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UPPER EOCENE FORAMINIFERA OF EAST POLAND AND THEIR PALAEOGEOGRAPHICAL MEANING

Contents

Abstract. — Foraminiferal assemblage found in Upper Eocene deposits from Siemień (Eastern Poland) includes over 70 species. This assemblage lived in cold shelf waters 80—100 m deep. The foraminifera-bearing deposits may be correlated with lower part of marls of Kiev stage from Ukraine, representing the lower horizon of the Upper Eocene and/or the Middle-Upper Eocene junction beds. Foraminiferal assemblage from Siemień beds is entirely different from that known from the stratotype of the Bartonian. Marine transgression responsible for deposition of Siemień beds presumably reached the area of Poland from the East, utilizing old tectonic frame: Dnepr-Donetz aulacogen and its extensions. This is confirmed by a marked similarity of foraminiferal assemblages as well as composition of heavy minerals present in deposits of Siemień beds.

INTRODUCTION

Marine deposits of the Upper Eocene in the Eastern Poland (Lublin region) were recognized at Siemień (fig. 1) by W. Pożaryski and E. Rühle in 1949 (Rühle 1955), who assigned them tentatively to the Eocene. Subsequently, these deposits here termed as Siemień beds were studied by several authors including Mojski *et al.* (1966), Woźny (1966, 1967, 1968, 1977), J. Uberna (1967, 1970, 1971, 1973), Pożaryska & Locker (1971) and

T. Uberna (1974). Because of the occurrence of phosphorites at the base of these beds the Geological Institute started prospecting in this area.

Rich fauna occurring in Siemień beds was described in several papers: macrofauna in Woźny (1977), planktonic foraminifera and calcareous nannoplankton in Pożaryska & Locker (1971), benthic foraminifera in Pożaryska (this paper), ostracods and problematic microfossils in Szczechura (1969, 1977).

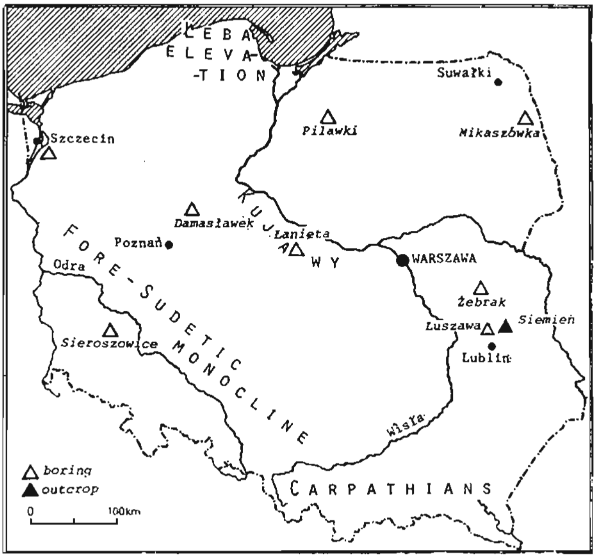

Fig. 1. Localities of the Upper Eocene in Poland.

The study on benthic foraminifera was carried out in the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw in years 1970—1974. The samples examined are derived from the collections of the Geological Institute in Warsaw (IG), gathered by Professor W. Pożaryski and Dr J. Uberna as well as from the collection of the present author, made during prospecting works carried out by Dr J. Uberna. Specimens described are housed in the Institute of Palaeobiology, Polish Academy of Sciences, Warsaw (ZPAL).

Acknowledgements. — Comparative micropalaeontological material from Museum d'Histoire Naturelle in Brussels was made available through the courtesy of Professor Van de Poel, and comparative materials of microfaunas from the Eocene and Oligocene from University of Utrecht — thanks to Professors C. W. Drooger and P. Marks. Dr H. Bartenstein from Celle furnished comparative material from F.R.G., and Dr S. Ritzkowski organized field trip to German outcrops of the Eocene and Oligocene, making possible collecting some samples. Thanks to Professor D. Curry from London the author visited the stratotype of Bartonian at Southampton and Lower Paleogene outcrops at Isle of Wright. Professor J. Małecki furnished samples of Upper Eocene from Miały locality nearby Grodno, gathered at the beginning of this century by Rydzewski (1908), and Dr Voloshina from Kiev — samples of Eocene deposits from Taykury locality nearby Rovne in Volhynia (USSR).

Thanks are due to Dr J. Uberna, Dr E. Woźny, Dr W. Brochwicz-Lewiński, T. Uberna M. Sc. and E. Odrzywolska-Bieńkowa M. Sc. (Geological Institute, Warsaw) for numerous discussions and critical comments.

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SEM micrographs of foraminifera were made in the Nencki Institute of the Experimental Biology, Warsaw, with Mr. A. Reński's help. Drawings of the foraminifera were made by Mrs E. Gadomska, and maps were drawn by Mrs K. Budzyńska (Institute of Palaeobiology, Polish Academy of Sciences).

GEOLOGICAL SETTING, FORAMINIFERA AND AGE OF THE SIEMIEŃ BEDS

The Upper Eocene deposits in the Lublin region represent relics of originally much more extensive sedimentary cover, left by erosion only in a very limited area. The outcrops are primarily confined to left bank of Tyśmienica stream, from Siemień to Wólka Siemieńska. The Siemień locality remains the only one where they are well exposed. Siemień beds were penetrated by IG borehole at Luszawa upon Wieprz river and found at Wólka Siemieńska and some other localities nearby Siemień. At Siemień the deposits are exposed in trenches by the road and deepened by earth works.

The profile of Siemień beds is as follows (after J. Uberna; macrofauna identification after E. Woźny):

0.00 — 1.20 m — Quaternary sands;

1.20 — 2.60 m — Eocene; greenish clay silts with rusty spots; some glauconite;

2.60 — 3.90 m — light-gray marly sands with glauconite; pelecypod fragments: *Amussium corneum, Chlamys bellicostata, Ch. biarritzensis, Ch. recondita, Ch. sokolovi, Ostrea plicata, Ostrea* sp.; echinoid fragments: *Cidaris* cf. *anhaltina*; bryozoans: *Orbitulipora petiolus*; otoliths.

2.60 — 3.90 m — green-gray marly sands with glauconite: macrofauna debris as above plus: *Chlamys rodkiewiczi*, brachiopods of the *Terebratula* group, fish — *Lamna* sp., corals — *Balanophylia subirregularis*, gastropods — *Mesalia sulcata, M.* cf. *marginata, Tomyris ukrainiae* and others. Lower parts of this bed yielded also *Chlamys carinata, Corbula cordasensis, Crassatella woodi raricostata, C. desmaresti, Meretrix incrassata, Ostrea prona longa, O. ventilabrum, O. cymbula, Spondylus buchi, S. tenuispina*; echinoids — *Cidaris anhaltina* and *C. interlineata*, and brachiopod — *Terebratulina nysti*;

3.90 — 4.50 m — green-gray marly sands with single phosphoritic nodules, phosphorites. Phosphatic-calcareous rock debris at the base;

4.50 — 4.70 m — brown-green calcareous sands with glauconite and fairly numerous phosphorite nodules. Numerous fragments of pelecypods, echinoids, bryozoans and corals. Besides the forms cited above there were found: *Crassatella compressa, Ostrea angusta, O. flabellula, O. submissa, O. virgata, O. wemmelensis, Batopora stoliczkai, Hornera porosa, Balanophylia cornu*, and *Terebratulina asperula*. The rock yields single angular or weakly rounded phosphatic-calcareous rock debris. Moreover, there occur numerous, well-rounded, bean-shaped quartz grains up to about 20 mm in size;

4.70 — 4.90 m — green, quartz-glauconite, phosphorite-bearing sands with very numerous brown-coloured phosphorite lumps or single concretions. Numerous bean-shaped quartz grains and phosphoritized wood fragments are found. Innumerous fragments of phosphorite-carbonate rock are bored by boring organisms. Faunal remains fairly numerous: *Cardita domgeri, Cidaris semiaspera*, numerous fish fragments (?);

4.90 — 5.40 m — Maestrichtian.

Maximum thickness of non-calcareous glauconite-bearing deposits occurring in the Siemień area is estimated at 8 m, whereas the maximum thickness of sandy-carbonate deposits is 2.30 m. Carbonate deposits are replaced in places by non-calcareous sands, gaizes and clays. The next occurrence of sandy-carbonate Upper Eocene deposits is found 25 km to SSW of Siemień in the Luszawa boring (Mojski *et al.*, 1966), where they are 1.2 m thick.

The foraminifera found in Siemień beds appeared to be rich in individuals and species. Over 70 species were identified and only some of them are represented by single individuals. No large foraminifera were found.[1] This foraminiferal assemblage comprises mostly calcareous forms and only a few taxa of agglutinated foraminifera. The former primarily include benthic forms. Contribution of planktonic species is no greater than 8% of the whole spectrum and they are represented by innumerous individuals.

The foraminiferal material is generally very well preserved. Only some species, and particularly so spirally coiled forms, have the last chambers usually damaged. Moreover, several specimens are somewhat coloured with iron compounds. Scarce material of planktonic foraminifera usually comprises poorly developed, immature or dwarfish individuals. They are usually smaller than representatives of the same species recorded from the areas of the Mediterranean province proper, where they lived under optimum conditions.

The foraminiferal spectrum obtained indicates richness of the assemblage — it consists of over 70 species belonging to 42 genera of 25 families. There is a distinct predominance of the family Nodosariidae, and especially of the genus *Lagena*, represented by over a dozen species and predominated by ornamented or keeled (*Fissurina*) forms. There is a predominance of the Tertiary and especially Miocene species. Similar phenomena are

[1] Woźny (1967, 1968) reported *Nummulites* from the same beds but this record was not confirmed in the course of the present study (see also remarks on p. 8).

found in the case of representatives of the genera *Dentalina, Nodosaria, Marginulina* and *Marginulinopsis*, represented almost exclusively by ornamented forms. The ornamentation comprises knobs and spines (*Dentalina spinulosa*) or ribs sometimes of gigantic, almost monstruous size (*Marginulinopsis behmi*). The ribs, particularly in the latter genus, during ontogeny grow into the form of relatively gigantic blades, proportional in width and height and often overhanging sutures. Other representatives of the family Nodosariidae, those of the genus *Lenticulina*, display keel of enormous width (*L. grodnensis*), spiny-denticulated and ragged. All bolivinids are more or less heavily ornamented and belong to a separate brizaline-group. Heavy ornamentation is also typical of representatives of the genus *Bulimina* recorded here (*B. subtruncana*). Species of this genus are more numerous and markedly more heavily ornamented than smooth-walled species from the Upper Cretaceous and lowermost Tertiary. The trend to heavy ornamentation is also displayed by species of the genus *Uvigerina* (*U. spinicostata, U. costellata* and *U. citae*). In the case of coiled forms some species of the Elphidiidae (e.g. *Elphidium hiltermanni*) are characterized by heavily spiny apertural surface, and some Nonionidae (e.g. *N. graniferum* and *Florilus winnianus*) — by heavy spiny lateral surface. Trochospiral forms have very wide and sharp keel (*Cibicides lobatulus*) and some species of the genus *Svratkina* (*S. perlata*) — large knobs developed on both, the whole spiral surface of test and a large part of umbilical side. Attention should be paid to an ornamented *Trimosina sectile*, occasionally found in the Eocene of Europe. It is characterized by chambers ended with longer or shorter, often tripartite spines. The spines are sometimes so large that they obscure the structure of test. This trend to heavy ornamentation is also displayed by representatives of the family Anomalinidae (*Anomalina affinis* and *A. nonioninoides*), where it is reflected by strongly elevated sutures. Thus it may be concluded that foraminifera from Siemień beds are characterized by a peculiar feature — rich and heavy ornamentation. This is an important feature indicating growth in especially favourable environment of marine basin with efficient system of bottom currents providing its good oxidation.

The analysis of this foraminiferal assemblage from the area of Siemień and comparison with other contemporaneous assemblages from Poland have shown that the former does not resemble any other upper Eocene assemblage from the northern Poland (e.g. those described by Odrzywolska-Bieńkowa 1967 MS) nor from the southern Poland (described by Grzybowski 1894; Uhlig 1886; Blaicher 1961; and Liszka 1957, from the Carpathians, and by Odrzywolska-Bieńkowa 1973, and Matl & Śmigielska 1977, from the Fore-Sudetic monocline).

The distinctness of this assemblage results from its following features: (1) the occurrence of planktonic forms, (2) the lack of large foraminifera (Pożaryska & Locker 1971) and (3) richness of forms and their heavy ornamentation. The planktonic forms, although relatively innumerous and poorly developed, make it possible to date accurately the Siemień beds and to establish marine connections. The lack of large foraminifera in spite of the large-scale searching (Olempska 1973) indicates that there was no direct connection of the Siemień basin with the late Eocene basin of the Carpathians (Grzybowski 1894; Liszka 1957) nor with those of Silesia and Fore-Sudetic monocline (Cimaszewski 1964; Olempska 1973; Odrzywolska-Bieńkowa 1973; Matl & Śmigielska 1977).

The difference between Upper Eocene foraminiferal assemblages from Siemień and other parts of northern and southern Poland may be partly attributed to the difference of age. The former were rightly interpreted as the oldest Late Eocene assemblage from the Polish Lowlands already by J. Uberna (1973) and T. Uberna (1974). In turn, Mandrikovka beds from Ukraine may be correlated with the Upper Eocene deposits from (fig. 1) Mosina nearby Poznań, Łanięta in Kujawy (Odrzywolska-Bieńkowa 1975) and Fore-Sudetic monocline (Odrzywolska-Bieńkowa pers. inf.). They represent the NP-19 Zone of the standard profile proposed by Martini (1970). In turn, Siemień beds may be referred to the zone 17 (Ritzkowski pers. inf.) and not the zone 16 as it was initially assumed by Locker (Pożaryska & Locker 1971). Thus the Siemień beds appear to be two nannoplankton zones older than Upper Eocene deposits from western Poland.

Upper Eocene microfauna from core material from Mikaszówka borehole (fig. 1, NE Poland) was correlated by Odrzywolska-Bieńkowa (1974) with Byeloglinsky horizon in Byelorussia (USSR), the uppermost horizon of the Kiev stage; whereas Siemień beds represent lower horizon of the Upper Eocene, the foraminiferal zone *Globigerapsis semiinvoluta* (see Pożaryska & Locker 1971) or nannoplankton zone NP-17 *Discoaster saipanensis* (according to Ritzkowski, pers. inf.). According to Martini's standard NP stratigraphy (1970) this is very important for explaining distinctness of Siemień beds both in lithology and foraminiferal and coccolith microfauna. Microfaunal differences are actually high as only 30% of 70 species of calcareous foraminifera known from Siemień beds are also known from northern Poland (Odrzywolska-Bieńkowa 1972*ab*, 1974, MS thesis) and less than 20% are known from southern and south-western Poland. The assemblage from Siemień appears to be much closer to that from Ukraine (75% in common with those described by Kaptarenko-Tshernousova 1951, and Kraeva 1969) and Byelorussia and southern Lithuania (60% in common with those described by Fursenko & Fursenko 1961).

These features of the Upper Eocene foraminiferal assemblage from Siemień, and particularly the occurrence of planktonic forms and the lack of large foraminifera, indicates that the Siemień beds belong to so called *Globigerina* facies distinguished in contemporaneous deposits in Ukraine (Kaptarenko-Tshernousova 1951, 1956). This facies comprised the most northerly deposits of the Mediterranean province, whereas in southerly areas of the USSR there was possible to distinguish Mediterranean facies proper, typical of deposits of the Tethyan ocean (Kaptarenko-Tshernousowa 1951, 1956). In Poland the latter occurs in the Carpathians and Fore-Sudetic monocline. However, there is the lack of modern overall studies of foraminifera of the Upper Eocene of this province and the old monographs (Uhlig, 1886; Grzybowski 1895) require revision. The monograph by Jednorowska (1968) deals only with foraminifera from Magura unit, whereas some other contributions deal with guide fossils of local sequences (Blaicher 1961). In turn, in Russian literature there are several extensive studies of these faunas (e.g. those of Maslakova 1955, and Mjatliuk 1970).

The outlines of studies on the Eocene from southern Poland were given by Uhlig (1886), Grzybowski (1895), Wójcik (1904) and Syniewska (1937). The studies on the part of the latter on Popielskie clays showed the occurrence of *Rotalia calcar, Asterigerina bimammata, Triloculina tricarinata* and other species typical of the Mandrikovka beds as well as numerous plankton. The former assemblage appears also very similar to that from Kruhel Mały (see Wójcik 1904) which, according to the last author, and Syniewska (1937) comprises *Clavulina szaboi* and other important species. Grzybowski (1895) assigned deposits from Wola Łużańska and Folusz, yielding *Rotalia lithothamnica, Asterigerina stellata, A. rotula, A. bimammata* and other species, to the Upper Eocene (Bartonian). Therefore it may be stated that the Upper Eocene deposits of the Carpathians are of the same age as those known from Fore-Sudetic monocline and Kujawy. They may be considered as time-equivalent of the Mandrikovka beds and thus they represent younger horizon of the Upper Eocene than Siemień beds. The above mentioned assemblage with *Claviculina szaboi* does not occur in Siemień beds.

The Upper Eocene foraminiferal assemblages from northern Poland are markedly better known than those from the Carpathians. Several boreholes drilled in the area stretching from Szczecin throughout Łeba elevation up to Suwałki region (Mikaszówka), penetrated the Upper Eocene deposits represented by quartz-glauconite sands passing upwards into claystones and siltstones and downwards into well-rounded quartz gravels with phosphorite nodules at the base. These deposits, known under local name of Pomorskie beds (Ciuk 1974), represent the *Clavulina szaboi* and *Globanomalina micra* Zone. Odrzywolska-Bieńkowa (1974) assigned them to the Upper Eocene and interpreted as time-equivalent of Byeloglinsky horizon, the uppermost horizon of Kiev stage in Byelorussia. Younger deposits already yield the typical Oligocene foraminifer species such as: *Turrilina alsatica, Cibicides ungerianus, Ceratobulimina contraria, Melonis affine, Heterolepa dutemplei* and *Asterigerina bracteata.*

In the northern Poland the most complete section of the Upper Eocene is that of borehole Szczecin IG-1, where it is 81 m thick. Thanks to good micropaleontological (Odrzywolska-Bieńkowa 1972*ab*) and palynological

(Grabowska 1968) records it is the marker point for contemporaneous deposits in this northern province (see Ciuk 1974). The foraminifer assemblage is rich but, nevertheless, it has only 30% species in common with the Upper Eocene deposits of Siemień. Among the species known from both Szczecin and Siemień areas there is planktonic species — *Acarinina rugosoaculeata*, one of two species recorded in the northern zone. The foraminiferal assemblage of this zone is characterized by the occurrence of the following species: *Globanomalina micra, Lenticulina dimorpha, Siphonina preareticulata, Karrieriella exilis, Astacolus decoratus* and others. This assemblage with *Globanomalina micra* was not recorded in Siemień beds and only some common elements of this assemblage as, e.g., *Bulimina praetruncana*, are represented by single elements in upper parts of beds.

Thus it may be concluded that the Upper Eocene Siemień beds cannot be considered as space or time equivalent of Upper Eocene deposits known from northern (Łeba elevation), southern (Carpathians) or south-western (Fore-Sudetic monocline) Poland, but they rather represent the most westerly deposits of the Upper Eocene horizon and biofacies known from the area of Old East-European Platform and representing the lowermost link of Kiev stage.

CORRELATION OF THE SIEMIEŃ BEDS WITH KIEV STAGE SEQUENCE

During the Paleocene in the area of Old East-European Platform and chiefly in the USSR the maximum extent of marine transgression is related to transgression of the late Eocene sea. Deposits of that sea form so called Kiev stage comprising the uppermost Middle Eocene, whole Upper Eocene and lowermost horizons of Lower Oligocene.

