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UPPER EOCENE PALEOBATHYMETRY APPROACH BASED ON PALEOECOLOGICAL ASSEMBLAGES FROM THE PLEŞCA VALLEY 2. OUTCROP, TRANSYLVANIA – A PRELIMINARY REPORT–

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Abstract. This study attempts to demonstrate that each ecological assemblage and sedimentological paleoenvironment in shallow water shelf is directly or indirectly related to water depth. The paleoenvironment is represented by a microfacies and sea-level changes correspond to changes in microfacies and qualitative/quantitative composition of bioclasts.

A qualitative, quantitative and statistical analysis of bioclasts permits precise paleoenvironmental interpretation and is one of the best indicators of any paleoenvironmental changes, usually linked to sea-level changes.

For this reason, we acquired data in thin section using always the same size area for counting and identification of grains. Bioclasts were later ranged in 6 (+1) paleoecological assemblages from distal outer ramp to near-shore environment.

Vertical fluctuations of each ecological assemblage percentage along a section reflect sea-level changes at that point that allows acquisition of relative paleobathymetry.

This method was applied to sections of the Pleşca Valley 2. outcrop of the Cluj Limestone Formation, in the vicinity of Cluj-Napoca, and is probably one of the best tool for recognition of systems tracts and parasequence sets.

Keywords: Paleoecological Assemblages, paleobathymetry, Upper Eocene, Transylvanian Basin.

INTRODUCTION

The aim of this study is to apply an updated method based on paleoecological assemblages, which can be used as well for correlation, or for sequence stratigraphy interpretations. We used this type of analysis for correlation process of several closely spaced sedimentary successions within the Transylvanian Paleogene Basin. Formerly this tool was applied successfully in different geological time-intervals, ranging from Cretaceous of France (Arnaud-Vanneau, 1980) and Spain (Bernaus, 2000), to Paleocene (Gonzáles-Lara, 2000).

In this paper, we don't present the analytical details, but, we present the interpretation in sequence stratigraphy of Turea Group deposits within the Gilău area. We defined 6 Paleoecological Assemblages and one group made of echinoderm fragments. These assemblages are composed of organisms constituting a biota, which lived more or less in the same paleoecological environments and were deposited at similar depth during that same time. In this report, we define working-assemblages belonging to the Late Eocene – earliest Oligocene interval.

Each ecological assemblage and sedimentological paleoenvironment in shallow water shelf is directly or indirectly linked to water depth. The paleoenvironment is represented by a microfacies and sea-level changes correspond to changes in microfacies and qualitative/quantitative composition of bioclasts. Thus, a qualitative, quantitative and statistical analysis of bioclasts describes precisely paleoenvironments and is one of the most sensitive indicators of any paleoenvironmental changes, usually linked to relative sea-level changes or changes in accommodation space. Vertical fluctuations of each ecological assemblage percentage along a section reflect sea-level changes at that point and allows acquisition of relative paleobathymetry.

A comprehensive paleoecological analysis integrated into sequence stratigraphy improves our understanding of facies-scale paleogeography.

Correlation procedures at this scale require identification of high-ordered architectural elements. However, specificity of carbonate systems is the fact that sedimentary structures are rarely observed in field. Paleoecological assemblages open up these hidden microfabrics and the enclosed biota allow their environmental interpretation. As the paleoecological analysis itself is outcrop-width independent, we can easily apply the method for 1D outcrops (e.g. gallies) also.

GEOLOGICAL BACKGROUND

The Pleşca Valley 2. outcrop is located in north-eastern Romania, one km south-west of Cluj-Napoca **(fig.1).**

Regarding the paleogeographical distribution of the main sedimentary depocenters of the Transylvanian Paleogene Basin, the Pleşca Valley is situated in the Aghireşu subarea (Popescu, 1984) of the Gilău area (outlined by Rusu, 1970). An exhaustive description of the sedimentary infill of the Transylvanian Paleogene Basin were given by

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Popescu et al. (1978), Popescu (1978b, 1984) and Proust & Hosu (1996).

The studied profile belongs to the Cluj Limestone Formation, which were deposited as the lower, transgressive part of the 'Second Marine Series', presently referred to Turea Group (Rusu, 1995). The Turea Group is roughly composed of lagoonal, bioclastic shoal and open carbonate platform deposits (Proust & Hosu, 1996).

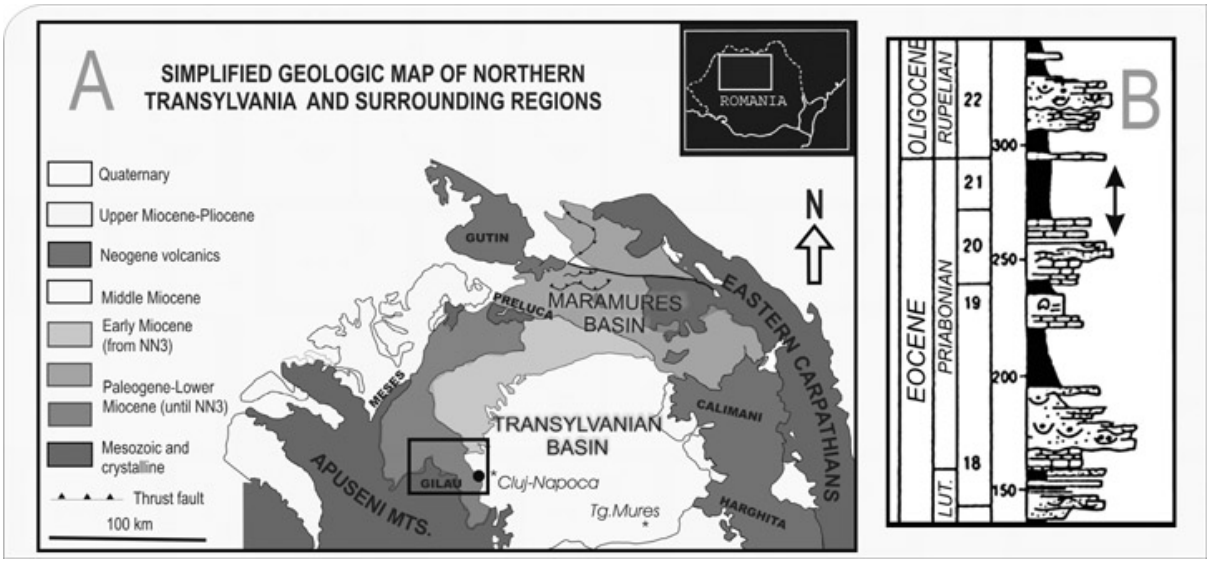

Fig. 1 Localization of the profile within the Gilău depocenter

Geologic map A, after Györfi et al. 1999;

