *Venus multilamella* LAM., *Hiatella arctica* L., *Thracia pubescens bellardi* PICTET, *Turritella venus* D'ORB., *T. beyrichi* HOFMANN, *Cerithium egerense* GÁBOR, *Amaea* [= “*Scalaria*”] *amoena* PHILIPPI, *Drepanocheilus speciosus* s. str. SCHLOTHEIM, *Polinices catena* DA COSTA s. l., *Globularia gibberosa* GRATELOUP s. l., *G. gibberosa sanctistephani* COSSM. & PEYR., *Ampullina crassatina* LAM., *Cassidaria depressa* BUCH, *Charonia tarbelliana transiens* BÁLDI, *Ficus condita* BRONGN., *Hexaplex deshayesi* NYST, *Typhis pungens* SOL. in BRAND., *Babylonia eburnoides umbilicosiformis* TELEGGDI-RÓTH, *Streptochetus* [= “*Fusus*”] *elongatus* NYST, *Volutilithes permulticostata* BELLARDI, *Athleta rarispina* LAM., *Turricula regularis* DE KONINCK, *Dentalium apenninicum* SACCO.

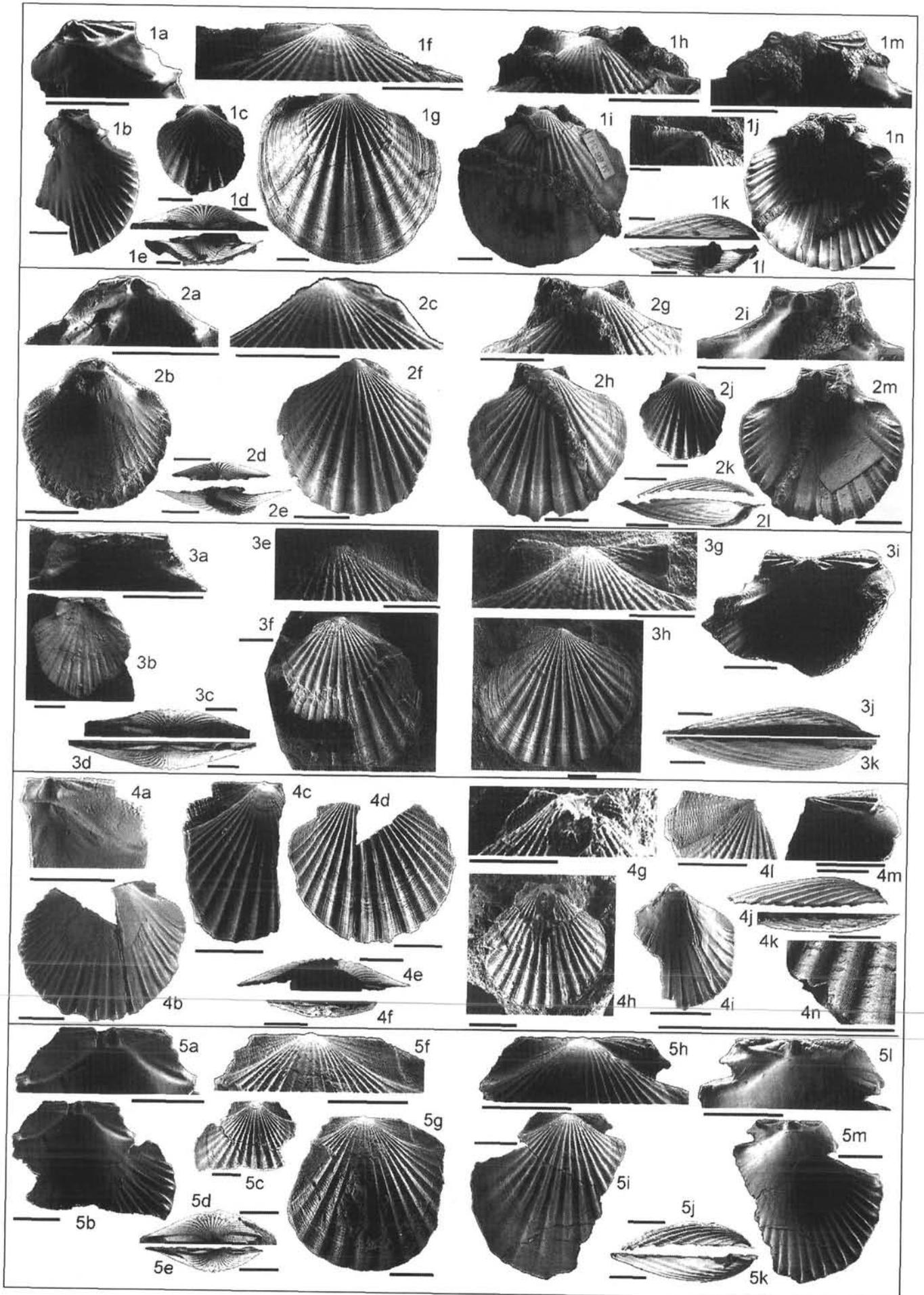
Another glauconitic sandstone outcrop with rather rich macrofauna, used to be found right beside the “**Rozália Cemetery and Chapel**” on **Merengő Street**, near to the clay pit of the Wind's brick-yard. The fauna, collected by BÁLDI, DOBAY and LEGÁNYI in 1958, is listed below: “*Flabellipecten burdigalensis*”, “*Chlamys noszkyi* Cs.-MEZN.”, *Arctica rotundata* AGASS., *Ampullina crassatina* LAM., *Ficus condita* BRONGN., *Diastoma grateloupi turritoapenninica* SACCO, *Athleta rarispina* LAM., *Volutilithes permulticostata* TELEGGDI-RÓTH, *Turris coronata* MÜNSTER, *Turricula regularis* De Koninck, *Babylonia eburnoides umbilicosiformis* TELEGGDI-RÓTH, *shark teeth*, *solitary corals*. Presently this outcrop does not exist, since the exploitation of the clay pit “consumed” those parts of the region. One can sporadically find macrofaunal shells in the newly outcropped section of the sandstone.