The wide basin of Kiev sea stretched primarily over the Ukraine, entering adjoining parts of Byelorussia, Lithuania and northern Poland in the north, eastern Poland (Siemień) in the west (fig. 2). To the south it was connected with vast Tethys (Carpathians and Alps) and to the east it comprised Donbas, Skifska Plate, Mangyshlak and adjoining areas of Caspian and Black Sea depressions, extending further to the Caucasus, Palestine and Iran. Thus it follows that this sea was a part of vast Mediterranean sea or northern extension of the Tethyan ocean, joining its western and eastern parts. Northern boundary of the Kiev sea roughly exceeds northern margins of Dnepr-Donetz aulacogen. Equivalents of the Kiev basin may be found in southern Europe, northern Africa as well as in Mexico, similarly as it is the case of the Paleocene basins (Szczechura & Pożaryska 1974). So vast distribution of the deposits of Kiev stage and their equivalents from other continents was already noted by Sokolov (1895).

In Ukraine, it is possible to distinguish two main areas of occurrence

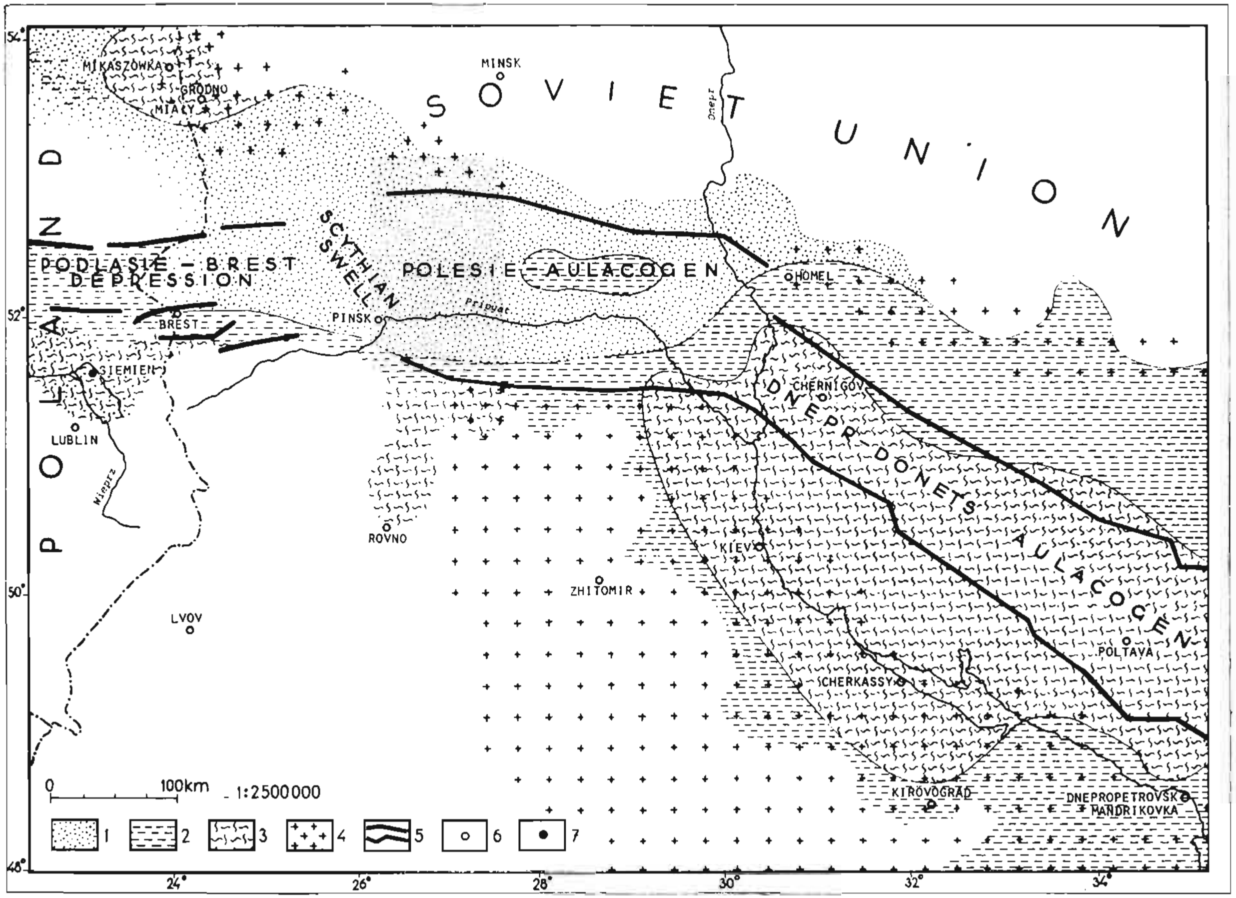

Fig. 2. Distribution of Upper Eocene facies in SW part of the East European Platform (after Khajn, Shutskaja 1961, and Bogdanov 1962). International tectonic Map of Europe modified. *1* sands; *2* marls; *3* calcareous facies; *4* crystalline massifs; *5* tectonic framework; *6* main towns; *7* Siemień locality.

of Kiev stage deposits: northern and southern, separated by Ukrainian crystalline massif. Connections between these areas are indicated by erosional patches of deposits of that age found in some places in the area of the massif. However, the deposits are reduced in thickness and primarily represent younger horizons. Deposits of the Kiev stage are most fully developed in the aulacogen area — in Dnepr-Donetz, Donbas, Polesie and Brest depressions, through which the transgression came from the south-east and proceeded towards the north-west and west. Initial stage of the transgression resulted in deposition of the quartz-glauconite deposits primarily confined to axial part of the aulacogen and adjoining northern slopes of the Ukrainian massif. These deposits gradually pass into sandy and subsequently pure, highly-calcareous marls. The sedimentary cycle ended with deposition of non-calcareous clay series. The successive links of this sequence reflecting progress of the transgression, extend progressively further from the aulacogen and overstep older links.

The whole Kiev stage, except for its lowermost and uppermost links, yields rich foraminifer microfauna. The microfauna was studied by several authors including Tutkovskij (1887, a.o.), Kaptarenko-Tshernousova (1946—1956) and Kraeva and Zernetzkij (1969).The lower marly parts of Kiev stage with weakly calcareous, quartz-glauconite, phosphorite-bearing sands at the base, yield rich plankton — globigerinids and globorotalids (*Acarinina*), as well as numerous representatives of typical benthic species, *Marginulinopsis behmi*. Younger strata yield the assemblage with *Clavulina szaboi*, and still younger — assemblage with *Spiroplectammina carinata*, *Cibicides pseudoungerianus*, *C. pygmeus* and others. The Siemień beds, also developed in *Globigerina* facies and having the same plankton and benthic calcareous foraminifer assemblage characterized by abundance of *Marginulinopsis behmi*, appear to be an equivalent of the lower, marly zone of the Kiev stage, corresponding to the junction beds of the Middle and Upper Eocene.

The upper zone of the Kiev stage with guide species, *Clavulina szaboi*, appears to be an equivalent of the Upper Eocene deposits from Łeba elevation and Mikaszówka in northern Poland. Contemporaneous deposits also include the Upper Eocene deposits from Byelorussia and southern Lithuania (Fursenko & Fursenko 1961) and Mandrikovka (Martini & Ritzkowski 1970). The younger horizons of Kiev stage developed in blue marl facies occur over vast areas of Europe and northern Africa (Hantken 1875; Liebus 1911; Gümbel 1868; Reuss 1863; Halkyard 1919; Kaptarenko-Tshernousowa 1951). This is proved by distribution of the large foraminifera and small guide forms such as *Clavulina szaboi*, *Rotalia lithotamnica*, *Asterigerina bimammata*, *A. rotula* and others. However, all these forms are lacking in eastern Poland. This assemblage is typical of upper marls of the Upper Eocene, younger than Siemień beds and present in the northern Poland and the Carpathians as well as the Mandrikovka beds in the area of the Ukrainian crystalline massif. The deposits bearing these forms belong to shallow-water facies typical of northern slope of the massif.

The Kiev stage represents a continuous sedimentary sequence beginning with Butschat series corresponding to higher horizons of the Middle Eocene and IIIrd Caucasian zone (Subbotina 1953), and ending with Kharkov series representing the Oligocene. It is characterized by lithological variability well traced in particular tectonic units of the aulacogen where there are more complete profiles than in the massif areas, the site of sedimentation of only younger links of this stage. Therefore the equivalents of the Siemień beds representing older links of marly series of the Kiev stage should be looked for primarily in the areas of the aulacogen and northern sloped of the Ukrainian and Byelorussian massifs and Caspian and Black Sea depressions (Barkhatova & Razmyslova 1974). Thickness of the Kiev stage deposits is of the order of a few tens of meters in Ukraine, and of hundreds of meters in the Caucasus, decreasing to a few meters in the case of lower links of this stage and about a dozen meters at the average in the northern Poland.

Deposits of the Kiev stage were originally assigned to the Oligocene and it was Tutkowskij (1887) who indicated their Eocene age on the basis of foraminiferal microfauna. However, in subsequent papers Tutkowskij changed his views and accepted the Oligocene age for these deposits. The controversy resulted from different interpretation of the concept of Lower Oligocene (Lattorfian) (Krutsch & Lotsch 1957*a*), presently widely considered as "Lattorfian facies of the Upper Eocene", and included into Upper Eocene (Cavelier & Pomerol 1976).

SIEMIEŃ BEDS VERSUS PALAEOGEOGRAPHY OF THE UPPER EOCENE IN EUROPE

As it follows from above, the Upper Eocene Siemień beds have the time-equivalents neither in northern (Łeba elevation) nor western Poland (Fore-Sudetic monocline) but rather represent the most westerly occurrence of the lower link of Kiev stage classically developed in Ukraine.

At the present state of knowledge it may be assumed that the Late Eocene marine transgression coming from the east and responsible of formation of the Siemień beds did not pass beyond the western margin of the Old East-European Platform and did not reach Łeba elevation nor Fore-Sudetic monocline. The latter areas were entered by that sea not before later Eocene coming most probably along the northern way through Byelorussian massif (Lithological-palaeogeographical Atlas 1961). Vast Late Eocene sea, i.e. Kiev sea from Ukraine, was widely connected with the Tethys on the south and occupied Dnepr-Donetz (syneclize) basin at the turn of the Middle and Late Eocene (Kaptarenko-Tshernousova 1951). Axis of sedimentation of that basin presumably passed roughly along south-western boundary of Palaeozoic Dnepr-Donetz aulacogen forming substratum of the Kiev basin. It continued parallel to both the directions of aulacogen and the Ukrainian crystalline massif delineating the basin from the south-west. The Upper Eocene in axial part of the basin ranges from 25 to 55 m in thickness and is developed in marly facies. Outwards to the north-east of the aulacogen boundary deposits of that age are thinner and developed only in sandy-clay deposits facies. On opposite side of the aulacogen, in the area of crystalline massif, margins of the Late Eocene sea are also delineated by deposits of sandy-clay facies, but these deposits are confined to relatively narrow strip and are relatively thin. Further to the west, in the area of Polesie aulacogen, there is a distinct shift of marly facies on the areas situated outside the aulacogen. Deposits developed in marly facies form a strip continuing along northern slope of Ukrainian crystalline massif and deposits occurring in the aulacogen area are developed exclusively in clay-sandy facies. The northernmost occurrence of marly facies deposits in the aulacogen area is found at Chernigov area. These deposits resemble very close those from Siemień in lithofacies and microfauna. In Polesie, the Upper Eocene series is thinner than in Dnepr-Donetz aulacogen section and marly facies is confined to southern periphery of the basin. Further to the west, south of Minsk in the area of Rovne and outside the aulacogen area, the deposits developed in marly facies are up to 30 m thick. Siemień beds seem to be equivalent of this facies belt in the west. It should be noted that the area of Siemień and area of marly sedimentation between Pińsk and Rovne are situated outside of the axis of Palaeozoic depressions situated at western extension of Polesie aulacogen (Polesie-Brest depression).

The Late Eocene sea transgressed Byelorussia fróm Prypet's depression (Ber 1963), along the axis of which passes the Polesie aulacogen. From the south the Polesie depression is delineated by southern margin of Ukrainian massif, and from the north — by Byelorussian massif, and in the Pińsk area the Prypet' river cuts crystalline substratum elevation connecting these two massifs, i.e. so called Scithian swell. Kaptarenko-Tshernousowa (1951) followed Shatski (1924) stating that the Late Eocene transgression was stopped in this area and did not pass beyond this swell further to the west. However, Ber (1963) showed that this transgression passed the Scithian swell in southern Byelorussia as it left some deposits in Brest depression. According to this author, through this seaway the Late Eocene sea from Dnepr-Donetz basin was connected with contemporaneous seas of western Europe. However, the new data from Poland indicate that the first Late Eocene transgression coming from the east reached not further than Siemień as there are no records of deposits referable to lower Upper Eocene horizons from more westerly and northerly areas in Poland. The subsequent Late Eocene transgression of the Late Eocene sea with Byeloglinsky horizon microfauna typical of Late Eocene, entered northern Poland and formed a seaway connecting Dnepr-Donetz basin with West-European sea through the area of northern Poland. Deposits of this link — sandy micaceous marls — were deposited in somewhat deeper sea which entered Ukrainian and Byelorussian crystalline massifs deposing sediments at Miały nearby Grodno and at Mikaszówka, and also entered the Łeba elevation. Moreover, at that time it was formed a seaway connecting that sea with the Late Eocene Tethyan sea through the area of western Poland, which is reflected by the appearance of warm-water elements (foraminifera of the families Miliolidae and Nummulitidae) in the former (Odrzywolska-Bieńkowa 1973*a*; Cimaszewski 1964; Olempska 1973). Subsequently, the sea entered vast areas of northern Germany, where also some warm-water foraminifera were found (Krutsch & Lotsch 1957*b*, 1958; Kiesel 1970). Further to the west it get connected with Belgian marine basin (Kaasschieter 1961) and probably with London basin, where also numerous miliolids, pararotalids and nummulites were found (Norvick MS). This is in contrast with the picture drawn by Pomerol (1973) and indicates a strong influence of vast Tethyan sea occupying the southern Europe and connected with epicontinental sea of northern Europe through the reactivated Moravian Gate situated between Bohemian and Małopolski massif (fig. 3). This seaway is responsible for immigration of some warm-water Tethyan elements as nummulites found in the Upper Eocene deposits of Fore-Sudetic monocline at Sieroszowice (Odrzywolska-Bieńkowa 1973*a*) and its vicinities (Matl & Śmigielska 1977), and in Kujawy at Damasławek (Cimaszewski 1964; Olempska 1973), at Mosina (Ciuk 1974), and at Łanięta (Odrzywolska-Bieńkowa, MS).

RELATIONSHIP BETWEEN THE LATE EOCENE PALAEOGEOGRAPHY AND THE SUBSTRATUM

In the Late Eocene the Flysch geosyncline of the Carpathians was still in its full development. The Carpathian sea had wide connections with epicontinental Boreal sea of northern Europe along southern margins of the East-European Platform (Black Sea and Caspian Sea). The Ukrainian massif and Małopolski massif adjoining it on the west were land areas breaking the connection between the Tethys and north-European sea. However, a transversal zone of depressions primarily including the Upper Silesian depression, a foreland or intermountain depression from the time of Variscan orogeny, made it possible formation of another seaway connecting these seas (Moravian Gate). Third seaway connecting north-European and Tethyan seas in the Late Eocene time was the Atlantic and the English channel. At that time Paris basin was rather unimportant, closed and brackish basin. It follows that the north-European basin was best con-

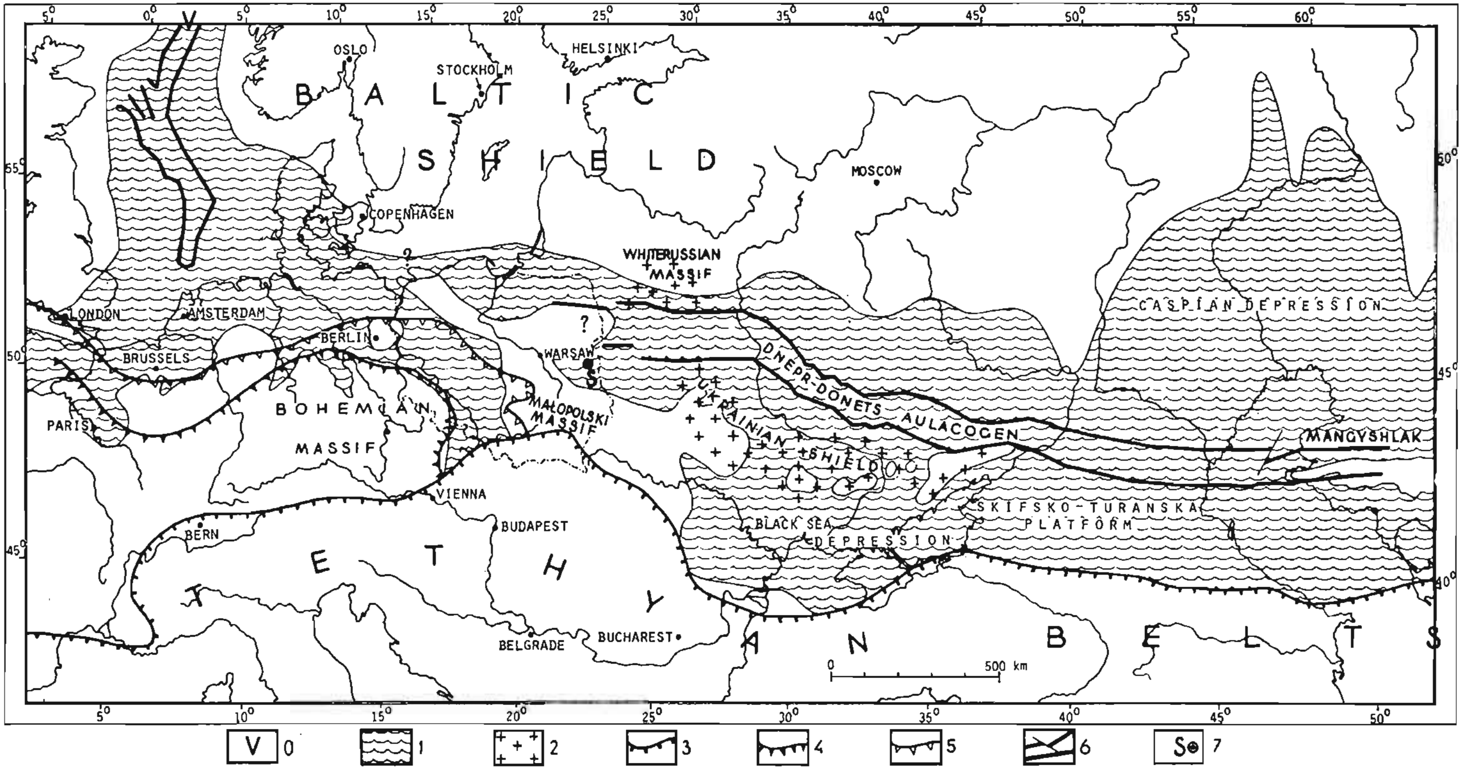

Fig. 3. Maximum transgression of the Late Eocene epicontinental seas in Europe. *0* Viking Graben; *1* Late Eocene epicontinental seas; *2* crystalline massifs (White Russian and Ukrainian); *3* northern Alpine front; *4* older Armorican belt; *5* younger Armorican belt; *6* intercontinental troughs; *7* Siemień locality.

nected with the Tethys through Kiev basin. The Kiev basin originated utilizing old tectonic feature — Dnepr-Donetz aulacogen — which along with its eastern and western extensions represents so called Sarmatian-Turonian lineament (Aisberg a.o. 1971). On the opposite side the north-European basin was, may be, connected with spreading Atlantic Ocean through the English channel. In this case, warm-water nummulites immigrated through the latter way. This way utilizes a depression continuing along Armoricanian arch of the Hercynids. Moreover, the north-European basin was connected with northern Atlantic through North Sea between Scotland and Norway, along tectonic frame of Mesozoic trough forming axis of the North Sea (Viking Graben). And on the opposite end of the Middle-European Hercynids, on the external side of the Variscan arch, the Tethys and north-European basin were connected through the Upper Silesian depression and the Moravian Gate. Following Pomerol's opinion (1973) the connection with the Atlantic throught English channel was at that time not active because of uplifting of Artois anticlinal.