Section B - the sedimentary succession of the Transylvanian Paleogene Basin (from Proust & Hosu, 1996) - arrow shows the stratigraphic range of the Pleşca Valley 2. section.

In the description of Popescu (1984), the Cluj Limestone Fm. in the Gilău area is made up of a lower part (3 to 5m) of marly limestones with marine mollusks and echinoderms (in the eastern region). This lower unit is overlain by the *Crassostrea transilvanica* level, a regional marker, 1 to 3 m thick. The upper part of the Cluj Limestone Formation consists of 10 to 25 meters of very fossiliferous calcarenites with thin marly interbeds.

Some local paleontological horizons can be recognized in the upper part; *Campanile* level in the Iara and Călățele subarea, *Echinolampas* horizon in the Aghireşu subarea. The paleontological marker *Nummulites fabianii* is located either in the uppermost Cluj Limestone Formation or in the overlying Brebi Marls Formation or in both formations.

Neither Popescu (1978, 1978b, 1984) nor other publication makes mention of reefal limestone facies below the *Nummulites fabianii* interval; similar lithofacies is registered only above the *N. fabianii* interval, namely the Izvorul Crişului Formation (Popescu, 1984) in the western region. This formation is composed of calcarenites and calcirudites with corals, crustose corallinaceans, *Nummulites*, rotaliids and rare mollusks.

In this regard we report a new facies element within the Cluj Limestone succession, described as an outer ramp slope coral patch-reef facies with an overall thickness of 5 m (see **fig. 2** for microfacies and micropaleontological composition).

The Eocene/Oligocene boundary in the Pleşca Valley 2. succession should be placed around the level of Pv 61. Thin-section displays some *Pseudohastigerina* (Plate 1, A/10) of the P 18 zone (Rupelian).

MATERIALS AND METHODS

A sedimentological and erosional profile of the Pleşca Valley 2. outcrop has been established at scale 1:20 (fig.2). Samples were taken every 20 to 50 cm in clean carbonates and 50 to 100 cm in marly facies. Data acquired for statistical analysis was carried out in three phases:

a) biota recognition phase, in order to answer the question 'what to count' we tried to recognize and discriminate bioclasts in thin-sections, washed materials or embedded artificial microfacies too, all possible appearances of organisms;

b) biota description phase, involved to group together and label with a name all the specimens credited with belonging to a given taxa, by emphasizing some of their main taxonomical features. In order to recover the missing taxonomical information, bibliographical references were considered (Popescu et al., 1978). Variations in

species of the genera identified in Cluj Limestone Formation are summarized in table 1.

c) counting phase. In order to use a uniform data-set evaluation, acquired data has been undertaken for statistical purposes using thin-sections only. In thin-section, we selected always the same size area, and applied the same methodology for counting and recognition of grains.

Data interpretation consisted of grouping established morphotypes into assemblages constrained by water-depth. The ordination principle usually followed ecological analogies encountered in actual and ancient environments for a major part of organisms. The rest of categories were included into assemblages when their abundance showed a systematic positive correlation with those already recognized.

BIOTA ASSEMBLAGE, RELATED LITHOFACIES AND PALEOBATHYMETRY APPROACH

The distribution of paleoecological assemblages across a carbonate platform has been outlined by Arnaud-Vanneau (1980). This study proposed a faunal and floral distribution over urgonian–type platform and described characteristic of paleoecological assemblages for different environments. Transposing these results, just as other for Cretaceous (Bernaus, 2000), Paleocene (Gonzáles-Lara, 2000) and Miocene (Pomar, 2001a; Brandano & Corda, 2002), six paleoecological assemblages were identified that show maximum abundance in different successive bathymetrical intervals.

The Paleoecological Assemblage Percentage Fluctuation Chart allowed us to highlight deepening and shallowing tendencies and variations in accommodation space. It is a good tool to perform stratigraphical key-surfaces such as parasequence or sequence boundaries, or any maximum flooding surfaces.

In order to better characterize the different ramp sectors we followed Pomar (2001a). Assemblages from distal to proximal are described below: (*for detailed composition of assemblages see table 1, 2.*)

Assemblage A

Biota: This assemblage is composed of planktonic foraminifera, mainly globorotalids, *(cf. Acarinina* sp.*, cf. Truncorotaloides* sp.), *Globigerina* sp.*, cf. Globigerinoides sp.;* benthic foraminifera represented by *Bulimina* sp, small biserial-triserial foraminifera (textulariids), small planispiral foraminifera*,* a few discorbids and quite persistently *Spiroloculina* sp.*).* Planktonic foraminifera are associated frequently with coral colonies that show a platy habitus (on polished surfaces) and are well-preserved in the intercolonial mudstones of this 'reefal' environment.

Maximum abundance Lithofacies: **distal outer ramp**; there is no interval of Pleşca Valley 2. succession particularly dominated by this assemblage; however they appear as significant in the *Vulsella cf. dubia transilvanica* bearing wackestone-floatstone facies, at the basal part of the section (e.g. Pv 26+).