About 10 km NE of Eger, Wind's brick-yard, the sequence of **Noszvaj, Nagyimány-hill** crops out. Here both the Kiscellian/Egerian boundary and a fossiliferous, tuffaceous pebbly sandstone are exposed with smaller gaps. Short discussion of the section and fauna can be read in BÁLDI (1973, p. 86–87). Large sized *Terebratula*, “*Flabellipecten*”, “*Chlamys*”, “*Cardita*” *arduini* BRONGN., *Turritella catagrapha* ROVERETO, *Ficus concinna* BEYRICH, *Cerithium* cf. *egerense*

GÁBOR, *Xenophorae*, etc. and perhaps *Lepidocyclina* were collected from the boundary layers of this locality by LEGÁNYI, BÁLDI.

Similar section and faunae were found **across the Sik-hegy and Áfrika-dűlo**, NE of Eger, between this city and Noszvaj. This place is also mentioned in BÁLDI (1973). Here LEGÁNYI and BÁLDI collected the following macrofauna from the sparsely outcropping glauconitic sandstone of an abandoned cellar in Áfrika-dűlo: “*Pecten burdigalensis* LAM.”, “*Chlamys* ex aff. *csepreghyemeznericsae* BÁLDI”, “*Aequipecten oligoelegans*”, “*Aequipecten supra biarrizensis* TELEGGDI-RÓTH” [these names were never published, they are totally invalid, perhaps the “*Chlamys biarrizensis novajensis* BÁLDI” is the equivalent], *Cassidaria nodosa* SOL. in BRAND., *Tortoliva* [= “*Ancilla*”] *subcanalifera* D'ORBIGNY, *Turritella* ex aff. *catagrapha* ROVERETO, *Cerithium* sp. ex aff. *egerense* GÁBOR, *Volutilithes permulticostata* TELEGGDI-RÓTH, *Ficus concinna* BEYRICH!!!, *Cypraea*, *Carditae*, *Xenophorae*, *Fusus* sp., *Thyasira flexuosa* L., *Terebratula* sp. [large specimens, common] !!, *Dentalium* ex aff. *haeringense* DREGER.