The influence of the Tethys on epicontinental north-European sea varied in space. It was the strongest in western Europe, where it is reflecied by rich nummulite and miliolid microfaunas recorded in the London basin, markedly weakening already in the Belgium basin. The influence was once again stronger in Germany and western and central Poland where also nummulites and miliolids are found. The influence is much weaker in eastern Poland (Siemień) where neither nummulites (Pożaryska & Locker 1971) nor miliolids were found and planktonic foraminifera are innumerous and poorly developed and dwarfish by Tethyan standards. Further to the north, in northern parts of the late Eocene Boreal basin the planktonic forms are represented by a single species, *A. rugosoaculeata* (Odrzywolska-Bieńkowa 1974) indicating that this area was situated outside the influences of the Tethys in the late Eocene times.

In the eastern Europe the influence of the Tethys is strong in basins of Caspian and Black Sea depressions having broad connections with the Tethys. Faunas from Mandrikovka from northern slope of the Ukrainian massif still yield numerous warm-water elements.

In accordance with the suggestions made by Kaptarenko-Tshernousova (1951—1956) and Odrzywolska-Bieńkowa (thesis MS) it is possible to trace zonal arrangement of Upper Eocene deposits in the western part of the USSR and in Poland. This arrangement seems to be related to original facies differentiation. Three zones — provinces may be distinguished: (1) northern, Boreal, (2) southern, Tethyan (Mediterranean), and (3) middle, transitional — *Globigerina* zone.

(1) Northern, Boreal province. In northern Poland there is a zone of the Upper Eocene deposits with relatively good microfaunal record (Ciuk 1974; Rühle 1974; Odrzywolska-Bieńkowa 1974 MS) which may be easily assigned to northern, Boreal province of Kaptarenko-Tshernousova

(1951—1956). This zone includes northern Poland and adjoining parts of the USSR, and primarily Byelorussia and southern Sambia (Fursenko & Fursenko 1961, and Lithological-palaeogeographical Atlas 1961), roughly delineated from the south by 53° of latitude. To the west of Poland this zone would include Mecklemburgia (Kiesel 1970), some areas south of Berlin, and further to the west it was connected with Belgian basin (Kaasschieter 1961). And to the east of Lithuania and Byelorussia it extended through the areas of Minsk and Homel as far as Kharkov.

(2) On the south, in the eastern Poland and western Ukraine this province was separated by land barrier from Tethyan (Mediterranean) province characterized by nummulite biofacies. The latter, southern Tethyan province was the second, southern zone in this subdivision. It primarily comprised areas formerly occupied by seas of the Tethyan ocean and its northern boundary passes somewhat north of Przemyśl and Cracow in Poland and north of Praha in Czechoslovakia. According to the data from the western Poland, the two provinces came in contact in the areas of Fore-Sudetic monocline (Odrzywolska-Bieńkowa 1973*a*) and Kujawy as nummulite biofacies extends to the north as far as Damasławek nearby Bydgoszcz (Cimaszewski 1964; Olempska 1973) and into the area of Germany (Kiesel 1970).

(3) The third, transitional *Globigerina* province or *Globigerina* biofacies of the Mediterranean province of Kaptarenko-Tshernousova (1951) appears to be confined to the areas of Old East European Platform. It stretches between the Mediterranean province proper and northern Boreal province in the areas from Cracow to Crimea with some overlappings. This general scheme is somewhat obscure because of marked changes in coast lines and wax and wane of marine connections which started in the late Eocene. These changes make it difficult to reconstruct regional distribution of the particular facies and palaeogeography of these times (see Drooger, 1966).

The overlapping of Boreal and Mediterranean provinces in the area of western Poland explains the lack of *Globigerina* biofacies, i.e. sediments bearing microfauna of the Siemień type, to the west of eastern Poland. Thus it may be assumed that the sediments with microfauna of the Siemień type originated thanks to marine transgression coming into the area of Poland from the east in the late Eocene times. This is supported by the results of analysis of the heavy minerals (Kosmowska-Ceranowicz *et al.*, 1974, 1976), indicating the presence of elements derived from Ukrainian crystalline massif. The assemblage of heavy minerals from Siemień markedly differs from those found in deposits occurring to the north and west areas from Siemień.

These conclusions are confirmed by results of the studies on mineralogical-petrological composition of the Tertiary deposits from Hipolitów borehole situated about a dozen kilometers to east of Warsaw (Kosmowska-Ceranowicz *et al.* 1976). The studies have shown that these deposits markedly differ from those from Siemień in mineral composition. According to Kosmowska-Ceranowicz *et al.* (1976) heavy mineral fraction of Siemień sands is characterized by predominance of zircon (30%) whereas contributions of tourmalin, granate and amphibole are roughly the same (12,7%, 14,3% and 11,7%, respectively); moreover, there is some admixture of dysten, staurolite, epidote, silimanite, apatite, topaz, andalusite, biotite, chlorite and titanium minerals. In turn, light fraction of these sands consists of pink and white feldspars and fragments of crystalline rocks. High concentration of amphibole and the occurrence of crystalline rock debris and various feldspars precludes any comparison between the Upper Eocene deposits from Warsaw area (Hipolitów borehole) and Siemień.

Similar mineralogical studies carried out by Kociszewska-Musiał and Kosmowska-Ceranowicz (1976) well support the hypothesis concerning the existence of some kind of barrier also effecting the nature of sedimentation of the somewhat younger Eocene deposits, put forward by the present author (fig. 3). This barrier had to separate sedimentary environments of central and northern Poland. The studies carried out by those authors have also shown that Siemień sands yield several elements derived from the Ukrainian crystalline mąssif, thus indicating that the late Eocene sea transgressed from the east. Thus it follows that reconstructions of directions of marine currents made on the basis of mineralogical and microfaunistic analyses gave the same result. T. Uberna (1974, 1976) is not of the same opinion, reporting from the Hipolitów borehole (Warsaw region) these sediments of the Kiev stage, i.e. *Globanomalina* beds, deposited on the Siemień beds. The last ones are, according to Pożaryska (present paper), restricted only to the area of Siemień, Lublin Upland.

The picture outlined above appears to be most similar to that suggested on Krutsch's and Lotsch's (1957) paleogeographic map for the Late Eocene. The main difference is connected with the position of a zone of mixing of cooler waters coming from the east with warmer waters coming from the west. According to the above authors this zone was situated somewhere in the GDR and according to the present author — west of the Mid-Polish anticlinorium in Poland.

It follows that the hypothesis of the lack of marine sediments of the late Eocene age in the Polish Lowlands (Łyczewska 1958) was improper. The largest Paleogene marine transgression in the extra-Carpathian Poland took place in the late Eocene (Pożaryska & Odrzywolska-Bieńkowa 1977).

ECOLOGICAL CONDITIONS

Foraminiferal fauna found in Siemień beds appeared to be very rich and well developed, except for planktonic foraminifera which are relatively innumerous and dwarfish. Benthic forms and particularly calcareous forms are well-developed, heavily ornamented and highly diversified. Composition of this foraminiferal spectrum is very typical. It primarily consists of representatives of the families Lagenidae, Bolivinidae and Buliminidae, primarily known from deeper shelf waters (Murray 1973). The occurrence of these forms together with representatives of the families Cibicididae and Anomalinidae indicates moderately deep, cold-water environment. It may be stated that the foraminiferal assemblage from Siemień lived in almost open marine basin with moderate cold waters of normal salinity. Modern brizalinas range from near-shore to bathyal zones with salinities of 3.2—3.6‰ (Murray & Wright 1974). Striated uvigerins and buliminids, so common in Siemień beds, and also typical of the Upper Eocene deposits of Egypt, Libia and Morocco, were interpreted as typical of deep water shelf by Schwager (1883) which is in accordance with modern views. These conclusions are supported by the presence of glauconite in these deposits, indicative of well-oxidated environment. The foraminiferal assemblage from Siemień is characterized by the lack of warm-water and shallow-water forms such as large foraminifera (with the exception of *Amphistegina nucleata*), and the lack of *Rotalia, Pararotalia*, Miliolidae and others.

The Upper Eocene marly deposits from Siemień represent deeper facies than those from Mandrikovka in Ukraine or from the Carpathians and Fore-Sudetic monocline in Poland. The latter yields warm- and shallow-water foraminifera such as *Rotalia calcar, R. lithothamnica* and large foraminifera as nummulitids.

These two facies of deposits of the Kiev stage were interpreted as contemporaneous, interfingering in Ukraine, by Kaptarenko-Tshernousova (1951, 1956), according to whom the layers with microfauna typical of Mandrikovka beds (i.e. warm-water microfauna — K. Pożaryska) sometimes wedge into marly series (with deeper- and cooler-water microfauna — K. Pożaryska) over large distances in Dnepr-Donetz depression. Moreover, Kaptarenko-Tshernousova (1951, 1956) stated that in such contact areas the small and large foraminifera occur together, i.e. there occur mixed assemblages comprising both deeper- and shallow-water forms. In Poland this phenomenon is found in Kujawy and Fore-Sudetic monocline (Sieroszowice and Miechów boreholes) and in Germany — in southern Brandenburgia (Kiesel & Lotsch 1963; Kiesel 1970).

The Siemień beds yield an assemblage comprising only foraminifera living in moderate cold waters of deeper shelf (80—100 m deep).

Sedimentary environment of the Upper Eocene deposits of London and Hamstead (Isle of Wight) basins in England was entirely different from that of the Siemień beds. The contemporaneous deposits from England yield numerous agglutinated forms (Isle of Wight) and miliolids. The two groups are especially important in upper parts of Bartonian series. Therefore it is assumed that "initially a deposition under shallow marine conditions took place, and during the deposition the sea rapidly shallowed, giving place to lagoonal or brackish-water conditions, as shown by the abundance of brackish-water fossils" (Bhatia 1957). The presence of representatives of the genera *Rotalia, Pararotalia* and miliolids as well as abundance of large foraminifera fully confirms these conclusions of Bhatia (see Murray & Wright 1974). Moreover, miliolids of the Bartonian in England are numerous and relatively highly differentiated (Norwick MS).

Thus the sedimentary environment of Siemień beds was entirely different from those of the Bartonian in England, which is shown by both the type of deposit and occurring microfaunal assemblages. Moreover, the sedimentary environments of England and Poland differed in hydrodynamic regime. Thus the Siemień beds should be compared with deposits of the Kiev stage, deposited under similar conditions, particularly in the case of lower parts of blue marl series.

SUMMARY

(1) The Siemień beds represent sedimentary series 8 m thick, comprising 2.5 m of marly deposits and about 5.5 m of quartz-glauconite sands with phosphorites at the base and noncalcareous gaizes at the top.

(2) Marly part of the Siemień beds yields rich microfaunal assemblage comprising foraminifera, ostracods and calcareous nannoplankton.

(3) Foraminiferal assemblage of the Siemień beds differs markedly from those known from northern and south-western Poland.

(4) This assemblage represents the lowermost foraminiferal zone of the Upper Eocene — *Globigerina semiinvoluta* Zone; in turn, nannoplankton is typical of the NP-17 Zone.

(5) Foraminiferal assemblage of the Siemień beds is characterized by especially heavy ornamentation, indicating development in well-oxidated environment; foraminiferal spectrum is typical of medium deep shelf waters (80—100 m deep).

(6) The presence of globigerinids and globorotalids and the lack of nummulites and miliolids in the foraminiferal assemblage of the Siemień beds indicates that it belonged to peripheral, most northerly extensions of the Meridional (non Mediterranean), i.e. transitional province, indirectly connected with the Tethys (Pożaryska 1976). Planktonic foraminifera are dwarfish, poorly developed.

(7) Transgression responsible for formation of the Siemień beds undoubtedly came from the east by seaway passing to the north of Ukrainian crystalline massif and utilizing old tectonic frame — so called Dnepr-Donetz aulacogen and its westward extensions, Polesie aulacogen and the Brest-Podlasie depression. The relation of the Siemień beds to transgression

coming from the east is also supported by the finds of similar facies with similar microfauna in several localities on northern slope of the Ukrainian massif, records in Siemień of some elements known previously only from Armenia (e.g. *Trimosina sectile*), as well as by the composition of fraction of the heavy minerals, comprising several elements in the similar proportions as in the deposits from the Ukrainian massif.

(8) The largest Paleogene marine transgression in the extra-Carpathian Poland took place in the late Eocene.

DESCRIPTIONS

Family **Ataxophragmiidae** Schwager, 1877
Genus *Karreriella* Cushman, 1933
Karreriella tutkowskii Fursenko & Fursenko, 1961
(pl. 4: 7*a*-*c*)

1925. *Textularia* sp.n; Tutkowskij: pl. 23: 18—20.
1961. *Karreriella tutkowskii* Fursenko & Fursenko: 263, pl. 2: 3a, b, 4a, b.

Material. — Two well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/1
length	0.375
max. width	0.325

Description as given by Fursenko & Fursenko (1961). Variation not signifcant as shown by these authors.

Remarks. — Our specimens are very similar to the illustrated holotype.

The comparision with similar species: *Heterostomella siphonella, Karreriella eubensis, K. hantkeniana* and *K. exilis* done by Fursenko & Fursenko (op. cit.).

Occurrence. — Upper Eocene of USSR and Poland. Not common.

Family **Miliolidae** Ehrenberg, 1839
Genus *Quinqueloculina* d'Orbigny, 1826
Quinqueloculina reicheli Le Calvez, 1966
(pl. 4: 1*a*, *b*)

1966. *Quinqueloculina (Scutuloris) reicheli* Le Calvez: 403, pl. 1: 9—11.
1970. *Quinqueloculina reicheli* Le Calvez: 39, pl. 5: 3.

Material. — A single specimen, damaged.

Dimensions (in mm):

	ZPAL FXXI/2
length	0.525
max. width	0.300

Description, variation and comparison are given by Le Calvez (1966).

Occurrence. — Upper Eocene — Lower Oligocene: common in Europe.

Family **Nodosariidae** Ehrenberg, 1838
Genus *Dentalina* d'Orbigny, 1826
Dentalina inornata d'Orbigny, 1846
(pl. 2: 25)

1846. *Dentalina inornata* d'Orbigny: 44, pl. 1: 50, 51.
1919. *Dentalina rostrata* Kalkyard: pl. 4: 1.

Material. — A few specimens well-preserved.

Dimensions (in mm):

	ZPAL FXXI/3
length	1.800
max. width	0.225

Description as given by d'Orbigny (1846).

Variation not significant.

Remarks. — Our specimens correspond well with the illustrated holotype by d'Orbigny (1846).

Occurrence. — Eocene-Miocene: Europe. Not common.

Dentalina vertebralis albatrossi (Cushman, 1923)
(pl. 2: 26)

1923. *Nodosaria vertebralis albatrossi* Cushman: 87, pl. 15: 1.
1949. *Dentalina vertebralis albatrossi* (Cushman); Bandy: 54, pl. 7: 4 (*with synonymy*).

Material. — A few well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/4
length	1.200
max. width	0.150

Description as given by Cushman (1923), completed by Bandy (1949).

Occurrence. — Eocene-Recent: Europe (France, Italy, USSR, Poland), USA, Jamaica.

Genus *Lagena* Walker & Boys, 1784
(pl. 1: 1—3, 5—10)

Several species of *Lagena* are fairly common in the Siemień beds. They are usually represented by ornamented, typical Tertiary forms, the majority of which are known to occur up to the present. According to Murray (1973) all recent *Lagena* are widely distributed throughout continental shelves, their littoral zones and the whole inner and outer shelf zones.

In the Siemień beds the following species were recorded: *Lagena asperoides* Galloway & Morrey, ZPAL FXXI/5; *L. hexagona* (Williamson), ZPAL FXXI/10; *L. vulgaris* Williamson, ZPAL FXXI/17; *L. semiornata* Terquem & Terquem, ZPAL FXXI/15; *L. cf. bermudezi* Gamez, ZPAL FXXI/6; *L. lacunocostata* Cushman & Jarvis, ZPAL FXXI/13; *L. mariae* Karrer, ZPAL FXXI/14; *L. sulcata strumosa* Reuss, ZPAL FXXI/16; *L.* cf. *florida* Terquem, ZPAL FXXI/7.

Genus *Lenticulina* Lamarck, 1804
Lenticulina gorynica Fursenko & Fursenko, 1961
(pl. 2: 23*a*, *b*)

1961. *Lenticulina (Lenticulina) gorynica* Fursenko & Fursenko: 268, pl. 3: *a*, *b*.

Material. — Several well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/18
largest diameter	0.500
smallest diameter	0.450

Description, variation and comparison with other similar species as given by Fursenko & Fursenko (1961).

Remarks. — Our specimens have five chambers instead of six as in the illustrated holotype. Other features are the same, so our specimens fall well within the limits of variation of this species.

Occurrence. — Upper Eocene: USSR and Poland. Common.

Lenticulina grodnensis Fursenko & Fursenko, 1961
(pl. 1: 2, 3)

1961. *Lenticulina (Lenticulina) grodnensis* Fursenko & Fursenko: 268, pl. 2: 8a, b.

Material. — Several well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/20
length	1.125
max. width	1.050

Description, variation and comparison with similar species are given by Fursenko & Fursenko (1961).

Remarks. — Our specimens fall well within the variation of this species described by Fursenko & Fursenko (1961). Some are exactly corresponding to the illustrated holotype.

Occurrence. — Upper Eocene of USSR and Poland.

Genus *Marginulinopsis* Silvestri, 1904
Marginulinopsis behmi (Reuss, 1866)
(pl. 2: 27*a*, *b*; pl. 3: 1—9; pl. 8: 1*a*-*c*)

1866. *Cristellaria (Marginulina) behmi* Reuss: 138, pl. 2: 37.
1969. *Marginulina behmi* (Reuss 1866); Kraeva & Zerneckij: 60, pl. 21: 5*a*, *b*. 6*a*, *b*. (*with synonymy*).
1975. *Marginulina behmi* (Reuss, 1866); Samuel: 126, pl. 65: 11.

Material. — Several specimens, some of them damaged.
Dimensions (in mm):

	ZPAL FXXI/24
length	1.475
max. width	0.425

Description and comparison with other species are given in Reuss' paper (1866).

Variation considerable, primarily concerning general shape of test and the evolutness of the early portion of test.

Remarks. — Only some of our specimens agree with the illustrated holotype. Most of them have well developed ribs on the two or three last chambers of test. Sometimes these ribs instead of tubercles are developed also on the early portion of test. *Marginulinopsis behmi* (Reuss) is a very characteristic species for the lower horizon of Upper Eocene. The most similar species with *Marginulinopsis behmi* (Reuss) is *Marginulina infracompressa* Thalmann.

Occurrence. — Eocene-Oligocene: common in Europe.

Genus *Saracenaria* d'Orbigny, 1824

Saracenaria arcuata (d'Orbigny, 1846)

(pl. 2: 22*a*, *b*)

1846. *Cristellaria arcuata* d'Orbigny: 87, pl. 3: 34—36.
1969. *Saracenaria arcuata* (d'Orbigny); Kraeva & Zerneckij: pl. 22: *2a*, *b* (*with* synonymy).