Assemblage B (*B_1+B_2)*

Biota B_1: In the proximal sector of the outer ramp, bryozoans (shade-area biota) were the primary sediment producers together with echinoids, mollusks, subordinately, benthonic (medium sized biserial foraminifera, small to medium size rotaliids) and attached foraminifera, as well as large and flat (with H/L ratios up to 1:8 in the Pv 56, 62) nummulitids.

Biota B_2: sub-assemblage dominated by various lens-shaped nummulitids (H/L ratio of 2:5), amphisteginid foraminifera (H/L ratio of 4:7), alveolinids, medium to large size rotaliids, elphidiids and few thick walled miliolids. Species of *Sphaerogypsina globula* and *Chapmanina* sp. are restricted to the Pv 49- Pv 57 interval, when especially large sized organisms proliferate, suggesting an increase in avaible nutrients.

Maximum abundance Lithofacies B_1: **proximal outer ramp**; with in situ bryozoan- community in wackestone-packstone lithofacies (e.g. Pv 59, 61).

Maximum abundance Lithofacies B_2 - **outer middle ramp**; autochtonous *Nummulites* wackestone-packstone lithofacies (e.g. PV 48+). Biota of some sandy *Nummulites* rudstone lithofacies (e.g. PV 52-55) claim for the outer middle ramp also, however these *Nummulites* rudstone lithofacies could be deposited by shedding outer middle ramp biota onto proximal outer ramp settings, as well.

Remarks: The bloom of suspension-feeding organisms, mostly bryozoans but also echinoids and pelecypods recorded in the upper third of the Cluj Limestone sequence, should be promoted by a change in trophic conditions (nutrient excess) that was responsible also of the coral demise underlying the *N. fabianii* level.

A similar case is reported from the Miocene of Central Italy (Brandano and Corda, 2002). An increasing continental runoff is supposed to be the major source of nutrient-excess, supported by the elevated siliciclastics/ carbonate ratio of the Pv 49-Pv 57 lithostratigraphic interval.

The absence of deeper photosynthetic biota (e.g. red algae) in comparison with modern analogue platforms (Hottinger, 1983; Tsuji, 1993; Basso, 1998) allowed us to interpret facies that show maximum abundance of sub-assemblage B_1 to be deposited in the low-light level, at a water depth of more than 70–90 m.

As regarding *Nummulites*, the main component of the second sub-assemblage (B_2), Geel (2000) concluded that large, flat species usually were

associated with large, flat '*Assilina*' and *Discocyclina,* and proliferated on the seaward side of the shallow water shelf and upper part of the deeper shelf (outer middle ramp - proximal outer ramp sensu Pomar, 2001a). Small and medium-sized, lens-shape *Nummulites* lived together with *Alveolina* on the platform interior (middle ramp).

Note: the distribution of morphotypes within the Pleşca Valley 2. sub-assemblages needs further investigations due to shedding phenomena; for the time being assemblage B as whole is considered more or less belonging to the proximal outer ramp.

Assemblage C

Biota: This assemblage incorporates ecological successions of attached organisms *Haddonia heisinghi* (foraminifera), cf. *Porites* (coral), rarely annelids. The substrate for these organisms is provided by platy frameworks of *Astreopora* sp., phaceloid colonies of *Plocophylia bartai* and others. Large solitaire *Antiguastrea lucasiana* is also found. These organisms are further accompanied by large agglutinated foraminifera or large miliolids with agglutinated wall.

In some samples a rich amount of planktonic foraminifera is also present. *Actinacis rollei* Reuss, the major framebuilder of the Late Eocene commonly found in shallower coral-zones (Bosellini, 1998), wasn't recognized in the Pleşca Valley 2. succession.

At the level of Pv35 it was identified a 10 to 20 cm thick level of fabric selective dissolution of coral tests.

Maximum abundance facies: **outer ramp slope**; bafflestone (e.g. 35), coral framestones (e.g. Pv 36) or reef-front debris (rudstone) lithofacies. (e.g. Pv 42).

Remarks: Corals change with depth in taxonomic composition, in percentage and proportion within the framework, and in growth form, allowing definition of a relative depth zonation of the recognized coral associations (Bosellini, 1998).

Astreopora spinulosum, a plate-like massive coral with thin septa and an intercorallite coenosteal meshwork, described from the Upper Eocene of Central Chiapas is estimated to have grown below the lower limit available for photosynthesis at a depth of 50-80m in the transitional zone from shelf to deeper basinal sediments (Frost, 1974).

Further paleobathymetry of coralmorphology zones is given by Pomar (2001a). He states 30-20 m for platy deeper-water coral colonies with finger-like vertical projections, and 20-10 m respectively, for predominantly branching intermediate colonies.

Taking into account the Pleşca Valley coral morphologies and taxonomic composition, just as their positive correlation with increasing plankton content, we inferred these coral facies could be assigned to deeper-water coral colonies.

Echinoderms fragments

Biota: As it has already been stated by Popescu (1978), within the Transylvanian Eocene, echinoderms reach their maximum abundance in the Cluj Limestone. In our succession this level is located around the level of Pv 61.

Maximum abundance facies: **intermediate outer ramp** (with reference from Miocene of Central Italy: Brandano & Corda, 2002); in the intermediate part of the outer ramp sediment is partially produced ''in situ'' by echinoids along with worm tubes, benthonic and planktonic foraminifera.

Remarks: The great variability in echinoderm ecomorphotypes (16 species cited, **table 1**) argues besides portraying them as a distinct unit within the Assemblage Percentage Fluctuation Chart (see **fig.2**).

Assemblage D

Biota: ingeniculate and geniculate red algae (*Corallina* sp., *Lithophyllum* sp., *Lithothamnion* sp., *Sporolithon* sp., *Lithoporella melobesioides),* peysonelliaceans *(Polystrata alba),* thin to thicker wall, *m*edium size rotaliids, benthic foraminfera like *Cibicides* sp., cf. *Gyroidina* sp., *Acervulina linearis, Silvestriella tetraedra* and quite sporadic green algae *(Neomeris* sp., only in the basal part of the section).