Not designated for faciostratotype, but a fossil-rich site was described N of the village **Dejtár**, rather far from Eger, westward, and W of the city of Balassagyarmat (about 55 km N of Budapest). The locality is a rather small outcrop, in a dirt road cut, “along a cattle track” (BÁLDI, 1973), in the valley of the river Ipoly, near to the Balassagyarmat railroad, N of the village. The Dejtár site was discovered by HEGEDŰS in 1947, and he picked out and described a rich solitary coral-fauna of the place (HEGEDŰS, 1962). Based on a longer collecting work (1965), the full fauna has been published in BÁLDI, HEGEDŰS, NYÍRÓ & JANKOVICH (1971) and in BÁLDI (1973). “The resemblance to the faunae occurring in a similar facies in the glauconitic beds at the bottom of the Eger formation is quite remarkable. There are a number of mollusc and coral species in common between them which are unknown from any other Hungarian Upper Oligocene locality...” (BÁLDI, 1973, p. 51). The rock is here a loose silty sandstone, with some glauconitic (!) grains. Unfortunately lacking exposures in the vicinity, the precise position of these layers within the Oligocene sedimentary sequence has remained so far unknown. But the composition of the fauna, the common occurrence of a diverse solitary coral and pectinid fauna, and many further elements of the fossil assemblage leave no doubt about the correctness of our correlation with the Eger and Novaj glauconitic sandstone. The list of the fauna (deposited in the Budapest Museum of Natural History) is, as follows: *Nucula mayeri* HÖRNES, *Pteria phalaenacea* LAM., *Musculus philippii* MAYER in WOLFF !!, *Modiolus dunkeri* KOENEN, “*Flabellipecten burdigalensis*” LAM. !!!, “*F. telegdirothi*” Cs.-MEZN., “*Chlamys csepreghyemeznericsae*” BÁLDI !, *Ostrea cyathula* LAM., *Cavilucina droueti schloenbachi* KOENEN, *Venus multilamella* LAM.!!!, *Macoma elliptica* BROCC. !, *Corbula gibba* OLIVI, *Pholadomya puschi* GOLDFUSS, *Thracia ventricosa* PHILIPPI !!, *Clavagella oblita* MICHT., *Calliostoma elegantulum hegeduesi* BÁLDI !!!, *Polinices catena helicina* BROCC., *Cypraea globosa* DUJARDIN, *Cassidaria nodosa* SOL. in BRAND., *Ficus concinna* BEYRICH, *Babylonia eburnoides umbilicosiformis* TELEGGDI-RÓTH !, *Streptochetus elongatus* NYST, *Volutilithes permulticostata* TELEGGDI-RÓTH, *Uxia granulata* NYST, *Bonellitia evulsa* SOL. in BRAND., *Turris coronata* MÜNSTER in GOLDFUSS, *Bathytoma cataphracta* BROCCI, *Dentalium fissura* LAM., *D. apenninicum* SACCO, *D. densitextum dejtarense* BÁLDI (= *D. ex aff. haeringense* DREGER). ----- The solitary, ahermatypic corals after HEGEDŰS [in BÁLDI et al. (1971)]: *Trochocyathus plicatus* MICHT. !!!, *Aplocyathus* [= “*Odontocyathus*”] *armatus* MICHT. !!!, *Caryophyllia cornucopia* MICHT., *Ceratotrochus duodecimcostatus* GOLDF.,



Flabellum sp., *Balanophyllia cylindrica* MIGHT. ----- NYÍRÓ treated the benthic foraminifera, but she did not find larger forams (in BÁLDI et al., 1971).