Material. — A few well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/37
length	0.875
max. width	0.500

Description and comparison given in d'Orbigny's (1846) and Subbotina's (1953) papers.

Variation not significant, it applies only to the ratio length/thickness of the test.

Remarks. — Our specimens fall within variation of this species and they agree with the illustrated holotype.

Occurrence. — Upper Eocene-Miocene: Europe, not common.

Genus *Guttulina* d'Orbigny, 1839

Guttulina communis (d'Orbigny, 1826)

(pl. 4: 3*a*, *b*)

1826. *Polymorphina (Guttulina) communis* d'Orbigny: 266, pl. 12: 1—4.
1949. *Guttulina communis* (d'Orbigny); Bandy: 66, pl. 9: 12a, b.
1965. *Guttulina communis* d'Orbigny; Pożaryska: 83, pl. 12: 1a, b.

Material. — 10 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/38
length	0.900
max. width	0.775

Description as given by Bandy (1949) and Pożaryska (1965). Variation not significant.

Remarks. — Our specimens are very similar to the illustrated holotype by d'Orbigny (1826). Described presumably under several specific names.

Occurrence. — Paleocene-Miocene: Europe. Known from the USA and Mexico.

Genus *Fissurina* Reuss, 1850

Fissurina marginata (Walker & Boys, 1784)

(pl. 1: 4*a*-*c*)

1957. *Fissurina marginata* (Walker & Boys); Pożaryska: 61, pl. 5: 5; pl. 6: 4 (*with synonymy*).

Material. — Some dozens of specimens or so.

Dimensions (in mm):

	ZPAL FXXI/40
length	0.375
max. width	0.325

Description and variability as given in Pożaryska's paper (1957).

Occurrence. — A very common species known from Cretaceous up to recent.

Family **Polymorphinidae** d'Orbigny, 1839

Genus *Raphanulina* [2] Zborzewski, 1834

Raphanulina gibba (d'Orbigny, 1826)

(pl. 4: 5*a*, *b*)

1826. *Globulina gibba* d'Orbigny: 266, fig. 63.
1949. *Raphanulina gibba* (d'Orbigny); Bandy: 70, pl. 10: 4a, b.
1965. *Globulina gibba* d'Orbigny; Pożaryska, 86, pl. 13: 3 (*with synonymy*).

Material. — 16 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/190
length	0.950
max. width	0.775

Description as given by previous authors (d'Orbigny 1826, Cushman 1951, Olsson 1960, Pożaryska 1965).

Variation of a considerable degree. It applies to the general shape and chambers not equally overlapping each other.

Remarks. — Our specimens cannot be compared with the holotype which is lost. They are much more globular than American representatives of this species, described by Bandy (1949).

Occurrence. — Paleocene-Miocene: Europe, N. America. Common.

Raphanulina inaequalis (Reuss, 1850)

(pl. 4: 6)

1850. *Globulina inaequalis* Reuss: 377, pl. 48: 9.
1949. *Raphanulina inaequalis* (Reuss); Bandy: 70, pl. 10: 5a, b (*with synonymy*).

Material. — Some specimens well-preserved.

Dimensions of one specimen (in mm):

	ZPAL FXXI/191
length	0.550
max. width	0.325

Description as given by Reuss (1850) and completed by Bandy (1949).

Variation rather significant in general shape of test, which can be more or less elongated and compressed.

Remarks. — Our specimens are much more elongated in comparison with the holotype illustrated by Reuss (1950). Very similar to *Raphanulina guttula* (Reuss, 1951).

Occurrence. — Eocene-Miocene: Europe, N. America, Mexico.

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[2] *Raphanulina* is incorrectly called *Globulina* by most authors, although Zborzewski's name is valid and was published five years before that of d'Orbigny's (Bandy, 1949).

Raphanulina tuberculata (d'Orbigny, 1846)
(pl. 14: 3)

1846. *Globulina tuberculata* d'Orbigny: 230, pl. 13: 21, 22.

Material. — Two well-preserved specimens.
Dimensions of one specimen (in mm):

	ZPAL FXXI/192
length	0.250
max. width	0.225

Description as given by d'Orbigny (1846).
Variation not known because of scarcity of material.
Remarks. — Our specimens are very similar to the holotype illustrated by d'Orbigny (1846). The only difference is in tubercles which are blunt in Polish specimens, what depends possibly on the state of preservation of the material.
Occurrence. — Eocene: France, Germany, Austria and USA.

Family **Turrilinidae** Cushman, 1927
Genus *Turrilina* Andreae, 1884
Turrilina alsatica Andreae, 1884
(pl. 10: 2)

1884. *Turrilina alsatica* Andreae: 212, pl. 8: 18, 19.

Material. — A single, well-preserved specimen.
Dimensions (in mm):

	ZPAL FXXI/41
length	0.200
max. width	0.175

Description as given by Andreae (1884) and completed by Fursenko & Fursenko (1961). Variation not significant, according to the latter authors.
Remarks. — Our specimen is very similar to the holotype illustrated by Andreae (1884). This species is characteristic for higher horizon of Upper Eocene. In Siemień it is his first appearance.
Occurrence. — Upper Eocene — Oligocene: Germany, USSR and Poland.

Family **Bolivinitidae** Cushman, 1927
Genus *Bolivina* d'Orbigny, 1839
Bolivina cookei Cushman, 1922
(pl. 9: 3)

1922. *Bolivina cookei* Cushman: 126, pl. 29: 1.
1961. *Bolivina cookei* Cushman; Kaasschieter: 195, pl. 8: 25, 26.

Material. — 10 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/42
length	0.375
max. width	0.200

Description as in Cushman's paper (1922), variation described by Kaasschieter (1961).

Remarks. — Our specimens are corresponding to the holotype illustrated. They are similar also to some illustrations of *Bolivina striatellata* Bandy (1949). Similar specimens were also described in the USSR under names *Bolivina adjiderensis* Khalilov and *B. antegressa* Subbotina.

Occurrence. — Eocene-Oligocene: widely distributed in Europe, known in USA.

Bolivina microlancetiformis Subbotina, 1953
(pl. 10: 1, 9)

1953. *Bolivina microlancetiformis* Subbotina: 222, pl. 10: 5—7.
1961. *Bolivina microlancetiformis* Subbotina; Fursenko & Fursenko: 309, pl. 9: 2a, b, 3.

Material. — 7 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/44
length	0.375
width	0.100

Description and variation as given by Subbotina (1953), completed by Fursenko & Fursenko (1961).

Remarks. — Our specimens are well corresponding to the holotype illustrated by Subbotina, as to those described by Fursenko & Fursenko (op. cit.). The minute „ribs" presented by these authors on the surface in reality are minute fissures, to be seen only in SEM.

Occurrence. — Upper Eocene: USSR and Poland.

Bolivina reticulataformis Khalilov, 1956
(pl. 9: 8)

1956. *Bolivina reticulataformis* Khalilov: 201, pl. 3: 11, 12.
1961. *Bolivina reticulataformis* Fursenko & Fursenko: 312, pl. 9: 7a, b (*non* 8).

Material. — A few well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/47
length	0.325
max. width	0.150

Description and variation are given in detail in Fursenko & Fursenko (1961).

Remarks. — Our specimens are similar to the illustration presented by Fursenko & Fursenko (1961: pl. 9: 7). But all these ornamented species of *Bolivina* have rather significant variation and mixed features in ribs. This is why it is rather difficult to prove the differences within them.

Bolivina striatellata Bandy, 1949
(pl. 3: 1—8; pl. 9: 1, 2, 5, 6, 7)

1949. *Bolivina striatellata* Bandy: 129, pl. 24: 8.

Material. — 5 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/48
length	0.350
max. width	0.200

Description as given by Bandy (1949).

Remarks. — Our specimens are similar to the illustrated holotype. But there is only small difference within *Bolivina cookei* Cushman and *B. striatellata*, concerning only the length of longitudinal ribs. This is why it is very easy to mix these two similar species.

Occurrence. — Eocene: USA and Poland. Not common.

Family **Buliminidae** Jones, 1875

Genus *Bulimina* d'Orbigny, 1826

Bulimina ovata d'Orbigny, 1846

(pl. 2: 24*a-c*)

1846. *Bulimina ovata* d'Orbigny: 185, pl. 11: 13.

1961. *Bulimina ovata* d'Orbigny; Fursenko & Fursenko: 315, pl. 9: 10, 11. (*with synonymy*).

Material. — 10 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/62
length	0.550
max. width	0.275

Description as given by Fursenko & Fursenko (1961).

Variation not significant. It applies mainly to the ratio length/width.

Remarks. — Our specimens are well corresponding to the holotype illustrated by d'Orbigny (1846).

Occurrence. — Paleocene-Miocene-Recent?: Europe. USA, Mexico.

Bulimina striatopunctata (Terquem), 1882

(pl. 10: 6)

1882. *Bulimina striato-punctata* Terquem: 116, pl. 12: 19.

1970. *Buliminella striatopunctata* (Terquem); Le Calvez: 109, pl. 23: 3.

Material. — 3 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/63
length	0.600
max. width	0.150

Description as given by Terquem (1882) and completed by Le Calvez (1970).

Variation not known because of scarcity of material.

Remarks. — Our specimens correspond with the specimen ilustrated by Le Calvez (1970).

Occurrence. — Eocene: France and Poland.

Bulimina subtruncana Hagn, 1954

(pl. 9: 4)

1947. *Bulimina truncana* Cushman & Parker (not Gümbel); Cushman & Parker: 89, pl. 21: 7, 8.

1954. *Bulimina subtruncana* Hagn: 17, pl. 4: 9.

Material. — 2 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/64
length	0.425
max. width	0.225

Description given in Hagn's paper (1954).

Remarks. — Our specimens do not differ from those illustrated by Hagn (fig. 9). Hagn illustrated not only specimens from *C. szaboi* beds in Hungary but also some Cushman's and Parker's specimens from the east coast of USA.

Occurrence. — Upper Eocene: very rare in Poland, Middle and Upper Eocene: Hungary, Germany (Alps), France (Aquitan Basin) and Italy (Alps).

Genus *Trimosina* Cushman, 1927

Trimosina sectile (Ter- Grigorjanc, 1965)

(pl. 13: 1)

?1939. *Bulimina* (?) *petalifera* Howe: 63, pl. 9: 22, 23.
1965. *Caucasina* (?) *sectile Ter-Grigorjanc*: 231, pl. 5: 10.

Material. — 17 specimens, most of them well preserved.

Dimensions (in mm):

	ZPAL FXXI/65
length	0.300
max. width	0.250

Description as given by Ter-Grigorjanc (1965).

Variation significant, concerning mainly character of chambers, which are ended by a prolongation, spine-like, more or less long, blunt at the end. These spines are accompanied by smaller ones and sometimes by coarse granulation in the form of small papillae. Sometimes there are three distinct spines at the end of each chamber, the central one longer. This very peculiar species has big pores, absent on the portion of test surrounding the aperture. The aperture is large, broad, rather deep umbilical hole, bordered by a half-moon like, narrow, non perforate lip starting from the outer edge of last formed chamber and going quickly down into umbilicus. The same type of aperture is developed in *Caucasina* specimens occurring in Upper Eocene of Siemień.

Remarks. — Our specimens differ from the description and illustration of holotype described by Ter-Grigorjanc (1965) from Armenia in having better developed spines and granulation obscuring the arrangement of chambers. The type of aperture and morphology of test and ornamentation are nearly the same as in the holotype. Similar to *Trimosina sectile* are the following species: *Buliminella mamilligera* Klasz and Rerat, *Textilaria (Bitubulogenerina) mamilleta* Terquem.

Occurrence. — Upper Eocene mainly, rare in Lower Oligocene: Caucasus, Ukraine; Upper Eocene of Poland.

Family **Uvigerinidae** Haeckel, 1894

Genus *Uvigerina* d'Orbigny, 1826

Uvigerina costellata Morozova, 1939

(pl. 2: 18*a*, *b*, 19; pl. 10: 3)

1939. *Uvigerina costellata* Morozowa: 76, pl. 2: 5.
1951. *Uvigerina costellata* Morozova; Kaptarenko-Tshernousova: pl. 7: 3.
1953. *Uvigerina costellata* Morozova; Subbotina: 237, pl. 11: 14—15.
1961. *Uvigerina costellata* Morozova; Fursenko & Fursenko: 317, pl. 10: 1a, b, 2, 3.

Material. — 77 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/75
length	0.300
max. width	0.225

Description given in Morozova's paper (1939).

Variation rather significant in the thickness of test, which can be more elongated and thinner, or short, thick and stocky. Ribs are better developed on the short specimens, less developed on the more elongated specimens.

Remarks. — Our specimens are very similar to the holotype illustrated by Morozova. This species is the most similar to *Uvigerina pygmea* d'Orbigny, differing in broad, plate-like, serrate costae. On the other hand *Uvigerina costellata* is very close to *Uvigerina jacksonensis* Cushman and *U. danvillensis* Howe & Wallace, and *U. spinicostata* Cushman & Jarvis differing from all these species in the unique character of its costae.

Occurrence. — Very common in the Upper Eocene of Europe. Very similar costate *Uvigerina* are common in contemporaneous deposits from N. America.

Uvigerina hispida Schwager, 1866
(pl. 10: 5)

1953. *Uvigerina hispida* Schwager; Subbotina: 235, pl. 114: 11—13.
1961. *Uvigerina hispida* Schwager; Fursenko & Fursenko: 319, pl. 10: 4.

Material. — 2 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/78
length	0.425
max. width	0.250

Description as given in Subbotina's and Fursenko & Fursenko (op. cit.). Variation not know, because of scarcity of material everywhere.

Remarks. — This species is very characteristic by its peculiar ornamentation, which is joining short ribs developed on the earlier portion of test with tubercles on the later portion. It appears in the higher part of Siemień beds.

Occurrence. — Upper Eocene: Poland, widely distributed in USRR.

Uvigerina spinicostata Cushman & Jarvis, 1929
(pl. 2: 20, 21; pl. 10: 4)

1922. *Uvigerina spinicostata* Cushman & Jarvis: 12, pl. 3: 9,10.

Material. — 50 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/79
length	0.500
max. width	0.250

Description given in Cushman and Jarvis (1929). Test elongated; chambers more or less inflated, rapidly increasing in size when added; sutures strongly depressed. Wall of all the chambers covered by well-developed costae, which are continuous with a prolongation on other chambers. Aperture terminal, rounded, on the unperforate neck, with a lip. The beginning of the test broadly rounded or blunt.

Variation significant. It concerns size, general shape of test and the degree of inflation of chambers. Ribs, costae-like, may cover not only the whole surface of last chamber but also the neck.

Remarks. — Our specimens are more similar to that of *Uvigerina spinicostata* Cushman & Jarvis illustrated by Drooger (1969) from Eocene-Oligocene of Kallo boring (Belgium) and to specimens illustrated by Kaasschieter (1961) from clays of Asse, than to the holotype illustrated by Cushman & Jarvis (1929). Cushman's & Jarvis' holotype from Cipero section of Trinidad has ribs independent on each chamber and "earlier portion of test is broken up into spinose projections", i.e. features not observed at all on Polish specimens nor on Belgian ones. This is why our specimens are assigned to the *Uvigerina spinicostata* species with reservation. A very similar species occurs in Pliocene beds. It is *Uvigerina peregrina* Cushman (Recent), described among others by Berggren (1972), from deep sea drilling in North Atlantic.

Species reported from the Eocene beds of Soviet Union, *Uvigerina costellata* Morozova is similar to European assemblage of *Uvigerina* cf. *spinicostata* Cushman & Jarvis, but it has high, well-developed plate-like costae, which are discontinuous from chamber to chamber and sometimes broadly spread out like wings with scalloped edges, becoming spinose at the early portion of test.

Occurrence. — Very common in Upper Eocene-Oligocene of Europe. Very similar species occur in N. America.

Genus *Trifarina* Cushman, 1923

Trifarina labrum Subbotina, 1953

(pl. 3: 1—8)

1953. *Trifarina labrum* Subbotina: 247, pl. 13: 8a—b.
1961. *Trifarina labrum* Subbotina; Fursenko & Fursenko: 321, pl. 10: 6a—w.
non 1969. *Trifarina labrum* N. Bykova; Kraeva & Zerneckij: 156, pl. 71: 6a—b.

Material. — A dozen well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/100
length	**0.375**
max. width	**0.175**

Description. — Test small, elongate; with margins becoming very quick parallel each other; triserial part very short, uniserial portion of test rather long. Chambers numerous, low, three times broader than high, regularly, slowly tapering. Sutures distinct, very weakly depressed, curved. Margins broadly rounded. Surface smooth. Aperture terminal on the top of test on a very low neck, with an uvigerina-like lip.

Variation very weak, mainly in margins more or less parallel and more or less incised by sutures.

Remarks. — Our specimens do not differ from the holotype from the Upper Eocene of Kiev stage, Kharkov region, illustrated by Subbotina (1953). The most similar species is *Trifarina wilcoxensis* (Cushman & Ponton) from the Eocene of Alabama, differing mainly by sharp, not rounded margins.

Occurrence. — Common in Upper Eocene beds of USSR and in Poland. It seems quite possible that in other countries the same species is described under the name of *Trifarina wilcoxensis* (Cushman & Ponton).

Family **Discorbidae** Ehrenberg, 1838

Genus *Baggina* Cushman, 1926

Baggina iphigenia (Samoilova, 1947)

(pl. 11: 2, 4)

1947. ***Baggina iphigenia*** Samoilova: 92, figs 24—26.
1953. ***Baggina iphigenia*** Samoilova; Mjatliuk: 97, pl. 12: 8.
1961. ***Baggina iphigenia*** Samoilova; Fursenko & Fursenko: pl. 5: 1a-g.

Material. — 10 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/109
smallest diameter	0.400
largest diameter	0.350

Description as given by Samoilova (1947) and Fursenko & Fursenko (1961). This species is similar to *Baggina subconica* (Terquem), but it has less opened umbilicus and less developed but more porous tena.

Occurrence. — Upper Eocene-Lower Oligocene: USSR (common in Crimea, Carpathians, Byelorussia), Poland.

Baggina subconica (Terquem, 1882)

(pl. 11: 1)

1882. ***Rotalina subconica*** Terquem: 61, pl. 6: 5a-c.
1949. ***Valvulineria subconica*** (Terquem); Le Calvez: 26, pl. 5: 87—89.
1961. ***Cancris subconicus*** (Terquem); Kaasschieter: 213, pl. 12: 6—8.
1970. ***Cancris subconicus*** (Terquem); Le Calvez: 145, pl. 43: 6.

Material. — 20 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/111
length	0.450
max. width	0.350

Description. — Test trochospiral, subglobular, with 5—6 chambers slightly inflated, rapidly increasing in size as added; the last chamber generally very big somewhat overlapping on spiral side, closed umbilicus on ventral side. Around umbilicus small, weakly developed, nonporous tena occur, well seen in micrographs, sutures distinct, weakly depressed, curved; aperture — an umbilical opening below unperforate lunate area in face of final chamber. Wall smooth.

Variation. — Some variation was found in the curvature of sutures of the dorsal side. Some specimens have a slightly lobulate periphery. The last chamber has the lobe variously developed.

Remarks. — Our specimens differ somewhat from the holotype illustrated by Terquem (1882) and revised by Le Calvez (1949) in not having such well-developed lobes of last chamber but our specimens are very similar to those described subsequently by Le Calvez (1970). Specimens described and illustrated from Eocene of Belgium by Kaasschieter (1961) differ from the holotype and from our material by having well-developed inner spire on dorsal side, never observed in forms from France nor Poland. The number of chambers is there also bigger and sutures not curved. Species described from USSR as *Baggina iphigenia* (Samoilova) seems to be similar to *Baggina subconica* (Terquem). Small difference is found only in the shape of aperture, slit-like in the latter and in the lack of the open umbilicus.