Maximum abundance facies: **1. middle ramp**; "maerl" (sensu Bosence, 1983) with free living branching red algae and algal debris or multi-component rhodolithes (e.g. 33+).

2. toe-of-slope/outer ramp; monospecific rhodolith floatstone with large foraminifera (e.g. Pv 60).

Remarks: Red algae grow from the shallowest euphotic to the deepest oligophotic environments. They are common to abundant in and on fore reef (Basso, 1998). In Japan, rhodoliths grow in fore reef areas at depths between 60 and 150 m, associated with larger foraminifera (Tsuji, 1993).

In the Western Mediterranean, they have been reported to be the most prolific between about 40 and 90 m (Fornos and Ahr, 1997). Depending on water turbidity, their range is between 20 and 160 m (Bosence, 1985). Among red algae, the presence of *Sporolithon* (Archaeolithothamnium) and *Lithoporella* in the ramp slope indicate tropical marine conditions (Bosence,1983; Vannucci et al., 1996).

Assemblage E

Biota: This assemblage is almost insignificant from the point of view of their contribution to the Plesca Valley biofacies. They are developed especially at the lower third of the section. In this cluster we have grouped large and very large size rotaliids, large and medium size miliolids, *Glomospira* sp., *Valvulina* sp., colonial annelids and large *Pseudotriloculina* sp., small *Spiroloculina* sp.

Maximum abundance facies: outer inner ramp; this assemblage appears as a minor component of

the Pleşca Valley microfacies associations. They usually appear in packstone-grainstones with miliolids and rotaliids meaning hard substrate environments (e.g. Pv 30); or in wackestone microfacies with *Pyrgo* sp. and *Orbitolites complanatus* as well other very flat foraminifera suggesting soft-substrate microenvironments (e.g. Pv 27).

Remarks: Robust, highly ornamented rotaliid forms live in very shallow, turbulent water (0-40 m waterdepth) in the shore zone, on lime sands, on reefs and in inter-reef regions. *Marginopora* sp., a closely related Recent counterpart of *Orbitolites*, proliferates in somewhat sheltered waters of algal and coral pools on reef flats and in backreef regions, also in 0-40 m waterdepth. The fossil *Orbitolites* is found mostly in carbonate facies free of terrigenous mud in well-flushed backreef environments (Geel, 2000).

Assemblage F

Biota and Maximum abundance facies: This nearshore association in the Pleşca Valley 2 succession is represented by poorly distributed bivalves and gastropods in addition to other elements such as quartz grains. As bivalves can live in very different environments this assemblage should be interpreted assuming all shell-taphonomical features observed on field (e.g. Pv. 52).

PARASEQUENCE KEY-SURFACE USING PALEOECOLOGICAL ASSEMBLAGES

Localization of sequence stratigraphical key-surfaces e.g. ‘parasequence boundary’ or ‘maximum flooding surface’ is clearly demonstrated by shift of Paleoecological Assemblages. Maximum flooding surfaces were picked, at a first instance, analyzing the Paleoecological Assemblage Percentage Fluctuation Chart (see fig. 2), when maximum abundance of deeper bathymetric assemblages occurs. Parasequence boundaries were traced at sudden right lateral shifts of a given assemblage between two successive samples. Both surfaces were then calibrated to sedimentological logs. Furthermore, estimating the hierarchy of erosional surfaces we could unravel the existence at least two orders of parasequences. An higher order parasequence extends for example between Pv 36 and Pv 52; a lower ordered is located between Pv 30 and Pv 36.

CONCLUSIONS

As we have mentioned in the introductory part, we conceptualized in this paper to demonstrate that the use of Paleoecological Assemblages greatly enhances subdivision of sedimentary successions into depositional units in Late Eocene deposits, without entering into the details of sedimentary dynamics.

The statistical analysis of various organism morphotypes allows recognition of seven ‘bathymetrical associations’, as follows from bottom to top:

Assemblage A, *distal outer ramp* association dominated by small benthic and planktonic foraminifera,

Assemblage B, a *proximal outer ramp* assemblage build up of mainly of subassemblage B_1 dominated by bryozoans and flat (H/L ratio between 1:8 – 1:3) nummulitids, frequently overprinted by presence of an allochtonous assemblage B_2 (dominated by lens-shaped (H/L ratio between 2:5 - 4:7) *Nummulites* and amphisteginid foraminifera; medium size rotaliids and few alveolinids) redeposited from the *outer middle ramp* sector,

Assemblage C, *outer ramp slope* deep-coral assemblage composed of platy frameworks of *Astreopora* sp., phaceloid colonies of baffling *Plocophylia bartai*, large solitaire *Antiguastrea lucasiana* corals and annelids, just as different incrusting organisms,

Echinoderms, the great variability in echinoderm ecomorphotypes (16 species cited, table 1) argues besides portraying them as a distinct unit within the assemblage percentage fluctuation chart (see fig.2),

Assemblage E, dominated by geniculate and ingeniculate coralline red algae, medium size rotaliid foraminifera being abundant in two different settings: 1. *middle ramp*; “maerl” (sensu Bosence, 1983) with free living branching red algae and algal debris or multi-component rhodolithes; 2. *toe-of-slope/ outer ramp*, recording monospecific rhodolith floatstone with large foraminifera,

Assemblage F, *outer inner ramp*; a minor component of the Pleşca Valley associations showing two different substrate environments: (1) a packstone-grainstone with different miliolids and rotaliids: hard substrates; or (2) wackestones with *Pyrgo* sp. and *Orbitolites complanatus* on soft substrates.

Assemblage G, poorly represented *near-shore* association.

As a final task, analyzing the Paleoecological Assemblage Percentage Fluctuation Chart (see fig. 2) we recognised maximum flooding and parasequence boundaries. Placing these surfaces into a hierarchical framework at least two orders of parasequences may be present.