The molluscfauna of the above seven localities was collected in a rather wide, transitional horizon along the K/EB. Its position was about 0–20 m, if 0 m is regarded, as the boundary level. 0–(-20) m was also examined and in two cases [Noszvaj, Nagyimány and Sik-hegy-Áfrika-dűlő] the molluscfauna is really somewhat older, being perhaps below the K/EB and probably of Latest Kiscellian in age. Otherwise the faunas are rather uniform. Some of them are a little younger, originating from higher level of the glauconitic sandstone, but still within the 0–20 m interval [see Novaj, fauna “C”–“F”, Eger, Vintner’s school, Dejtar].

We could recognize the following groups of the macrofaunal taxa. 1) Uncertain taxa, being under revision, not included into the present evaluation. Ex. gr. all *Pectinacea*. 2) New taxa, unknown from the Kiscellian, appearing first always above, however near to the K/EB. Their origin can be traced back into the European Early Oligocene, evolution changed them more or less. They make up only 22 % of the whole fauna. 3) New taxa, but deeply rooted in the older Oligocene, evolution hardly changed them. They remained rather only subspecies of the old forms. About 4 % of the total fauna. 4) 74 % of the taxa are old forms, known from the shallow marine Upper Kiscellian (Hárshegy Sandstone) or from the turbiditic intercalations of the Kiscell Clay (see BÁLDI, 1986).

For marking the K/EB, only the taxa of the 2) group can be suitable, supposing that the species is rather common. We list here some of the forms which could be markers: *Nucula nucleus*, *Isocardia s. abbreviata*, *Lyria gardonyii*, *Cyclocardia o. subparvocostata*, *C. scalaris*, *Glycymeris p. lunulata*, *Modiolus dunkeri*, *Camptonectes incomparabilis*, *Laevicardium cyprium*, *L. tenuisulcatum*, *Venus multilamella*, *Hiatella arctica*, *Turritella venus*, *T. beyrichi*, *Globularia g. sanctistephani*, *Corbula gibba*, *Cavilucina d. schloenbachi*, *Calliostoma e. hegeduesi*, *Polinices c. helicina*, *Dentalium apenninicum*.

A thorough revision and further field work are still needed to form a reliable and lasting list of marker mollusc taxa.

6. New taxonomic results for *Amussiopecten* and “*Aequipecten*” *northamptoni* group in the Hungarian Lower Egerian

This chapter provides partial revision on the Upper Oligocene pectinid taxonomy by proofing the original material. Material collected at Novaj, Dejtar, Vintner’s school Eger

and Wind’s brickyard Eger, localities of the Hungarian Lower Egerian, was searched thoroughly for representatives of genus *Amussiopecten* (SACCO, 1897) and *Chlamys northamptoni* group (ROGER, 1939). Most of the investigated specimens are in the paleontological collection of the Natural History Museum in Budapest. Some additional specimens from Novaj were provided personally by Tamas Báldi.

The investigation resulted in differentiating one *Amussiopecten* species emended here to *Amussiopecten minor* (ROTH v. TELEGD, 1914) and three species of the *northamptoni* group: “*Aequipecten*” *telegdirothi* (CSEPREGHY-MEZNERICS, 1960), “*Ae.*” *csepreghyomeznericsae* (BÁLDI, 1961) and “*Ae.*” nov. sp.?. Additionally it can be proved that the *northamptoni* group does not belong to *Aequipecten* sensu WALLER (1991). Until a revision is complete, the genus will be referred to in quotation marks.

This contribution provides a sketch of the new taxonomic results, which will be published in a more complete form in a separate paper.

Amussiopecten SACCO, 1897

The genus *Amussiopecten* with *Pecten burdigalensis* LAMARCK, 1806 as the type species by original designation, has a rather complicated taxonomic history (MASUDA, 1971). It was originally defined as a subgenus of *Pecten* by SACCO, 1897 but shortly thereafter was elevated to full genus rank (UGOLINI, 1907). DEPÉRET and ROMAN (1912) that greatly influenced European paleomalacology placed *Pecten burdigalensis* in *Flabellipecten* SACCO, 1897, where it is still placed by many present-day taxonomists. Knowledge of the taxonomic scope of *Amussiopecten*, now has greatly expanded. MASUDA (1971), for example, showed that the genus has a worldwide circumequatorial distribution with probably more than 20 species ranging from Oligocene to Pliocene. Clearly a more modern generic definition of the genus is needed.