Occurrence. — Upper Eocene-Oligocene: Europe, common. A similar form is described from the European part of USSR and Asia as *Baggina iphigenia* (Samoilova).

Family **Asterigerinidae** d'Orbigny, 1839

Genus *Asterigerina* d'Orbigny, 1839

Asterigerina falcilocularis Subbotina, 1960

(pl. 4: 2*a*-*c*; pl. 11: 3)

1958. *Asterigerina bracteata* Kraeva: 75, pl. 1: 4.
1960. *Asterigerina falcilocularis* Subbotina: 194, pl. 6: 12, 13.
1961. *Asterigerina falcilocularis* Subbotina; Fursenko & Fursenko: 285, pl. 6: 4a-w.

Material. — 9 specimens well-preserved.

Dimensions (in mm):

	ZPAL FXXI/113
largest diameter	0.250
smallest diameter	0.225

Description as given by Subbotina (1960) and Fursenko & Fursenko (1969).

Remarks. — Our specimens are very similar to those described from Byelorussia by Fursenko & Fursenko (1969). Sometimes they have only 5 petaloids instead of 6 ones. Amount of apertural tubercles is not stable in all specimens. Sometimes tubercles enter into the central part of the umbilical side, penetrating also into sutures.

Occurrence. — Upper Eocene: Byelorussia, Poland. Not common.

Family **Elphidiidae** Galloway, 1933

Genus *Cribrononion* Thalmann, 1947

Cribrononion nonioninoides (Fursenko & Fursenko, 1961)

(pl. 5: 4*a*-*c*)

1961. *Anomalina (Anomalina) nonioninoides* Fursenko & Fursenko: pl. 6: 7a-w.

Material. — 30 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/118
largest diameter	0.46
smallest diameter	0.43

Description and comparison with other species as given by Fursenko & Fursenko (1961).

Variation not significant, concerning only the amount of glassy filling in the umbilicus.

Occurrence. — Upper Eocene: Byelorussia and Poland.

Cribrononion subnodosum (Roemer, 1838)

(pl. 10: 7)

1961. *Elphidium subnodosum* (Roemer); Kaasschieter: 239, pl. 16: 17, 18.
1969. *Cribrononion subnodosum* (Roemer); Drooger: 25, pl. 5: 3, 4.

Material. — 17 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/119
largest diameter	0.500
smallest diameter	0.450

Descriptions are given by Cushman (1939) and several remarks added by Kaasschieter (1961) and Drooger (1969).

Variation is rather significant.

Remarks. — Our specimens are rather flattened and on both sides they have distinct small depressions (holes) and several tubercles not observed by Drooger (1969) on the Belgian material. They have distinct sutural openings.

Occurrence. — Upper Paleocene-Oligocene: common in Europe.

Family **Globorotaliidae** Cushman, 1927

Genus *Turborotalia* Cushman & Bermudez, 1949

Turborotalia centralis (Cushman & Bermudez, 1937)

(pl. 4: 8*a-c*)

1937. *Globorotalia centralis* Cushman & Bermudez: 26, pl. 2: 62—65.
1971. *Turborotalia centralis* Cushman & Bermudez; Pożaryska & Locker: 60, pl. 1: 1a-c (*with synonymy*).

Material. — A dozen of specimens. Some of them have last chamber damaged.
Dimensions (in mm):

	ZPAL FXXI/120
largest diameter	0.275
smallest diameter	0.250
height	0.12

Description as given by Cushman & Bermudez (1937) and Pożaryska & Locker (1971).

Remarks. — Specimens found in Upper Eocene of Siemień are generally badly developed and dwarfish, presumably representing young ontogenetical stages.

Occurrence. — Uppermost Middle Eocene-Upper Eocene: common in Tethys region, occasionally found in epicontinental region.

Genus *Truncorotaloides* Bronnimann & Bermudez, 1953

Truncorotaloides rohri Bronnimann & Bermudez, 1953

(pl. 12: 2—4)

1953. *Truncorotaloides rohri* Bronnimann & Bermudez: 818, pl. 87: 7—9.
1953. *Globorotalia crassa* Cushman; Beckmann: 396, pl. 26: 10—11.
1957. *Truncorotaloides rohri* Bronnimann & Bermudez; Bolli: Loeblich & Tappan, 170, pl. 39: 8—12.

Material. — A dozen of specimens or so.
Dimensions (in mm):

	ZPAL FXXI/121
largest diameter	0.245
shortest diameter	0.170
height	0.145

Description and variability as given by Bronnimann & Bermudez (1953) and Bolli *et al* (1957).

Remarks. — Our specimens have chambers more spherical and ornamentation not so well developed. Specimens found in the Siemień beds are not numerous, generally badly developed and dwarfish.

Occurrence. — Uppermost Middle Eocene — Upper Eocene: common in Tethys region, occasionally found in epicontinental regions.

Genus *Globigerina* d'Orbigny, 1826

Globigerina praebulloides praebulloides Blow, 1962

(pl. 4: 9*a*-*c*)

1962. *Globigerina praebulloides praebulloides* Blow: 92, pl. 9: o, p, q.
1971. *Globigerina praebulloides preabulloides* Blow; Pożaryska & Locker: 60, pl. 1: 3a-c.
1975. *Globigerina praebulloides praebulloides* Blow; Samuel: 158, pl. 41: 2—4.

Material. — 15 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/123
largest diameter	0.325
smallest diameter	0.275

Description as given by Blow (1962).

Variation not significant.

Remarks. — Our specimens do not differ from the holotype illustrated and described by Blow (1959). Banner and Blow (1960) suggested to consider this species as an ancestor of the recent living *Globigerina bulloides* d'Orbigny.

Occurrence. — Uppermost Middle Eocene-Miocene: common in Tethyan region, rather scarce in epicontinental regions.

Genus *Acarinina* Subbotina, 1953

Acarinina rugosoaculeata Subbotina, 1953

(pl. 12: 1*a*, *b*, 2, 3)

1953. *Acarinina rugosoaculeata* Subbotina: 7235, pl. 25: 4—6.
1961. *Acarinina rugosoaculeata* Subbotina; Fursenko & Fursenko: 307, pl. 8: 7a-w.

Material. — 22 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/125
largest diameter	0.250
smallest diameter	0.225

Description as given by Subbotina (1953) and Fursenko & Fursenko (1961).

Variability concerning mainly the number of chambers in the last whorl, from four to five. Specimens from Poland have 4 chambers up 4.5 ones.

Remarks. — Our specimens are very similar to those described from the Upper Eocene of Byelorussia (USSR). The comparison of this species with similar ones like *Acarinina rotundimarginata* Subbotina, *A. pentacamerata* (Subbotina) and *A. acarinata* Subbotina, is given in Fursenko & Fursenko's paper (1961).

Occurrence. — Upper Eocene of USSR and Poland.

Family **Eponididae** Hofker, 1951

Genus *Eponides* de Montfort, 1888

Eponides candidulus (Schwager, 1883)

(pl. 5: 3*a-c*; pl. 7: 1*a-c*)

1883. *Pulvinulina candidula* Schwager: 133, pl. 28(5): 10a-b.
1944. *Eponides candidulus* (Schwager); Ten Dam: 119, pl. 4: 4a-c.

Material. — 5 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/129
length	0.725
max. width	0.650

Description, variation are given by Ten Dam (1944).

Remarks. — Our specimens are more similar to the Dutch ones, than to the holotype illustrated from Egypt as they have no central plug on the umbilical side of test. *Eponides candidulus* somewhat resembles *E. toulmini* Brotzen. But these species differ because first of them has high spiral side, while the second of them has high umbilical side. Moreover *E. candidulus* has broadly rounded keel, while the *E. toulmini* has periphery subangular. Pores are larger in the *E. toulmini*, and much more smaller and dense at the *E. candidulus*.

Occurrence. — Middle and Upper Eocene: Europe, rare (in USSR it occurs in the Black Sea Depression only), N. Africa.

Genus *Neoeponides* Reiss, 1960

Neoeponides schreibersi (d'Orbigny, 1846)

(pl. 5: 2*a-c*)

1846. *Rotalina schreibersi* d'Orbigny: 154, pl. 8: 4—6.
1961. *Eponides schreibersi* (d'Orbigny); Kaasschieter: 210, pl. 11: 14, 15.
1970. *Eponides schreibersi* (d'Orbigny); Kiesel: 292, pl. 16: 15; pl. 17: 3 (*with synonymy*).
1970. *Neoeponides schreibersi* (d'Orbigny); Le Calvez: 177, pl. 42: 3.

Material. — 7 specimens, most of them have last chamber damaged.

Dimensions (in mm):

	ZPAL FXXI/131
length	0.550
max. width	0.475

Description, variation and comparison are given by Kaasschieter (1961) and Kiesel (1970).

Remarks. — Our specimens are very similar to the holotype illustrated by d'Orbigny. They are only not so high on spiral side and have outer margin of test better marked by a rim of clear shell material. Our specimens correspond well to the meaning of this species as interpreted by Kassschieter (1961) and Kiesel (1970) as well. The American species described by Cushman as a *Pulvinulina (recte Eponides) mexicanus* seems to be conspecific with European *Neoeponides schreibersi* (d'Orbigny).

Occurrence. — Species characteristic of Upper Eocene beds in Europe and, presumably, of America (the case of *Eponides mexicanus* (Cushman)).

Family **Amphisteginidae** Cushman, 1927

Genus *Amphistegina* d'Orbigny, 1826

Amphistegina cf. *nucleata* Terquem, 1882

(pl. 14: 1*a*-*c*, 2*a*, *b*)

Material. — 2 specimens, somewhat damaged.

Dimensions (in mm):

	ZPAL FXXI/132
largest diameter	**0.950**
smallest diameter	**0.900**

Remarks. — Supplementary chambers are not to be seen. Our specimens seem do not differ from the holotype of *Amphistegina nucleata* described by Terquem (1882) from Paris Basin, having the same type of central plug, but the state of preservation and scarcity of material do not permit to include them with certainty to this species.

Occurrence. — Upper Eocene: Poland. Very rare.

Family **Cibicididae** Cushman, 1927

Genus *Cibicides* de Montfort, 1808

Cibicides fortunatus Martin, 1943

(pl. 7: 2*a*-*c*; pl. 13: 2, 3)

1943. *Cibicides fortunatus* Martin: 121, pl. 8: 5.
1953. *Cibicides pharaonis* Le Roy: 24, pl. 7: 9—11.
1961. *Cibicides biumbonatus* Fursenko & Fursenko: 300, pl. 7: 7.

Material. — A dozen of specimens or so, well-preserved.

Dimensions (in mm):

	ZPAL FXXI/134
largest diameter	0.475
smallest diameter	0.375

Description as given by Martin (1943).

Remarks. — Our specimens differ from the holotype illustrated by Martin (1943) in having 11 chambers instead of 10 in the last whorl and by a small umbilical depression in the central plug on the umbilical side. In this respect is more similar to *Cibicides biumbonatus* Fursenko & Fursenko (1961). But this small detail does not change the idea that the last species is conspecific with *C. fortunatus* Martin, having all other specific features in common, same as in the case of *C. pharaonis* Le Roy (1953).

Occurrence. — Eocene (including Paleocene): Lodo Fm. of USA; Upper Eocene: Byelorussia (USSR) and Poland, common; Egypt (?).

Cibicides karpaticus Mjatliuk, 1956

(pl. 8: 4)

1956. *Cibicides karpaticus* Mjatliuk: 283, pl. 4: 7.
1961. *Cibicides* (*Cibicidoides*) *karpaticus* Mjatliuk; Fursenko & Fursenko: 295, pl. 8: 2a-w.

Material. — A few well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/139
largest diameter	0.475
smallest diameter	0.300

Description as given by Mjatliuk and completed by Fursenko & Fursenko.

Variation rather significant in general size, proportion of the convexity of both sides as well as in the length of the aperture, which can have its continuation on the spiral side.

Remarks. — Our specimens seem not to differ from the holotype illustrated by Mjatliuk (1956), as well as from specimens described from Byelorussia (USSR) by Fursenko & Fursenko (1961).

Occurrence. — Upper Eocene: rather common in epicontinental regions.

Cibicides lobatulus (Walker & Jacob, 1798)

(pl. 6: 1—4)

1798. *Nautilus lobatulus* Walker & Jacob; Adams essays Kanmacher's ed.: 642, pl. 14: 36.
1931. *Cibicides lobatulus* (Walker & Jacob); Cushman: 118, pl. 21: 3a-c.
1958. *Cibicides lobatulus* (Walker & Jacob); Batjes: 153, pl. 9: 7, 8.
1961. *Cibicides lobatulus* (Walker & Jacob); Kaasschieter: 221, pl. 14: 6a-c (*with synonymy*).
1970. *Cibicides lobatulus* (Walker & Jacob); Le Calvez: 181.

Material. — Some dozen specimens, most of them well-preserved.

Dimensions (in mm):

	ZPAL FXXI/140
length	0.550
max. width	0.475

Description, variation and comparison are given by Batjes (1958) and Kaasschieter (1961).

Remarks. — Our specimens differ from the holotype described and figured by Walker & Jacob (1798) in chambers more numerous (8—9 instead of 6—7) and much more overlapping each other, with periphery of test not so deeply lobulate. Spiral side is very often not flat, but concave. Our specimens are quite similar to those described by Batjes from the Oligocene of Belgium and by Kaasschieter from the Eocene of Belgium.

Occurrence. — Thanetian-Recent; common in Upper Eocene and Oligocene of Europe; known also from America.

Cibicides oligocenicus Samoilova, 1947

(pl. 6: 1—6; pl. 7: 3*a-c*; pl. 13: 8, 9)

1947. *Cibicides dutemplei* var. *oligocenica* Samoilova: 96, figs 34—36.
1954. *Cibicides (Gemellides?) oligocenicus* Samoilova: 194, pl. 35: 2.
1961. *Cibicides (Gemellides?) oligocenicus* Samoilova; Fursenko & Fursenko: 298, pl. 7: 6a-w.

Material. — Several well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/144
largest diameter	0.675
smallest diameter	0.550

Description as given by Fursenko & Fursenko (1961).

Variation not very significant. It concerns mainly the size and development of central plug of the spiral side, and the length of aperture, which can be more or less extended into both sides of the test.

Remarks. — The detailed comparison of *Cibicides oligocenicus* Samoilova with *C. dutemplei* d'Orbigny is done by Fursenko & Fursenko (1961).

Occurrence. — Upper Eocene-Oligocene: USSR and Poland; more common in Upper Eocene beds than in Oligocene ones.

Cibicides westi arguta Bykova, 1954
(pl. 5: 5*a-c*)

1954. *Cibicides* (*Cibicides*) *westi* Howe var. *arguta* Bykova; Vassilenko: 126, pl. 18: 4a-w, 5a-w.
1970. *Cibicidoides westi argutus* (Bykova); Mjatliuk: 143, pl. 40: 3a-w.

Material. — A few well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/153
largest diameter	0.375
smallest diameter	0.300

Description as given by Bykova (*in* Vassilenko, 1954) completed by Mjatliuk (1970).

Variation not significant.

Remarks. — The comparison of *Cibicides westi arguta* Bykova with *C. westi westi* (Howe) is done by Mjatliuk (1970). Our specimens are very similar to those described by Bykova (*in* Vassilenko) and Mjatliuk.

Occurrence. — Upper Eocene: USSR, Poland. Not common.

Family **Caucasinidae** Bykova, 1959
Genus *Fursenkoina* Loeblich & Tappan, 1961
Fursenkoina halkyardi Cushman, 1936
(pl. 3: 1—9; pl. 10: 8)

1936. *Fursenkoina halkyardi* Cushman: 47, pl. 7: 5a, b.
1918. *Virgulina schreibersiana* Halkyard (not Czjzek): 48, pl. 8: 5.

Material. — Some dozens of specimens, well-preserved.

Dimensions (in mm):

	ZPAL FXXI/154
length	0.800
max. width	0.225

Description as given by Cushman (1936).

Variation significant as shown on plate 3, figs 1—9. It depends mainly on the degree of twisting the test.

Remarks. — Our specimens show the highly twisted biserial development of the test at its base. *Fursenkoina halkyardi* Cushman is very similar to *Virgulina schrei-*

bersiana Czjzek (1848), but our specimens have more elongated and more thick biserial portion of test in comparison with *V. schreibersiana*. Several Polish specimens do not differ from the illustrated holotype of *Fursenkoina halkyardi* Cushman (1936). A similar species was described from the Eocene of Pakistan (Haque 1960) under the name *Virgulina pseudoacuta*.

Occurrence. — Upper Eocene — Oligocene: common in France, Spain, USSR, Poland.

Genus *Caucasina* Khalilov, 1951

Caucasina alpina Espitalié & Sigal, 1961 emend. Pożaryska, 1975

(pl. 13: 10, 11)

1961. *Caucasina alpina* Espitalié et Sigal: 204, pl. 1: 9a-d, 10, 11.
1970. *Caucasina alpina* Espitalié et Sigal; Le Calvez: 130, pl. 25: 5, 6.

Material. — Five well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/166
length	0.200
max. width	0.175

Description. — Test small, more or less elongated, consisting of two parts. Initial part of test blunt, cut off, formed by 5—6 chambers arranged discorbine-like; subsequent part slowly enlarging, formed by 2 or 3 spirally arranged coils, with 3 chambers per whorl rapidly increasing in size when added. Last coil showing a tendency to unfolding. Chambers initially low, later inflated, but not high, and elongated. Only 3 chambers in the last whorl. Sutures distinct, depressed. Wall finely perforated. Surface smooth. Aperture large, not elongate loop at the inner margin of final chamber at right angles to sutures, with a short, narrow, not porous lip.

Variation significant, concerning size of tests and general shape. Some specimens are high-spired, another low-spired, but always widest at the last coil. This species described by Espitalié & Sigal (1961) was revised later on by Glaçon & Sigal (1974).

Remarks. — Our specimens assigned to *Caucasina alpina* are not quite the same as the holotype and the topotypes described and illustrated by Espitalié & Sigal. But among all known species of *Caucasina*, they are the most similar to *C. alpina*. However, they generally differ in shape, e.g. in more rapidly increasing test width resulting in the bowl-like shape. They are not so "bulimine" in shape as *Caucasina alpina* from the Alps, being more similar to those described by Le Calvez from Paris Basin.

The aperture in *C. alpina* was described by Espitalié & Sigal (1961) as similar to that in *Bulimina*, i.e. a loop-shaped without a lip. However, SEM studies have shown that the apertures of *Caucasina alpina* from Siemień locality are rather large, opened hole arranged by a narrow, half-moon in shape ledge, starting from the outer edge of last chamber and going rather quickly down into the umbilicus. The same type of aperture, bordered by a lip, has *Trimosina sectile*, thus it was also called *Caucasina*.

It seems that the differences in the development of aperture of *Caucasina* described by Espitalié & Sigal and specimens of *Caucasina* and *Trimosina* found by the present author in Poland are so big, that the Polish specimens may be isolated in a separate group (genus).

Recently Glaçon & Sigal (1974) described morphological details of aperture at *Caucasina*, but still it resembles *Bulimina* loop-like shape being not similar to that found at Polish specimens.

If generic characteristics depend on the initial part of test as Sigal (1961) likes, our specimens belong to *Caucasina*. But if we take into consideration the morphology of aperture, they ought to be separated from *Caucasina* genus.

Occurrence. — Priabonian: France; Upper Eocene: Poland.