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Morphotype used for counting (this paper)	**Species referred by Popescu et al. (1978) from the Cluj Limestone Fm. and Brebi Marls**	**Pal. Eco. Ass.**
Planktonic foram. (large)	*Globigerina ouachitaensis, G. gnaucki, G. postcretacea, Globorotalia cerroazulensis pomeroli, Gt. rugosoaculeata, Gt. cerroazulensis cocoaensis*	**A**
Planktonic foram. (small)		**A**
Small biserial-triserial foram.	*Textularia adalta* Cush., *T. dibolensis* Cush and Applin, T. minuta (Terq.)	**A**
Bulimina sp.		**A**
Discorbids	*Discorbis limbata* (Terq.), *D. perovalis (Terq.)*	**A**
Spiroloculina B (large)	*Spiroloculina canaliculata* d'Orb., *S. cf. tricarinata* Terq.	**A**
Reusella sp.	*Reusella terquemi Cush., R. elongata (Terq.)*	**B**
Bryozoans		**B**
Nummulites (flat, thin walled)	*Nummulites perforatus* (Montf.), *N. beaumonti* d'Arch. and Haim., *N. fabianii* (Prev.), *N. chavanessi* de La Harpe, *N. incrassatus* de La Harpe	**B**
Nummulites (v. large)		**B**
Nummulites fabianii		**B**
Macrospheric small *Nummulites* sp.		**B**
Rotaliids (v. small)	*Pararotalia auduini* (D'orb)	**B**
Verneuilina sp.		**B**
Pseudotriloculina sp.		**B**
Miliolids (small)		**B**
Elphidiidae, forma A (thicker outer w.)	*Elphidium cf. texanum* (Cush.and Applin), *E. olssoni* Berri, *Nonion comune* (d'Orb.), *Eponides lotus* (Schw.), *Nonionella spisa* Cush., *Nonion scaphum* (Ficht. and Moll.)	**B**
other Elfid.		**B**
Elphidiidae, forma B		**B**
Valvulina sp.	*Valvulina guillaumei* Calv., *Valvulina texana* Cush. and Ellisor, *Valvulina triedra*	**B**
Large foram. Tip A		**B**
Arenobulimina sp. B (izom. chamb.)		**B**
cf. *Globulina* sp.	*Globulina gibba fissicostata* Cush., *G. gibba miristiformis, W*illiamson), *G. gibba longicamerata* Bandy, *G. gibba punctata* d'Orb.	**B**
Miliolid B (angular chambers)		**B**
Chapmanina sp.	*Chapmanina gassinensis* Silv.	**B**
Dorothia sp B.		**B**
Amphisteginid foram.		**B**
Arenobulimina sp. A		**B**
Sphaerogypsina globulus	*Sphaerogypsina globulus* (Reuss)	**B**
Miliolid A (thick wall)		**B**
Alveolinid		**B**
Orbitolites complanatus		**B**
Miliolid D (strongly costulated)		**B**
High-chamber trochosp. cib.		**B**
Acervulina sp.		**B**
Lituolid		**B**
Marsonella sp.		**B**
Brachiopoda		**B**
Calcareous sponges		**C**
Agglut. for. B (conical elong.)		**C**
Verneuilina sp. A		**C**
Large attached annelids		**C**
Haddonia heisinghi		**C**
Microbial construction B		**C**
colonial Corals		**C**
Astreopora sp.		**C**
solitaire *Antiguastrea lucasiana* (Defrance)		**C**
Plocophyllia bartai Russo		**C**
Echinolampas beaumonti altus Koch, *Echinolampas beaumonti* Desor., *E. archiaci* Cott., *Schizaster lucidus* Lamb., *S. vicinalis* Ag., *Eupatagus pavayi* Koch., *E. inflatus* Koch, *Laganum (Peronella) transilvanicum* Páv., *Poriocidaris pseudostratus* (Cott.), *Leiopedina samuei* Páv., *Pernaster alpinus* Desor., *Atelospatangus transsilvanicus* Koch		**Echi**
Sylvestriella tetraedra	*Silvestriella tetraedra* (Gümb.)	**D**
Mesophyllum sp.		**D**
Lithothamnium sp.		**D**
Sporolithon sp.		**D**
Lithoporella melobesoides		**D**
Polystrata alba		**D**
Cibicides sp. A	*Cibicides dampelae* Byc. and Chram., *C. cocoaensis* Cush., *C. proprius* (Brotz.)	**D**
Rotaliids (medium)	*Pararotalia subinermis* Bath., *P. armata* (d'Orb.), *P. calcar, P. calveze* (Loeblich and Tappan), *P.byramensis* Cush., *P. cf. curryi* Loeb. and Tappan, *P. trochiformis* (Lmk.),	**D**
Rotaliids (large)	*Pararotalia lithothamnica* (Uhlig)	**E**
Miliolid (medium)	*Triloculina trigonula* (Lmk.), *T. brevidentata* Calv., *Quinqueloculina ludwigi* Reuss, *Q. costata* Kar., *Q. semiluna* Linné	**E**
Miliolid (large)		**E**
Elphidiidae ind.		**E**
Glomospira sp.		**E**
Large Pseudotriloc		**E**
Spiroloculina A (small)		**E**
Pyrgo sp.	*Pyrgo bulloides* d'Orb.	**E**
Very large Rotaliid		**E**
Annelids, colonial		**E**
Bivalves		**F**
Gastropods		**F**
Quartz		**F**

Table 1.
Checklist of Priabonian (P16 - P17) interval microfossil genera identified in the Pleşca Valley 2. succession and related species referred from the Gilău area of the Transylvanian Paleogene Basin