Original description of *Amussiopecten burdigalensis* made by LAMARCK (1806) was a short annotation without figure, exact stratum or locality. Stratum (beds with *Pecten beudanti*) and locality (Saucats = Burdigalian of the Aquitan Basin) were cited firstly by BASTEROT (1825), since the first figure (topotype) was given by SACCO (1897). DEPÉRET and ROMAN (1912) were the first authors who gave a detailed diagnosis, description and comparative analysis of the types. Despite to their work a high grade of taxonomic uncertainty within the species remained until recent days. For example BAGLIONI MAVROS et al. (1986) understood under their “*Flabellipecten burdigalensis*” 6 distinct species of Upper Oligocene to

Plate 2

[Scale bar = 1 cm; all specimens coated with ammonium chloride]

- Amussiopecten minor* (ROTH v. TELEGD, 1914) morphotype 1
j (right valve, -) – Novaj (Coll. Baldi); a, b (left valve, H326); c (left valve, M63/3001); d, g, k, f (left valve, M63/3008); e, i, h, l, m, n (right valve, M66.341) – Wind’s Brickyard Eger (Coll. HNHM).
- Amussiopecten minor* (ROTH v. TELEGD, 1914) morphotype 2
a, b, c, d, f, k (left valve) & j (right valve) (articulated valves, H326); e, g, h, i, l, m (right valve, M62/5154) – Wind’s Brickyard Eger (Coll. HNHM).
- “*Aequipecten*” nov. sp. ?
c, e, f, j (left valve, M83.119) – Wind’s Brickyard Eger (Coll. HNHM); d, g, h, k (right valve, -); i (right valve, -); a, b (left valve, -) – Dejtar (Coll. HNHM).
- “*Aequipecten*” *csepreghyomeznericsae* (BÁLDI, 1961)
b, d, e, j (left valve, -); a, c (left valve, -); i (right valve, -); l, m, n (right valve, -) – Dejtar (Coll. HNHM); f, g, h, k (right valve, holotypus, M60/10787.) – Novaj (Coll. BÁLDI).
- “*Aequipecten*” *telegdirothi* (CSEPREGHY-MEZNERICS, 1960)
a, c, b (left valve, holotypus, M59/2841); d, f, g, j (left valve, M53.740.1/H326); e, h, i, k, l, m (right valve, H326) – Wind’s Brickyard Eger (Coll. HNHM).

Middle Miocene age: *burdigalensis* LAMARCK, 1806, *pasini* MENEGHINI, 1857, *koheni* FUCHS, 1876, *vinassai* UGOLINI, 1907, *ugolini* DEPÉRET et ROMAN, 1912 and *pseudopasini* VENZO, 1933. An additional species – the Upper Oligocene *Pecten (Amussiopecten) burdigalensis Minor* ROTH v. TELEGD, 1914 – was included indirectly by citing the *Flabellipecten burdigalensis sensu* CSEPREGHY-MEZNERICS, 1960.

***Amussiopecten minor* (ROTH v. TELEGD, 1914)**
(pl. 2, figs. 1–2)

Diagnosis: Disc medium sized, orbicular, inaequilateral, posteroventrally oblique, equally biconvex, surfaces smooth, with slight radial lineation and fine accretion lines, no significant microsculpture observed, umbonal app. 18 prominent ribs, bright as interspaces, marginally fading away (morphotype 1) or (morphotype 2) these of the central region getting major; ribs and interspaces equally folded. Ears medium sized, right posterior and left auricles generally smooth but umbonally fine, at very begin microscopically crenated ribs, the right anterior auricle with fine crenated ribs above a broad byssal fasciole, byssal notch initially very deep later probably shallowing, left hinge margin strait, right obtuse angled, cristate. Hinge with 3 teeth, resiliar tooth rather reduced, dorsal one long and prominent, auricular crura with denticles prominent, internal rib carinae prominent.