Family **Nonionidae** Schultze, 1854
Genus *Nonion* de Montfort, 1808
Nonion graniferus (Terquem, 1882)
(pl. 11: 6)

1882. *Nonionina granifera* Terquem: 42, figs 8, 9.
1965. *Nonion graniferus* (Terquem); Pożaryska: 93, pl. 21: 5 (*with synonymy*).

Material. — Several well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/171
largest diameter	0.275
smallest diameter	0.225

Description as given in Terquem (1882), completed in Pożaryska (1965).

Variation insignificant, concerning mainly the different development of the umbilical region of test.

Remarks. — The Upper Eocene specimens fall within the limits of variability of representatives of this species recorded from the Paleocene of the Polish Lowlands.

Occurrence. — Paleocene-Oligocene: Europe, Greenland, N. America and Asiatic part of USSR.

Genus *Florilus* de Montfort, 1808
Florilus winnianus (Howe, 1939)
(pl. 8: 5*a*, *b*, 6)

1939. *Nonionella winniana* Howe; 60, pl. 7: 26, 27.
1949. *Nonionella winniana* Howe; Bandy: 78, pl. 11: 6a-c.

Material. — 7 well-preserved specimens.

Dimensions (in mm):

	ZPAL FXXI/172
largest diameter	0.525
smallest diameter	0.325

Description as given by Bandy (1949/1960).

Variation rather significant. It applies mainly to the development of umbilical depression, which can be empty or filled with papillae. Sutures more or less depressed.

Remarks. — Our specimens are very similar to those described and illustrated from the Eocene of Alabama (USA), differing only by the lack of papillae on spiral side of test. ***Florilus winnianus*** (Howe) is similar to ***Nonion scaphum*** (Fichtel & Moll), differing in having umbilical depression covered by papillae.

Occurrence. — Eocene: Europe, N. America. Common.

Family **Alabaminidae** Hofker, 1951
Svratkina Pokorny, 1956
Svratkina perlata (Andreae, 1884)
(pl. 5, 1*a*-*c*)

1884. *Pulvinulina perlata* Andreae: 216, pl. 8: 12.
1958. *Alabamina perlata* (Andreae); Batjes: 157, pl. 8: 8, 9.

Material. — 12 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/177
largest diameter	0.250
smallest diameter	0.200

Description as given by Andreae (1884), completed by Batjes (1958).

Variation significant. It applies only to the ornamentation. Small tubercles can be scattered on the whole dorsal side, the ventral side being more or less smooth, especially so in its central portion.

Remarks. — Our specimens are more similar to those described by Batjes from the Oligocene of Belgium, being also rather smooth on the umbilical side, than to the illustrated holotype, which is covered by papillae on both sides.

Genus *Gyroidina* d'Orbigny, 1826

Gyroidina soldanii d'Orbigny, 1826

(pl. 4: 4*a-c*; pl. 13: 12, 13)

1826. *Gyroidina soldanii* d'Orbigny: 278, model 36.
1884. *Rotalina soldanii* d'Orbigny; Brady: 706, pl. 107: 6, 7.
1958. *Gyroidina soldanii* d'Orbigny; Batjes: 147, pl. 7: 13, 14 (*with synonymy*).

Material. — A dozen or so of specimens, well-preserved.
Dimensions (in mm):

	ZPAL FXXI/178
largest diameter	0.500
smallest diameter	0.425

Description as given by Brady (1884) completed by Batjes (1958).

Variation rather significant. It applies to the height of central depression on umbilical side, and the degree of flattening of dorsal side.

Remarks. — Our specimens are much more higher than the Belgian ones, illustrated by Batjes (1958).

Occurrence. — Eocene — Recent: Europe, N. America.

Family **Anomalinidae** Cushman, 1927

Genus *Anomalinoides* Brotzen, 1942

Anomalinoides granosus (Hantken, 1875)

(pl. 7: 4*a-c*)

1875. *Truncatulina granosa* Hantken: 224, pl. 10: 2a-c.
1969. *Anomalina granosa* (Hantken); Kraeva: 87, pl. 34: 5.
1971. *Anomalinoides granosus* (Hantken); Hagn & Ohmert: 138: 6a-c.

Material. — 10 well-preserved specimens.
Dimensions (in mm):

	ZPAL FXXI/188
largest diameter	0.500
smallest diameter	0.400

Description as given by Hantken (1875) and revision by Hagn & Ohmert (1971). The last authors discussed in detail differences between *Anomalinoides granosus*, *A. calymene* Hagn, *A. rubiginosa* Cushman, *A. danica* (Brotzen) and *Korobkovella grosserugosa* (Gümbel), all its subspecies included. In this way, *Anomalinoides granosus* (Hantken) was revised very detailed by Hagn (1971).

Remarks. — Our specimens are very similar to the holotype illustrated by Hantken (1875), having only somewhat larger central depressions on both sides.

Occurrence. — Eocene-Oligocene: Europe. Common.

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REFERENCES

AISBERG, R. E. GARECKIJ, R. G., SINITSHKA, A. M. (АЙЗБЕРГ, Р. Е. ГАРЕЦКИЙ, Р. Г., СИНИЧКА, А. М.) 1971. Сарматско-Турапский линеамент земной коры. Пробл. Теорет. Регион. Тект., 41—51, Москва.

АТЛАС литолого-палеогеографических карт Русской платформы, ч. II, масштаб 1 : 5.000.000, 1961, Москва—Ленинград.

BANDY, O. L. 1949 (1960). Eocene and Oligocene Foraminifera from Little Stave Creek, Clarke County, Alabama. — *Bull. Amer. Paleont.*, **32**, 131, 1—210.

BARKHATOVA, N. N. & RAZMISLOVA, S. S. (БАРХАТОВА, Н. Н. & РАЗМЫСЛОВА С. С.) 1974. Стратиграфия и нуммулитиды эоценовых отложений прикаспийской впадины. — АН СССР, Геол. Инст., Изд. „Наука", 1—92, Ленинград.

BATJES, D. A. J. 1958. Foraminifera of the Oligocene of Belgium. — *Mém. I. R. Sci Nat. Belg.*, **143**, 1—188.

BER, A. G. (БЕР, А. Г.) 1963. Палеогеография территории припятского прогиба и северо-западной части днепровско-донецкой впадины в палеогеновом периоде. — *Тр. ВСЕГЕИ*, **91**, 173—190, Ленинград.

BERGGREN, W. A. 1972, A Cenozoic time scale. Some implications for regional geology and paleobiogeography. — *Lethaia*, **5**, 195—215.

BHATIA, S. B. 1957. The paleoecology of the late Palaeogene sediments of the Isle of Wight, England. — *Contr. Cush. Fdn. Foram. Res.*, **8**, 11—28.

BLAICHER, J. 1961. Poziom wapiennej mikrofauny w górnym eocenie serii magurskiej. — (Z badań geologicznych w Karpatach. — *Biul. Inst. Geol.* **166**, 7, 5—56.

CAVELIER, C. & POMEROL, Ch. 1976. Les rapports entre le Bartonien et Priabonien. Incidence sur la position de la limite Eocène moyen — Eocène supérieur. — *C. R. somm. géol. France*, **2**, 49—51.

CIMASZEWSKI, L. 1964. Uwagi o utworach trzeciorzędu Polski zachodniej. — *Geofiz. Geol. Naft.*, **6—7**, 171—175.

CIUK, E. 1974. Schematy litostratygraficzne paleogenu Polski poza Karpatami i zapadliskiem przedkarpackim. Z badań trzeciorzędu w Polsce. — *Biul. Inst. Geol.*, **281**, 7, 7—40.

CUSHMAN, J. A. 1939. A monograph of the foraminiferal family Nonionidae. — *Geol. Surv. Prof. Pap.*, **191**, 1—100.

— & JARVIS, P. W. 1929. New foraminifera from Trinidad. — *C. C. Lab. For. Res.*, **5**, 1, 6—17.

DROOGER, C. W. 1966. Zonation of the Miocene by means of planktonic Foraminifera — a review and some comments. — Proc. III Session Int. Union Geol. Sci., Comm. stratigr. Neogène (8—13 June, 1964), 40—50, Bern.

— 1969. Microfauna close to the Eocene-Oligocene boundary in the boring at Kallo. — *Mém. Expl. Cartes Géol. Min. Belgique*, **11**, 1—26.

EAMES, F. E., BANNER, F. T., BLOW, W. H. & CLARKE, W. J. 1962. Fundamentals of Mid-Tertiary stratigraphical correlation. 1—153. Cambridge Univ. Press, Cambridge.

ESPITALIÉ, J. & SIGAL, J. Microstratigraphie des "marnes bleues" des bassins tertiaires des Alpes Méridionales; le genre Caucasina (Foraminifère). — *Rev. Micropal.*, **3**, 4, 201—206.

FURSENKO, A. V. & FURSENKO, K. B. (ФУРСЕНКО, А. В. & ФУРСЕНКО, К. Б.) 1958. О стратиграфическом и палеогеографическом значении находок фораминифер в верхнем эоцене БССР (автореферат доклада). — Бюл. Моск. о-ва испыт. природы, отд. геол., 33 (4).

— 1961. Фораминиферы верхнего эоцена Белоруссии и их стратиграфическое значение. — В кн.: „Палеонтология и стратиграфия БССР", 246—371, Минск.

GLAÇON, G. & SIGAL, J. 1974. Morphologie de l'appendice buccal chez Caucasina (Foraminifère), suivie d'une comparaison avec celui de divers genres de Buliminidae. — *Rev. Esp. Micropal.*, **6**, 2, 209—227.

GRIGELIS, A., BALTAKIS, V., KATINAS, V. (ГРИГЕЛИС, А., БАЛТАКИС, В., КАТИНАС, В.) 1971. Стратиграфия палеогеновых отложений Приблатики. — Изв. АН СССР, Сер. геол., **3**, 107—116, Москва.

GRZYBOWSKI, J. 1895. Mikrofauna karpackiego piaskowca z pod Dukli. — *Rozpr. Akad. Umiej.*, **2**, 9, 181—214.

HAGN, H. 1954. Some Eocene Foraminifera from the Bavarian Alps and adjacent areas. — *Contr. Cushm. Fiund. For. Res.*, **5**, 1, 13—20.

— & OHMERT, W. 1971. Révision de "Truncatulina" grosserugosa Gümbel (Foraminifères) de l'Éocène des Préalpes bavaroises. — *Rev. Micropal.*, **14**, 5, 131—144.

HAQUE, A. F. M. M. 1956. The Foraminifera of the Ranikot and the Laki of the Nammal Gorge, Salt Range. — *Mem. Geol. Surv. Pakistan, Pal. Pakist.* **1**, 1—300, Quetta.

JEDNOROWSKA, A. 1968. Zespoły otwornicowe w zewnętrznych strefach jednostki Magurskiej Karpat i ich znaczenie stratygraficzne. — *PAN prace geol.*, **50**, 1—89.

KAASSCHIETER, J. P. H. 1961. Foraminifera of the Eocene of Belgium. — *Mém. Inst. Roy. Sci. Nat. Belgique*, **147**, 1—271.

KAPTARENKO-TSHERNOUSOVA, O. K. (КАПТАРЕНКО-ЧЕРНОУСОВА, О. К.) 1946. Про фауналъни зміни киïвського мергелю. — *Геол. Жур.*, **8**, 4.

— 1951. Киевский ярус и элементы его палеогеографии. — *Тр. Инст. Геол. Наук, Сер. страт. и палеонт.*, **3**, 5—179.

— 1956.Форамініфера Киïвського ярусу Дніпровсько-Донецькоï западнини та північно-західних окраïн Донецького басейну. — *Ibidem*, **8**, 7—188.

KHALILOV, D. M. (ХАЛИЛОВ, Д. М., 1948. Стратиграфия верхнемеловых и палеогеновых отложений Малого Балхана по фауне фораминифер. — Азербайджанский Науч.-Исслед. Инст. по Добыче Нефты, 5—77.

— 1956. Новые виды Bolivina палеогеновых отложений Азербайджана. — *Тр. Инст. Геологии АН АзССР*, **18**, 181—218.

— 1967. Микрофауна и стратиграфия палеогеновых отложений Азербайджана. — Изд. Акад. Наук Азербайджан. ССР, 3—245, Баку.

KIESEL, I. 1970. Die Foraminiferenfauna des Paläozänen und Eozänen Schichtenfolge der Deutschen Demokratischen Republik. — *Paläont. Abh.* A, **4**, 2, 163—394.

— & LOTSCH, D. 1963. Zur Mikrofauna des südbrandenburgischen Obereozäns. — *Geologie*, **38**, 1—71.

KLJUSCHNIKOV, M. N. (КЛЮШНИКОВ, М. Н.) 1950. О положении так называемых мандрыковских слоев. — Уч. зап. Киевского гос. инст., 3.

KOSMOWSKA-CERANOWICZ, B., HANCZKE, T. & KOCISZEWSKA-MUSIAŁ, G. 1974. Osady trzeciorzędowe z wierceń okolic Gdańska. — *Prace Muz. Ziemi*, **22**, 95—136.

— , KOCISZEWSKA-MUSIAŁ, G. & MUSIAŁ, T. 1976. Mineralogiczno-petrograficzne podstawy wydzieleń kompleksów osadów trzeciorzędowych i “preglacjalnych” w wierceniu Hipolitów. — *Kwart. geol.*, **20**, 2, 365—379.

KRAEVA, E. A. & ZERNECKIJ, B. F. (КРАЕВА, Е. Я. & ЗЕРНЕЦКИЙ Б. Ф.) 1969. Палеонтологический справочник. — Инст. Геол. Наук, Изд. „Наукова Думка”, **3**, 5—199. Киев.

— 1974. Стратиграфічные розчленування куївської світи південно-східної частини Дніпровсько-Донецької западини. — *Геол. Жур.*, **34**, 4, 48—55.

KRUTSCH, W. & LOTSCH, D. 1957a. Zur stratigraphischen Stellung der Lattorf Stufe im Paläogen. — *Geologie*, **6**, 5.

— & — , 1957. Atlas für Paläogeographie in 1:5 000 000. — *Geol. Ges. DDR*, **3**, 2/3.

LE CALVEZ, Y. 1966. Contribution à l'étude des Foraminifères de l'Oligocène inférieur (Sannoisien) dans le Basin de Paris. — *Ecol. Géol. Helv.*, **59**, 1, 401—419.

LE ROY, L. W. 1953. Biostratigraphy of the Maqfi section, Egypt. — *Geol. Soc. Amer.*, **54**, 1—54.

LISZKA, S. 1957. Mikrofauna górnego eocenu z Grabna. — *Roczn. Pol. Tow. Geol.*, **25**, 3, 161—202.

LITHOLOGICAL-PALAEOGEOGRAPHICAL ATLAS, 1961. *see*: АТЛАС...

ŁYCZEWSKA, J. 1958. Stratygrafia paleogenu i neogenu Polski północnej. — *Kwart. Geol.*, **2**, 1, 127—160.

MARTIN, L. T. 1945. Eocene Foraminifera from the type Lodo formation, Fresno County, California. — *Stanford Univ. Publ.*, Ser. Geol. Sci., **3**, 3, 1—121.

MARTINI, E. 1970. Standart Palaeogene Calcareous Nannoplankton Zonation. — *Nature*, **226**, 5245, 560—561.

— & RITZKOWSKI, S. 1970. Stratigraphische Stellung der obereozänen Sande von Mandrikovka (Ukraine) und Parallelisierungs-Möglichkeiten mit Hilfe des fossilen Nannoplanktons. — *Newsl. Stratigr.*, **1**, 2, 49—60.

MASLAKOVA, N. J. (МАСЛАКОВА, Н. И.) 1955. Стратиграфия и фауна мелких фораминифер палеогеновых отложений Восточных Карпат. — Материалы по биостратиграфии западных областей Украинской ССР, 5—394, Москва.

MATL, K. & ŚMIGIELSKA, T. 1977. Morskie osady paleogenu między Głogowem a Sieroszowicami (Paleogene marine sediments between Głogów and Sieroszowice). — *Roczn. Pol. Tow. Geol.*, **47**, 1.

MJATLJUK, E. V. (МЯТЛЮК, Е. В.) 1953. Ископаемые фораминиферы СССР. Спириллиниды, роталииды, эпистоминиды и астеригериниды. — *Тр. ВСЕГЕИ*, н. сер., **71**.

MOJSKI, J. E., RZECHOWSKI, I. & WOŹNY, E. 1966. Górny eocen w Luszawie. — *Przegl. Geol.*, **12**, 513—517.

MOROZOVA, W. T. (МОРОЗОВА, В. Т.) 1946. О возрасте нижнефораминиферовых слоев северного Кавказа. — *Доклады АН СССР*, **4**, 1.

MURRAY, J. W. 1973. Distribution and ecology of living benthic foraminiferids, 1—274, Heinemann, London.

— & WRIGHT, C. A. 1974. Palaeogene Foraminiferida and palaeoecology, Hampshire and Paris basins and the English Channel. — *Spec. Papers Palaeont.*, **14**, 1—129.

NORVICK, M. (MS). Foraminiferida from the English Upper Eocene (Plates only). (From the Hampshire Upper Bracklesham beds).

ODRZYWOLSKA-BIEŃKOWA, E. 1966. O mikrofaunistycznej granicy eocenu i oligocenu na Kujawach. — *Kwart. Geol.*, **10**, 4, 1072—1078.

— 1967. Utwory trzeciorzędowe z otworu Szczecin 461 w świetle badań mikropaleontologicznych. — *Ibidem*, **12**, 3, 624—627.

— 1972*a*. Wstępne wyniki badań mikrofaunistycznych starszego trzeciorzędu rejonu Zatoki Puckiej. — *Przegl. Geol.*, **12**, 570—573.

— 1972*b*. Wyniki badań mikropaleontologicznych starszego trzeciorzędu w wierceniu Koszalin 461. — *Ibidem*, **11**, 527.

— 1973*a*. Mikrofauna starszego trzeciorzędu w rejonie Sieroszowic. — *Ibidem*, **7**, 376—377.

— 1973*b*. Stratygrafia mikropaleontologiczna starszego trzeciorzędu w wierceniu Szczecin 461. Profile głębokich otw. wiert. — *Inst. Geol.*, **6**, 92—96.

— 1974. Wyniki badań mikropaleontologicznych starszego trzeciorzędu w otworze wiertniczym Mikaszówka. Z badań trzeciorzędu w Polsce. — *Biul. Inst. Geol.* **281**, 7, 109—117.

— (MS, Thesis) Foraminifera and stratigraphy of the Upper-Eocene-Oligocene transitional beds in N Poland.

OLEMPSKA, E. 1973. Górnoeoceńskie numulity z wiercenia Damasławek w północno-zachodniej Polsce (Upper Eocene nummulites from the Damasławek borehole (NW Poland)). — *Acta Pal. Pol.*, **18**, 2, 211—220.

POMEROL, Ch. 1973. Ere Cénozoïque, in Stratigraphie et Paleogéographie. — DOIN éd. Paris, 1—269.

POŻARYSKA, K. 1957. Lagenidae du Crétacé Supérieur de Pologne. — *Palaeont. Pol.*, **8**, 1—190.

— 1965. Foraminifera and biostratigraphy of the Danian and Montian in Poland. — *Ibidem*, **14**, 1—151.

— 1976. Distribution and the routes of migration of the Late Eocene Foraminifera in Europe. — 7[th] African Coll. Micropaleont. Ile Ife Nigeria.

— & LOCKER, S. 1971. Les organismes planctoniques de l'Eocène supérieur de Siemień, Pologne orientale. — *Rev. Micropal.*, **5**, 14, 57—72.

— & ODRZYWOLSKA-BIEŃKOWA, E. 1977. O górnym eocenie w Polsce pozakarpackiej (On the Upper Eocene in the extra-Carpathian Poland). — *Kwart. Geol.*, **21**, 1.