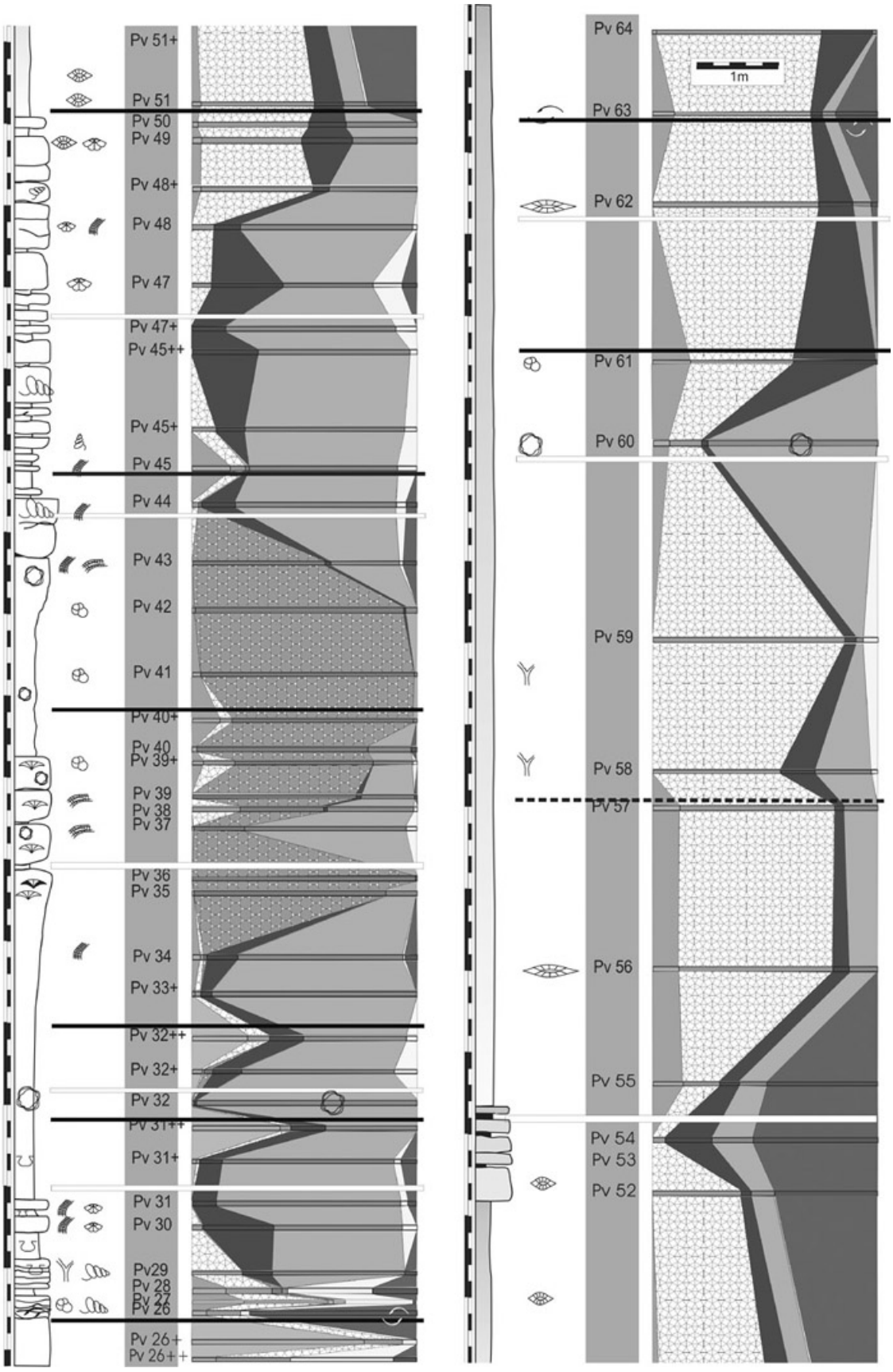
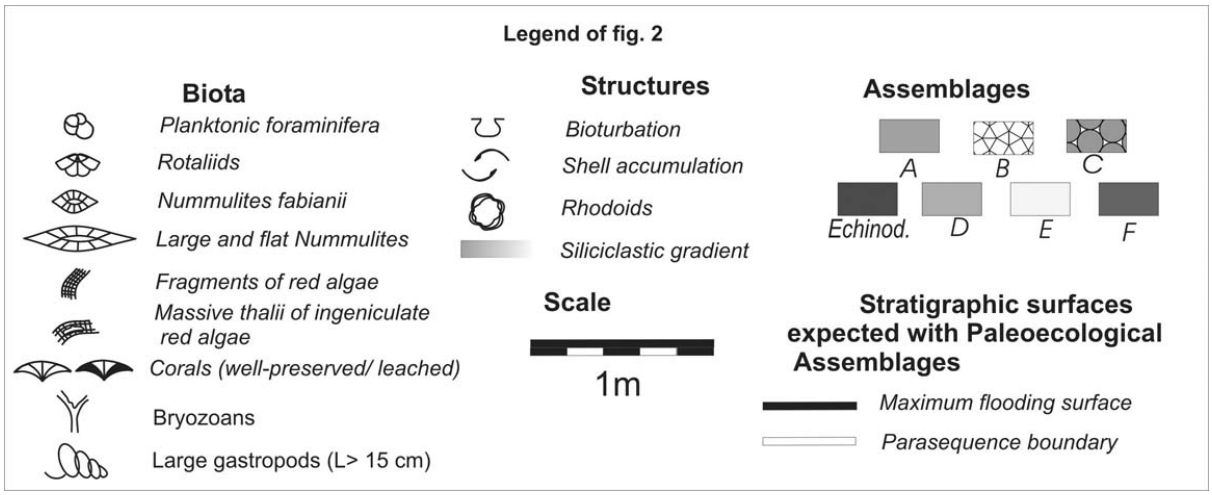


Fig. 2 Plots Paleoecological Assemblage Percentage Fluctuations into sequence stratigraphical surfaces in the Pleşca Valley 2 succession. Assemblages range from distal outer ramp (A) to nearshore (F) environments. See legend on the previous page.