Discussion: The major reasons why *A. minor* does not fit the morphotypy of *A. burdigalensis* are as follows: dorsal crista – partially a scaly crenation of dorsal margin never observed at *A. burdigalensis*, crenated radial auricular ribs, significant smaller adult size, generally higher convexity of articulated valves, prominent ribs in the early ontogeny, generally rounded ribs and interspaces. These characters are indicating its relationship with the Miocene amussiopectens like *A. pasini* or *A. barranensis* and probably also the Oligocene *Aequipecten pseudopasini* (VENZO, 1933). The last one because of the rather deep byssal notch was emended by its author (VENZO, 1937) to the genus *Aequipecten* close to *Aequipecten deleta*. OPPENHEIM (1903) discussed the same type (*Pecten pasini* non MENEGHINI) to be related to the *A. burdigalensis* as like as to the "*Aequipecten*" *northamptoni* (MICHELOTTI) and "*Ae.*" *spinulosa* (MÜNSTER in GOLDFUSS).

"*Aequipecten*" *northamptoni* group (ROGER, 1939)

The group includes Oligocene to Miocene northeastern Atlantic, Mediterranean and Paratethys forms like "*Ae.*" *northamptoni*, "*Ae.*" *haueri* and "*Ae.*" *spinulosa*. The hinge region (checked on the "*Ae.*" *spinulosa* topotypes) is almost identical to *A. minor* (see above) however completely different from the *Aequipecten opercularis* hinge type, which is a generic character after WALLER (1991). Furthermore no aequipectinoid preradial coarse pitting of the left dissoconch is present but it appears rather smooth. From these reasons, following the pectinid taxonomic revision by WALLER (e. g. 1991), this group can not be assigned to the genus *Aequipecten* FISCHER. *Camptonectes* type of microscopic antimarginal striation partially sculpturing the whole left and right dissoconch (e.g. "*Ae.*" *spinulosa*) is well developed.

"*Aequipecten*" nov. sp.? (pl. 2, fig. 3)

Comparative notes: Differs from *A. minor* in showing fine but well developed radial ribbings on the left and the right

posterior auricles. These ribs are crossed by the accretion lines rising to very fine scales or nodes at the contacts. The surface of the both valves showing rare but significant very fine crenated radial lines. *Camptonectes* microsculpture present especially in the posterior and anterior marginal disc regions was not found in *A. minor*.

Discussion: These taxon was formerly mixed up with *A. minor*, now major distinctive characters are pointed out. Its great resemblance with *Aequipecten pseudopasini* (VENZO, 1933) should be proofed on the type material.

"*Aequipecten*" *csepreghymeznericsae* (BÁLDI, 1961)
(pl. 2, fig. 4)

Comparative notes: Differs from the last one by much more prominent developed secondary radial sculpture of same scaly type presented at the auricles and dissoconch ribs flanks and interspaces, ribs trigonal, in later ontogeny flattened, interspaces plane, microscopic *Camptonectes*-striation sculptures the whole surface. Specimens much smaller in size.

Discussion: This form possess great similarity with the figures and descriptions of the *Aequipecten deleta* subspecies *intercosticillatina* (SACCO, 1897) which is showing the radial sculpture not only at the left but also at the right valve. Proof of this thesis would exclude *Ae. deleta* from the *Ae. opercularis* – as thought by ROGER (1939) and include it into the *northamptoni* group.

"*Aequipecten*" *telegdirothi*
(CSEPREGHY-MEZNERICS, 1960) (pl. 2, fig. 5)

Comparative notes: Small sized, *Camptonectes*-microsculpture present. Right dissoconch surface completely smooth, resembling well the "*Ae.*" sp. ?, differing from it by having the dorsal half of the posterior auricle smooth, its ventral part is showing just 2–3 fine, scaly ribs settled near the dissoconch edge, no fine crenated lines at the dissoconch present. The left valve strongly concentric sculptured but in habitus resembling "*Ae.*" *csepreghymeznericsae*, radial sculpture present only as fine radial auricular ribbings, characteristic concentric scales ornament the interspaces and dissoconch rib flanks.