RÜHLE, E. 1955. Przegląd wiadomości o podłożu czwartorzędu północno-wschodniej części Niżu Polskiego. — *Biul. Inst. Geol.*, **70**, p. 159—172.

— 1974. Pokrywa kenozoiczna. *In*: Skały platformy prekambryjskiej w Polsce. 2: Pokrywa osadowa. — *Prace Inst. Geol.*, **74**, 186—206.

SAMOJLOVA, R. B. (САМОЙЛОВА, Р. Б.) 1946. Стратиграфическое распределение фораминифер в верхнепалеогеновых отложениях р. Альмы (Крым). — *Бюл. Моск. о-ва испыт. природы, отд. геол.*, **21** (2).

SAMUEL, O. 1975. Foraminifera of Upper Priabonian from Lubietowa (Slovakia). Západne Karpaty, seria paleontologia, **1**, 111—176, Bratislava.

SCHATSKIJ, N. S. (ШАТСКИЙ, Н. С.) 1924. Стратиграфия и тектоника верхнемеловых и нижнетретичных отложений северной окраины Донецкого кряжа. — *Тр. КМА*, **4**.

SOKOLOV, N. A. (СОКОЛОВ, Н. А.) 1895. О нижнетретичных отложениях Южной России. — *Тр. СП общ. ест.*, **23**.

SUBBOTINA, N. N. (СУББОТИНА, Н. Н.) 1953. Верхнеэоценовые лягениды и булиминиды юга СССР. — Тр. Всес. нефт. научн.-иссл. геологоразвед. ин-та, 69, Микрофауна СССР, **6**, 115—255, Москва.

SYNIEWSKA, J. 1937. O faunie otwornicowej paleogeńskiego fliszu Koniuszy koło Dobromila. — *Roczn. Pol. Tow. Geol.*, **13**,

SZCZECHURA, J. 1977. Ostracoda from the Upper Eocene of East Poland. — *Acta Palaeont. Pol.* **22**, 1, 55—92.

— & POŻARYSKA, K. 1974. Foraminiferida from the Paleocene of Polish Carpathians (Babica Clays). — *Palaeont. Pol.*, **31**, 1—142.

TER-GRIGORJANTZ, L. S. (ТЕР-ГРИГОРЬЯНЦ, Л. С.) 1965. Некоторые характерные виды аглютинированных фораминифер из пограничных слоев эоцена и олигоцена Ставрополья. — Тр. ВНИГРИ, 44, Изд. „Недра", 212—244, Москва.
TUTKOVSKIJ, P. A. (ТУТКОВСЬКИЙ, П. А.) 1887. Фораминиферы из третичных и меловых отложений Киева. — Зап. Киевск. о-ва естествоиспыт. за 1886 г, 8, 2.
UBERNA, J. 1967. Fosforyty okolic Siemienia w powiecie parczewskim. — *Kwart. Geol.*, **11**, 4, 926—927.
— 1970. Profil litologiczny osadów eoceńskich z Siemienia w powiecie parczewskim. — *Ibidem*, **14**, 3, 580—581.
— 1971. Fosforyty w Polsce oraz możliwości występowania dalszych obszarów fosforytonośnych. — *Biul. Inst. Geol.*, **246**, 7—38.
— 1973. Fosforytonośność osadów trzeciorzędowych północnej Lubelszczyzny. — *Kwart. Geol.*, **17**, 3, 600—601.
UBERNA, T. 1974. Sytuacja utworów paleogeńskich w północnej części Niżu Polskiego na tle ukształtowania powierzchni podłoża utworów kenozoicznych. Z badań trzeciorzędu w Polsce. — *Biul. Inst. Geol.*, **281**, 7, 93—103.
— 1976. Trzeciorzęd i rzeźba podłoża czwartorzędowego rejonu Okuniewa w świetle profilu Hipolitów. — *Kwart. Geol.*, **20**, 2, 343—364.
UHLIG, V. 1886. Ueber eine Mikrofauna aus dem Alttertiär der westgalizischen Karpathen. — *Jahr. k. k. Reichsanst.*, **36**, 1.
VASILENKO, V. P. (ВАСИЛЕНКО, В. П.) 1954. Аномалиниды. — *Тр. ВНИГРИ*, **80**, 5—281.
VOLOSHINA, A. M. & ANDREEVA, L. P. (ВОЛОШИНА А. М. & АНДРЕЕВА Л. П.) 1974. Нові знахідки верхноеоценових форамініферових комплексів на Волині і Розточчі. — Допов. АН Україн. РСР, Сер. Б. 8, 678—681, Київ.
WOŹNY, E. 1966. Eocen z Siemienia koło Parczewa. — *Kwart. Geol.*, **17**, 843—850.
— 1967. Występowanie numulitów w bartonie z Siemienia koło Parczewa. — *Przegl. Geol.*, **9**, 419—420.
— 1968. Stratigraphy of the Tertiary of Northern Poland. — *Mém. BRGM*, **58**, 683—692.
— 1977. Pelecypods from the Upper Eocene of East Poland. — *Acta Palaeont. Pol.*, **22**, 1, 93—112.
WÓJCIK, K. 1904. Die unteroligocäne Fauna von Kruhel Mały bei Przemyśl. Die Clavulina Szaboischichten. — *Bull. Acad. Sci. Cracoviae, Math. nat.*

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GÓRNOEOCEŃSKIE OTWORNICE WSCHODNIEJ POLSKI I ICH ZNACZENIE PALEOGEOGRAFICZNE

Streszczenie

W regionie Siemienia na Lubelszczyźnie stwierdzono występowanie osadów górnego eocenu zawierających bogatą faunę. Reprezentują one otwornicową biozonę *G. semiinvoluta*, oraz zonę 17 standartowego profilu nannoplanktonowego (NP 17)

D. saipanensis. W ten sposób sprecyzowano wiek warstw z Siemienia jako najstarszy poziom górnego eocenu. W osadach tych stwierdzono obecność bardzo bogatego zespołu otwornicowego. Spektrum otwornicowe wykazuje bogactwo form zimnolubnych, na które składa się ponad 70 gatunków. Są to w dominującym stopniu otwornice bentoniczne, wśród których zaznacza się przewaga przedstawicieli nodosaridów, buliminidów, boliwinidów i uwigerinidów, przy braku miliolidów i numulitidów. Formy te charakteryzują się dużymi rozmiarami i silnie rozwiniętą ornamentacją. Otwornice planktoniczne w przeciwieństwie do bentonicznych są bardzo nieliczne, zarówno co do ilości gatunków jak i osobników. Są to formy bądź skarlałe, bądź reprezentujące juwenilne stadia. Analogiczny zespół otwornicowy znany jest z piętra kijowskiego na Ukrainie. Również analizy minerałów ciężkich warstw z Siemienia są najbardzej zbliżone do analiz warstw górno-eoceńskich z północnych peryferii masywu ukraińskiego. Pozwala to przypuszczać, że górno-eoceńska transgresja morska odpowiedzialna za warstwy z Siemienia dotarła do Polski ze wschodu, wykorzystując zapewne stare założenia tektoniczne składające się na całość aulakogenu dnieprowsko-donieckiego. W następnym etapie transgresja ta dotarła do Polski północnej, gdzie osady górnego eocenu są nieco młodsze od warstw z Siemienia. W tym czasie w Polsce zachodniej istniał zalew morza bartońskiego, które objęło bruzdę północno-europejską. Na terenie Polski zachodniej wody tych dwóch transgresji, ciepłego morza z zachodu i chłodnego ze wschodu spotkały się a fauny ich uległy pewnemu wymieszaniu. Typ osadów warstw z Siemienia i charakter stwierdzonego w nich zespołu otwornicowego wskazuje na środowisko dobrze przewietrzane, a spektrum otwornicowe jest typowe dla średniogłębokich wód szelfowych (80—100 m). Obecność globigerin i globorotalid wskazuje, że warstwy z Siemienia reprezentują najbardziej północne peryferie prowincji przejściowej, merydionalnej, rozwiniętej w Polsce już w paleocenie.

Niniejsza praca została wykonana w ramach problemu międzyresortowego II/3.

КРЫСТИНА ПОЖАРЫСКА

ВЕРХНЕЭОЦЕНСКИЕ ФОРАМИНИФЕРЫ ВОСТОЧНОЙ ПОЛЬШИ И ИХ ПАЛЕОГЕОГРАФИЧЕСКОЕ ЗНАЧЕНИЕ

Резюме

В окрестностях Семеня Люблинского района обнаружено залегание отложений верхнего эоцена с богатой фауной. Эти отложения представляют собой фораминиферовую зону *G. semiinvoluta*, а также зону 17 стандартного разреза

наннопланктонного (NP-17) *D. saipanensis*. Исходя из этого, был определён возраст слоёв Семеня как самый древний горизонт верхнего эоцена. В этих отложениях был обнаружен очень богатый комплекс фораминифер. Этой ассоциации присуще обилие форм, существовавших в холодной воде, она охватывает более 70 видов. Это, в подавляющим большинстве, бентосные фораминиферы, среди которых преобладают представители: нодозарид, булиминид, боливинид и увигеринид, в то время как милиолиды и нуммулитиды отсутствуют. Эти формы характеризуются большими размерами и хорошо развитым орнаментом. Представители планктонных фораминифер в противоположность бентосным немногочислены, как по количеству видов, так и по количеству особей. Они представляют собой или же карликовые формы или же ювенальную стадию развития. Идентичный комплекс фораминифер известен в киевском ярусе на Украине. Также результаты анализов тяжёлых минералов для отложений Семеня и верхнеэоценских слоёв северной части украинского массива очень подобные. Это позволяет предположить, что верхнеэоценская трансгрессия моря происходила в Польше со стороны востока, используя при этом, по всей вероятности старые тектонические основания, которые в целом составляют днепровско-донецкий аулакоген. В последующим этапе эта трансгрессия дошла до северной Польши, где отложения верхнего эоцена являются более молодыми по сравнению с отложениями Семеня. В это самое время в западной Польше существовал залив бартонского моря, охватывающего также и северо-европейскую борозду. На территории западной Польши воду этих двух трансгрессий тёплого моря от запада и холодного с востока, слились, а их фауна в какой то степени перемешалась. Тип отложений Семеня и характер обнаруженного в них комплекса фораминифер укнзывает на среду с большим содержанием кислорода, а ассоциация фораминифер является типичной для шельфовых вод средней глубины (80—100 м). Наличие глобигерин и глобороталид указывает на то, что слои Семеня являются наиболее северной периферией переходной, провинции, меридиональной развитой в Польше уже в палеоцене.

EXPLANATION OF PLATES

Plate 1

1. *Lagena asperoides* Galloway & Morrey: *a* side view, *b* top view, × 110. ZPAL FXXI/5.
2. *Lagena hexagona* (Williamson): *a* side view, *b* top view, × 90. ZPAL FXXI/10.

3. *Lagena vulgaris* Williamson: *a* side view, *b* top view, × 100. ZPAL FXXI/17.
4. *Fissurina marginata* (Walker & Boys): *a* side view, *b* top view, *c* front view, × 200. ZPAL FXXI/40.
5. *Lagena semiornata* Terquem & Terquem: *a* side view, *b* top view, × 115. ZPAL FXXI/15.
6. *Lagena* cf. *bermudezi* Gamez: *a* side view, *b* top view, *c* front view, × 115. ZPAL FXXI/6.
7. *Lagena lacunocostata* Cushman & Jarvis: *a* side view, *b* top view, × 110. ZPAL FXXI/13.
8. *Lagena* cf. *florida* Terquem: *a* side view, *b* top view, × 125. ZPAL FXXI/7.
9. *Lagena mariae* Karrer: *a* side view, *b* top view, × 110. ZPAL FXXI/14.
10. *Lagena sulcata strumosa* Reuss: *a* side view, *b* top view, × 110. ZPAL FXXI/16.

Plate 2

17. *Uvigerina spinicostata* Cushman & Jarvis: ontogeny and intraspecific variation, × 65. ZPAL FXXI/83—99.
18. *Uvigerina costellata* Morozova: *a* side view, *b* top view, × 80. ZPAL FXXI/75.
19. *Uvigerina costellata* Morozova: side view, × 80. ZPAL FXXI/76.
20, 21. *Uvigerina spinicostata* Cushman & Jarvis: side view, ×80. ZPAL FXXI/78,80.
22. *Saracenaria arcuata* (d'Orbigny): 22 side view, 22 front view, × 55. ZPAL FXXI/37.
23. *Lenticulina gorynica* Fursenko & Fursenko: *a* side view, *b* front view, × 65. ZPAL FXXI/18.
24. *Bulimina ovata* d'Orbigny: *a, b, c* views from 3 sides, × 80. ZPAL FXXI/62.
25. *Dentalina inornata* d'Orbigny: side view, × 40. ZPAL FXXI/3.
26. *Dentalina vertebralis albatrossi* Cushman: side view, × 60. ZPAL FXXI/4.
27. *Marginulinopsis behmi* (Reuss): *a* side view, *b* top view, × 50. ZPAL FXXI/24.

Plate 3

A. 1—9. *Fursenkoina halkyardi* (Cushman): intraspecific variation, × 50. ZPAL FXXI/54.
B. 1—8. *Trifarina labrum* Subbotina: intraspecific variation, × 90. ZPAL FXXI/101—108.
C. 1—8. *Bolivina striatellata* Bandy: intraspecific variation, × 80. ZPAL FXXI/49—56.
D. 1—9. *Marginulinopsis behmi* (Reuss): ontogeny and intraspecific variation, × 65. ZPAL FXXI/28—36.

Plate 4

1. *Quinqueloculina reicheli* Le Calvez: *a, b* views from both sides, × 80. ZPAL FXXI/2.
2. *Asterigerina falcilocularis* Subbotina: *a* spiral side, *b* umbilical side, *c* side view, × 200. ZPAL FXXI/113.
3. *Guttulina communis* (d'Orbigny): *a, b* views from both sides, × 40. ZPAL FXXI/38.
4. *Gyroidyna soldanii* d'Orbigny: *a* umbilical side, *b* spiral side, *c* side view, × 70. ZPAL FXXI/178.
5. *Raphanulina gibba* (d'Orbigny): *a, b* views from both sides, × 45. ZPAL FXXI/190.
6. *Raphanulina inaequalis* Reuss: side view, × 70. ZPAL FXXI/191.
7. *Karreriella tutcowskii* Fursenko & Fursenko: *a, b* views from both sides, *c* top view, × 95. ZPAL FXXI/1.

8. *Turborotalia centralis* (Cushman & Bermudez): *a* spiral views, *b* umbilical side, *c* side view, × 120. ZPAL FXXI/120.
9. *Globigerina praebulloides praebulloides* Blow: *a* umbilical side, *b* spiral view, *c* side view, × 150. ZPAL FXXI/123.

Plate 5

1. *Svratkina perlata* (Andreae): *a* umbilical side, *b* spiral side, *c* side view, × 150. ZPAL FXXI/177.
2. *Neoeponides schreibersi* d'Orbigny: *a* umbilical side, *b* spiral side, *c* side view, × 80. ZPAL FXXI/131.
3. *Eponides candidulus* (Schwager): *a* spiral view, *b* umbilical view, *c* side view, × 60. ZPAL FXXI/129.
4. *Cribrononion nonioninoides* Fursenko & Fursenko: *a*, *b* front view, *c* side view, × 160. ZPAL FXXI/118.
5. *Cibicides westi arguta* Bykova: *a* umbilical view, *b* spiral view, *c* side view, × 90. ZPAL FXXI/153.
6. *Anomalina affinis* (Hantken): *a* spiral view, *b* umbilical view, *c* side view, × 80. ZPAL FXXI/183.
7. *Pullenia quinqueloba* (Reuss): *a* side view, *b* frontal view, × 150. ZPAL FXXI/175.
8. *Alabamina almaensis* (Samoilova): *a* umbilical view, *b* spiral view, *c* side view, × 60. ZPAL FXXI/176.

Plate 6

A. 1—4. *Cibicides lobatulus* (Walker & Jacob): upper part-spiral view, lower part-umbilical view, × 70. ZPAL FXXI/140.

B. 1—6. *Cibicides oligocenicus* Samoilova: upper part- umbilical view, lower part-spiral view, × 65. ZPAL FXXI/145—150.

Plate 7

1. *Eponides candidulus* (Schwager): *a* spiral view, umbilical view, *c* side view, × 75. ZPAL FXXI/129.
2. *Cibicides fortunatus* Martin: *a* spiral view, *b* umbilical view, *c* side view, × 120. ZPAL FXXI/134.
3. *Cibicides oligocenicus* Samoilova: *a* spiral view, *b* umbilical view, *c* side view, × 90. ZPAL FXXI/144.
4. *Anomalinoides granosus* (Hantken): *a* umbilical view, *b* spiral view, *c* side view, × 95. ZPAL FXXI/188.

Plate 8

1. *Marginulinopsis behmi* (Reuss): *a* side view, *b* earlier portion of test, *c* aperture, × 125, × 265. ZPAL FXXI/26.
2. *Lenticulina grodnensis* Fursenko & Fursenko: side view, × 50. ZPAL FXXI/20.
3. *Lenticulina grodnensis* Fursenko & Fursenko: side view, × 80. ZPAL FXXI/21.
4. *Cibicides karpaticus* Mjatliuk: umbilical side, × 250. ZPAL FXXI/139.

5, 6. *Florilus winnianus* (Howe): *5*, *a* side view, × 170, and *b* detail, × 490, *6* side view, × 170. ZPAL FXXI/172.

Plate 9

1, 2, 5, 6, 7. *Bolivina striatellata* Bandy: side view, × 180. ZPAL FXXI/57—61.
3. *Bolivina cookei* Cushman: side view, × 180. ZPAL FXXI/42.
4. *Bulimina subtruncana* Hagn: side view, × 180. ZPAL FXXI/64.
8. *Bolivina reticulataformis* Khalilov: side view, × 180, and detail, × 380. ZPAL FXXI/47.

Plate 10

1, 9. *Bolivina microlancetiformis* Subbotina: side view, × 210, and details, × 600. ZPAL FXXI/44, 45.
2. *Turrilina alsatica* Andreae: side view, × 240. ZPAL FXXI/41.
3. *Uvigerina costellata* Morozova: side view, × 100. ZPAL FXXI/77.
4. *Uvigerina spinicostata* Cushman & Jarvis: side view, × 100. ZPAL FXXI/81.
5. *Uvigerina hispida* Schwager: side view, × 180. ZPAL FXXI/78.
6. *Bulimina striatopunctata* (Terquem): side view, × 180. ZPAL FXXI/63.
7. *Cribrononion subnodosum* (Roemer): umbilical view, × 120. ZPAL FXXI/119.
8. *Fursenkoina hakyardii* (Cushman): side view, × 100, and detail × 600. ZPAL FXXI/164.

Plate 11

1. *Baggina subconica* (Terquem): umbilical view, × 100, detail, × 350. ZPAL FXXI/112.
2, 4. *Baggina iphigenia* Samoilova: umbilical view, × 100, and detail, × 350. ZPAL FXXI/110.
3. *Asterigerina falcilocularis* Subbotina: umbilical view, × 250. ZPAL FXXI/115.
5. *Anomalinoides granosus* (Hantken): umbilical view, × 340. ZPAL FXXI/189.
6. *Nonion graniferum* (Terquem): umbilical view, × 180, and detail, × 400. ZPAL FXXI/171.

Plate 12

1, 3. *Acarinina rugosoaculeata* Subbotina: *1 a, c* umbilical view, × 240, and *b* detail, × 1500, *3* umbilical view, × 240. ZPAL FXXI/125—127.
2, 4. *Truncorotaloides rohri* Bronniman & Bermudez: *2* — front view, × 240, *4, a* umbilical view, × 240, and *b* detail, × 1500.