PLATES

PLATE I

Scale bar: 0,1 or 1mm.

Assemblage A
Planktonic foraminifera:
1. Globigerinoides sp. (Pv 46);
2, 3. small biserial-triserial foraminifers, (Pv 40+, 27);
4. cf. *Chiloguembelina* sp., (Pv 62);
8. *Globigerina* sp*.,* (Pv38);
12-22, 25 Globorotaliids., (Pv 26++);
13 *cf. Acarinina* group, (Pv 26+);
21. cf. *Truncorotaloides* group *sp*., (Pv 60).
Benthic foraminifera:
5-7. *Bulimina* sp., (Pv 62, 38);
9. small planispiral for*.* .(PV62);
10*.* cf. *Pseudohastigerina* sp., (Pv 61);
11. *Spiroloculina* morphosp. *A,* (Pv 26+);
23, 24. discorbids, (Pv 27, Pv 2 – of section Plesca Valley 1., for comparision);
26.*Turrilina* sp.

Assemblage B
1, 26. *Nummulites fabianii (*Prever), (Pv 57, 48+);
2,13, 24. Nummulitid morphosp.*B* (thick and reticulate wall), (Pv 61, 58, 48+);
3. (11?) *Sphaerogypsina globulus* (Reuss), (Pv 57);
4. Attached foraminifera morphsp. *A,* (Pv 49*)*
5. Bryozoan, (Pv 29);
6. *Chapmanina* sp., (Pv 49);
7. *Orbitolites complanatus* Lamk. (Pv 27);
8. Large foram. morphosp. *B*., (Pv 27);
9. Attached foram. morphosp. *B,* (Pv 27);
10.*Arenobulimina* morphosp. *B.,* (Pv 26);
12. Amphisteginid. (Pv 45++);
14, 15. Alveolinids (cf. *Neoalveolina*), (Pv 27, 30);
16.Elphidium. morphosp. *B.,* (Pv 26);
17.*Pseudotriloculina* sp., (Pv 27);
18. Lituolid morphosp. *A,* (Pv 49);
20. Thick wall miliolid, (Pv 49);
21. Large biserial foram morphosp. *A.,* (Pv 45++);
22. *Arenobulimina* morphosp. A, (Pv 57);
23. Angular miliolid, (Pv 27);
25. Nummulitid C – *Assilina sp.*?, (Pv 60).

PLATE II

Assemblage C
1. *Haddonia heisinghi*, (Pv 35)
2. Ecol. succession of incrusting org., (Pv 35);
3. Large agglutinated foram., (Pv 35);
4. *Antiguastrea lucasiana* (Defrance)*,* (Pv 35);
5. Incrusting coral (cf. *Porites*), (Pv 35);
6. *Astreopora* sp., (Pv 35).

Assemblage D
1, 7, cf. *Cibicides* sp. A, (Pv 45++, Pv 30);
2, 8 cf. *Gyroidina* sp., (Pv 64);
3. *Lithophyllum* sp., (Pv 30);
4. *Neomeris* sp., (Pv 27);
5. *Corallina* sp., (Pv 44);
6. *Lithothamnion* sp., (Pv 60);
9. *Sporolithon* sp., (Pv 38);
10. *Lithoporella melobesioides* (Foslie)*,* (Pv 35);
11. Medium size rotaliid, (Pv 29);
Thick (12) and thin (13) wall rotaliids., (Pv 49, 45+);
14. *Acervulina linearis* (Hanzawa)*,* (Pv 31+);
15. *Polystrata alba* (Pfender)*,* (Pv 49).

Assemblage E
1. *Pyrgo*.sp., (Pv 27)
2. Thick wall, large miliolid, (Pv 27)
3. small porcelaneous foram., (Pv 30)
4. *Glomospira* sp., (Pv 27)
5. colonial annelids, (Pv 30)
6, 7. Large rotaliids., (Pv 30, 44).