Discussion: Difference in the valves ornamentation, formerly never pointed out for the described form, is a typical character of *Ae. deleta*, although these are never showing a concentric sculpture.

Conclusive remarks

Initially this contribution was intended to be a revision of the *Flabellipecten burdigalensis* (non LAMARCK) known to have the first appearance near the base of Egerian (BÁLDI & SENES, 1975). A detailed check of the original material showed that with "*Fl. burdigalensis*", not only representatives of *Amussiopecten* (*A. minor*) but also of the *northamptoni* group ("*Aequipecten*" nov. sp.?) were previously designated (e. g. BÁLDI, 1973, pl. 5, fig. 7). Contrary "*Aequipecten*" *telegdirothi* initially thought to be related to *Amussiopecten* (CSEPREGHY-MEZNERICS, 1960) turned out to be a member of the *northamptoni* group. Further taxonomic proof of the *northamptoni* group resulted expectantly in its exclusion from the *Aequipecten* genus sensu WALLER (1991, 1993). Discussion on the significance of their morphologic resemblance with

the representatives of *Amussiopecten*, especially *Amussiopecten pasini*, passes over the rather limited scope of this study.

For the future, the clear definitions of these two pectinid groups based on a cladistic analysis would be needed. This should have special emphasis on their early radiation documented by presented material. Representatives of the north-eastern Italian Upper Oligocene especially of the *Aequipecten pseudopasini* group should be there included as well.

7. Correlation with sequences

The datum of the great eustatic regression of the Oligocene was estimated by HAQ (1991) for the "traditional" 30 My. Rupelian/Chattian boundary was correlated with the level of the great regression for a long time. Much earlier already BÁLDI (1974) identified the K/EB with the event of the above global regression.

Now it is likely that these presuppositions were erroneous. The "great eustatic regression" was not so great and it did not occur so suddenly. It is presently accepted too that during the Rupelian a global high-stand of sea-level dominated, which turned to a global low-stand for the time of the Chattian. The datum of the change is presently calculated to be at 28,5 My. Therefore a younging took place in the latest chronostratigraphic tables, in which also the Rupelian/Chattian boundary has been transferred to the 28,5 My niveau.

The K/EB is 27,1 My old, younger than the datum of the sea-level fall. It has been drawn within the Chattian low-stand period. The bathymetric changes in Hungary do not follow the eustatic events. E.g. the deepest facies of the Oligocene here, the Kiscell Clay, was sedimenting undisturbed by the global sea level changes. The regression around the K/EB and during the Early Egerian can not be explained by eustatic changes. The explanation may be found perhaps in the strong local tectonic motions, as it has been shown latest by SZTANÓ, MAGYARI & NAGYMAROSY (1998). Anyhow, further research-work is still necessary to investigate this problem.

Acknowledgements

The authors are grateful first of all to Harry Lobitzer for his invitation to publish this paper. Thanks are due to Mrs. Mária Báldi-Beke for her advices related to the problems of nannoplankton. O. Mandic wants to thank Thomas R. Waller (U.S. National Museum of Natural History) for review, Werner E. Piller (Karl-Franzens-Universität Graz) and Mathias Harzhauser (Natural History Museum Vienna) for discussions and Alfred Dulai (Hungarian Natural History Museum) for providing the material. His work was financially supported by the FWF Project Nr.: P11886-GEO. Gy. Less's work was financed by the National Scientific Fund of Hungary (OTKA, grants T 16863, 23880 and 23882). Báldi's work was also financed by National Scientific Fund of Hungary (OTKA, grants T 015976 and T 026623). Thanks are due to Mr. Antal Pentelényi (Budapest) for the drawings.

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Zeitschrift/Journal: [Abhandlungen der Geologischen Bundesanstalt in Wien](#)

Jahr/Year: 1999

Band/Volume: [56_2](#)

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Artikel/Article: [Some new aspects of the lower boundary of the Egerian stage \(Oligocene, chronostratigraphic scale of the Paratethys area\) 653-668](#)