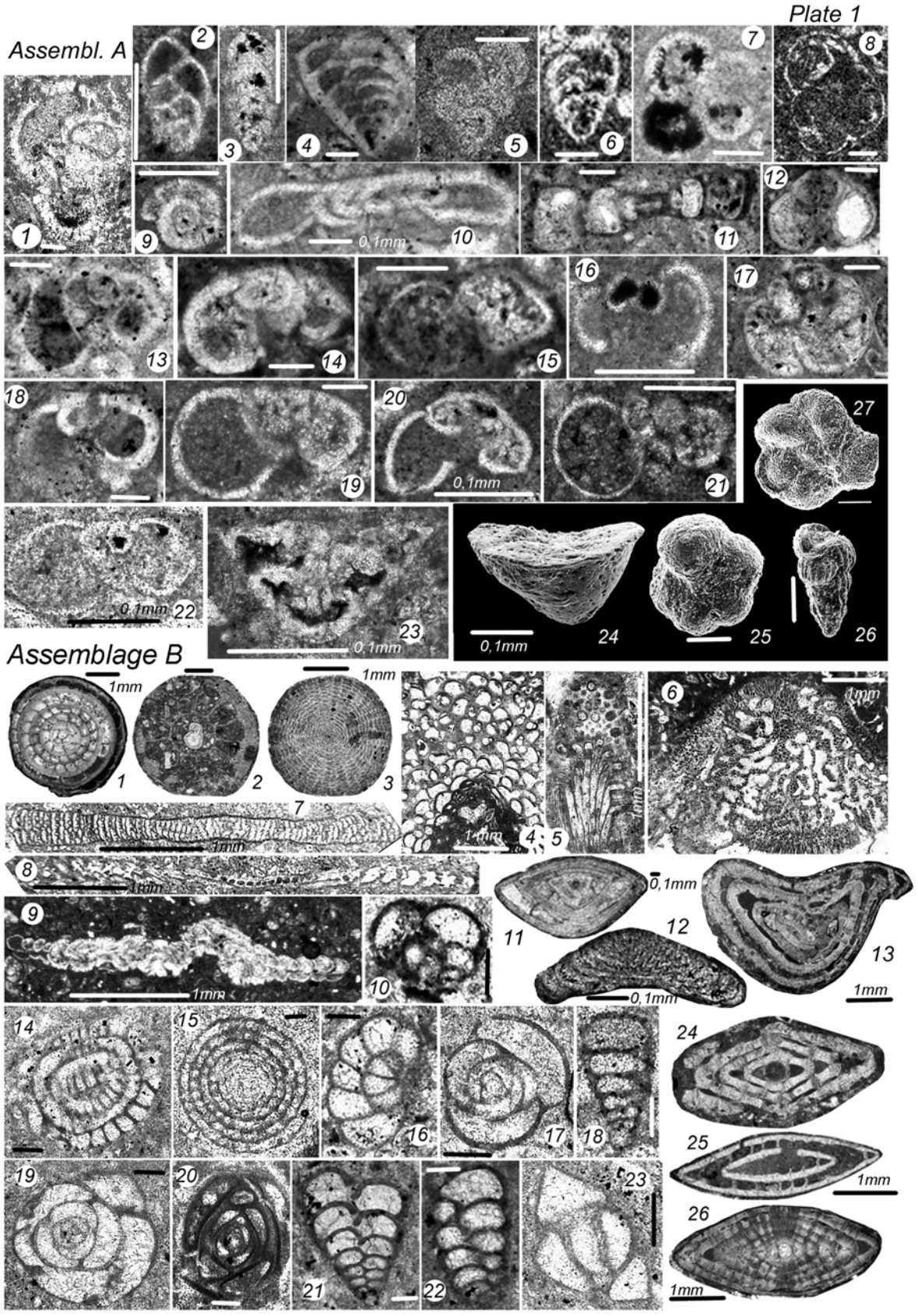
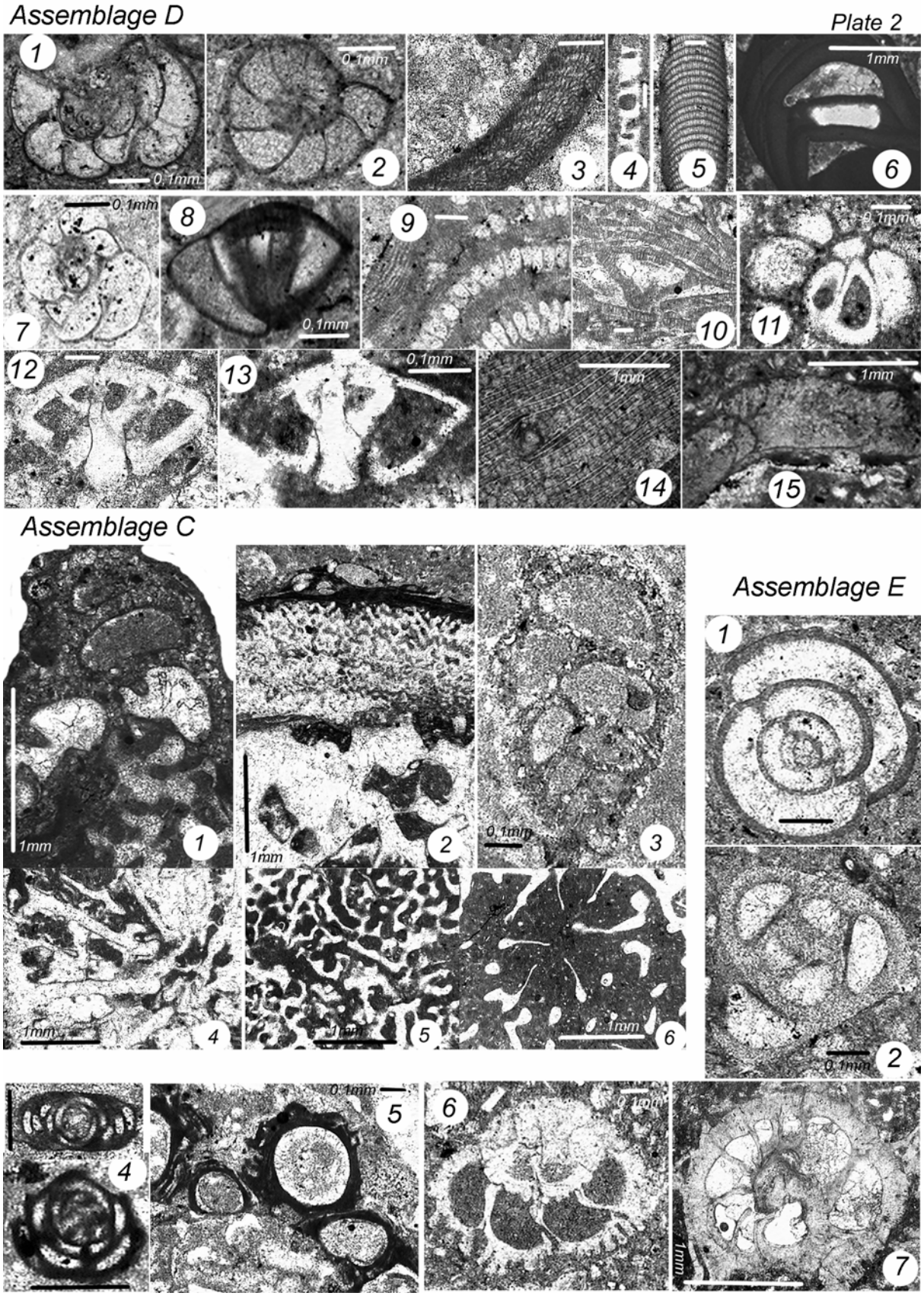


Plate 1
Assembl. A
0,1mm
Assemblage B
1mm
0,1mm


Assemblage D
Plate 2
Assemblage C
Assemblage E