Plate 13

1. *Trimosina sectile* (Ter Grigorjanc): side view, × 250. ZPAL FXXI/68.
2, 3. *Cibicides fortunatus* Martin: *2* spiral view, *3* umbilical view, × 120. ZPAL FXXI/135, 136.
4, 5, 6, 7. *Anomalina nonioninoides* Fursenko & Fursenko: *4, 6* umbilical view, *5, 7* front view, × 150. ZPAL FXXI/184—187.
8, 9. *Cibicides oligocenicus* Samoilova: *8* spiral view, *9* umbilical view, × 110. ZPAL FXXI/151, 152.

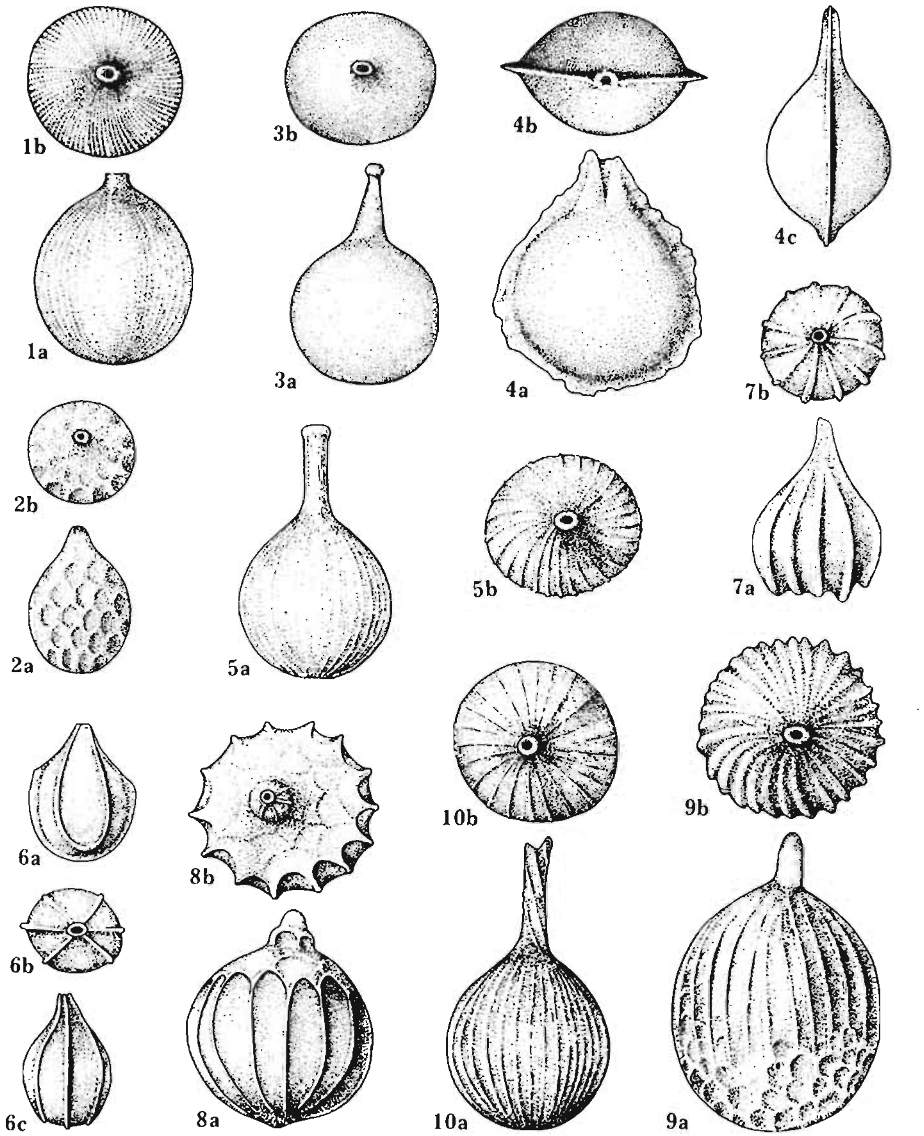
10, 11. *Caucasina alpina* Espitalié & Sigal: *10* umbilical view, *11* spiral view, × 270. ZPAL FXXI/169, 170.

12, 13. *Gyroidina soldanii* d'Orbigny: *12* profil view, *13* umbilical view, × 160. ZPAL FXXI/180, 181.

Plate 14

1, 2. *Amphistegina* cf. *nucleata* Terquem: side view, *1, a* × 45, *b* × 90, *c* × 140, *2, a* × 60, *b* × 190. ZPAL FXXI/132, 133.

3. *Raphanulina tuberculata* (d'Orbigny): side view, × 240. ZPAL FXXI/192.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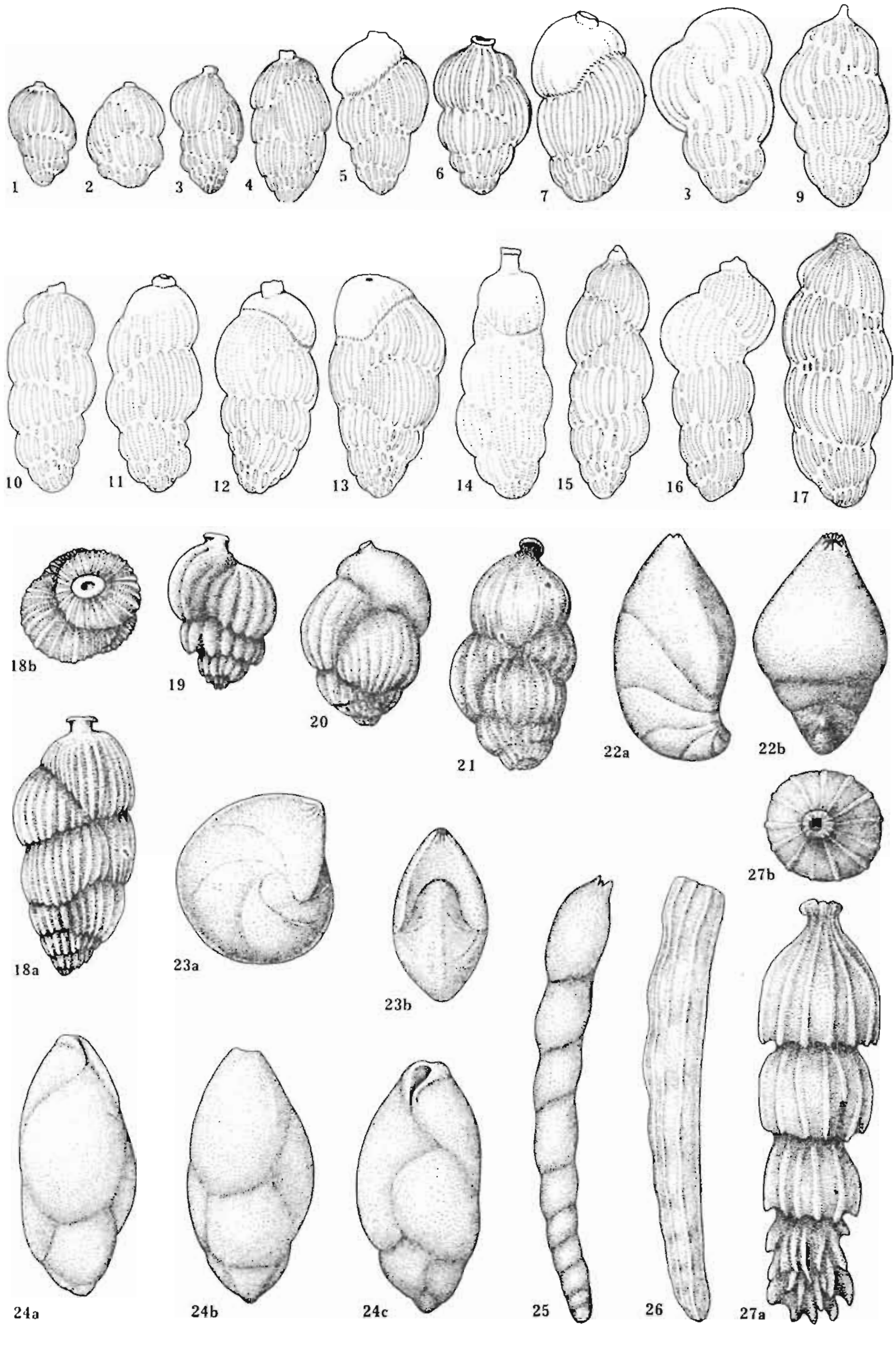
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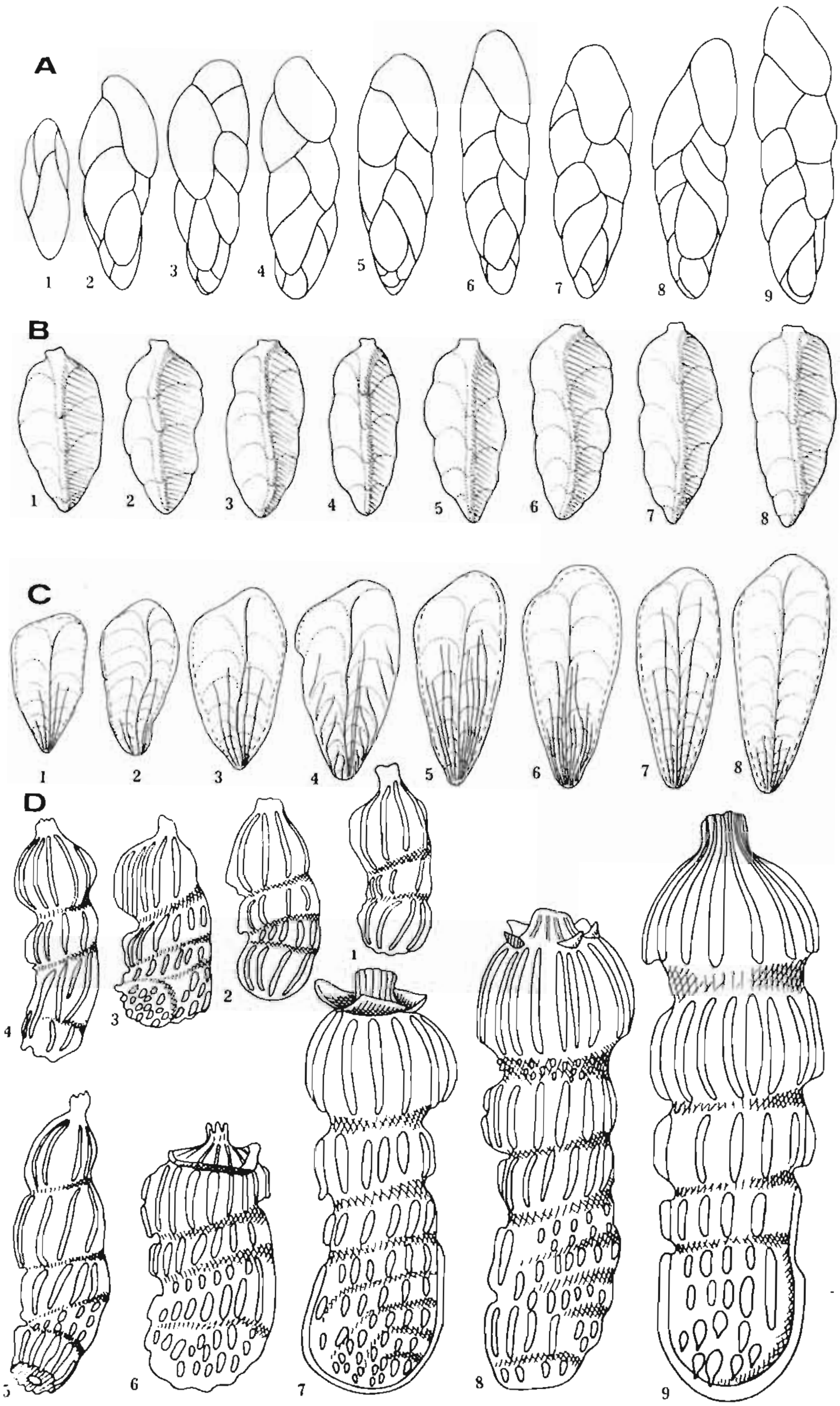
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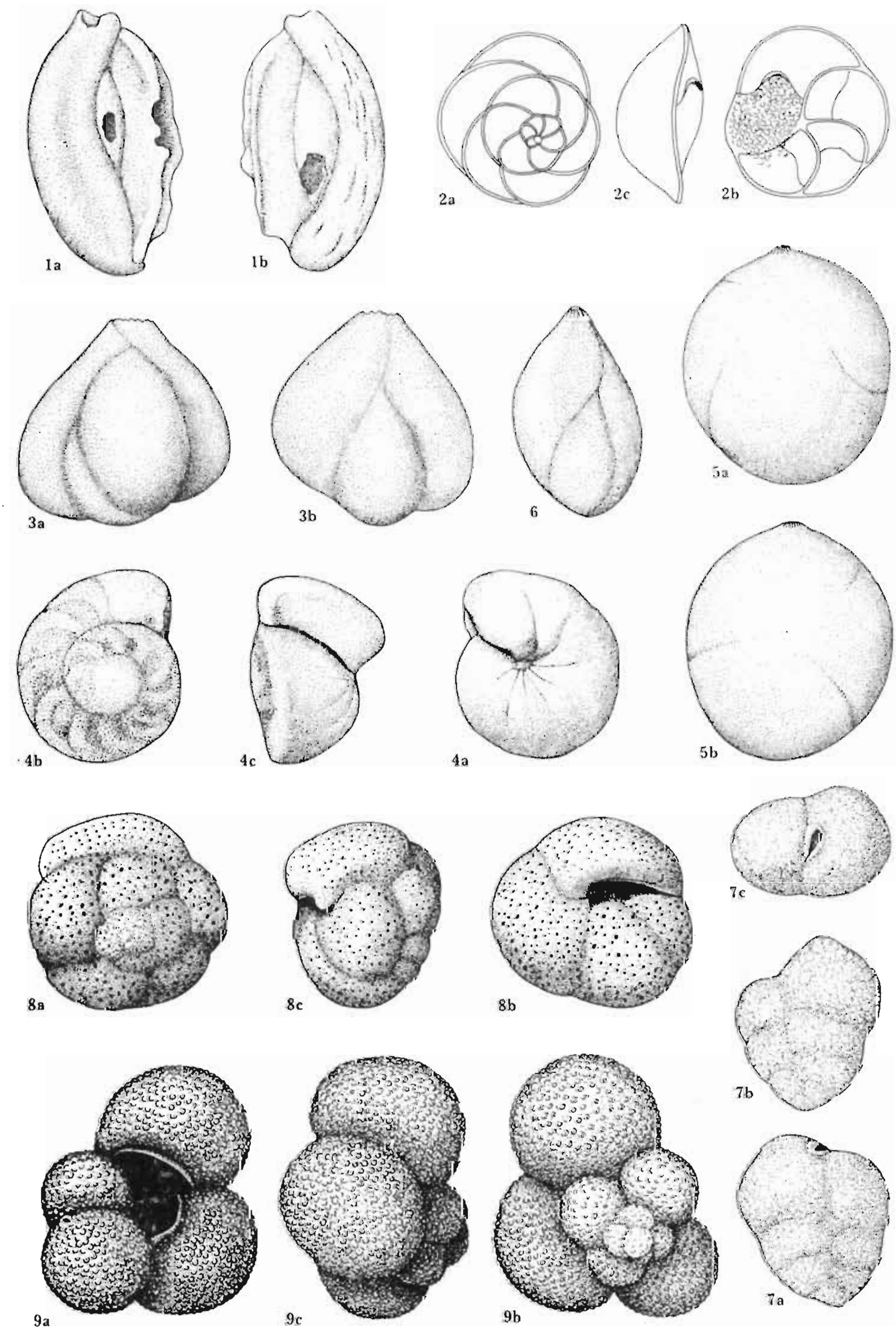
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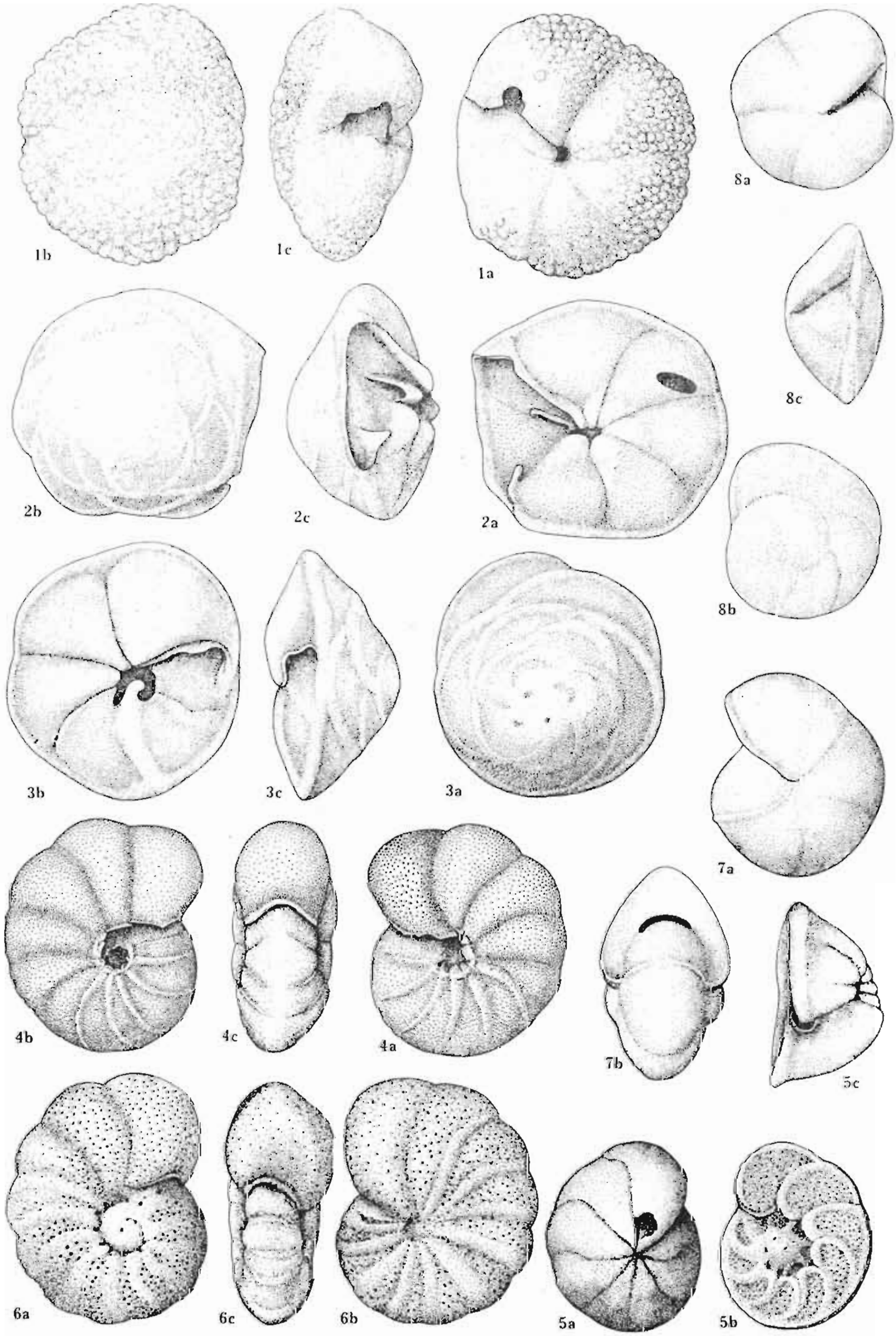
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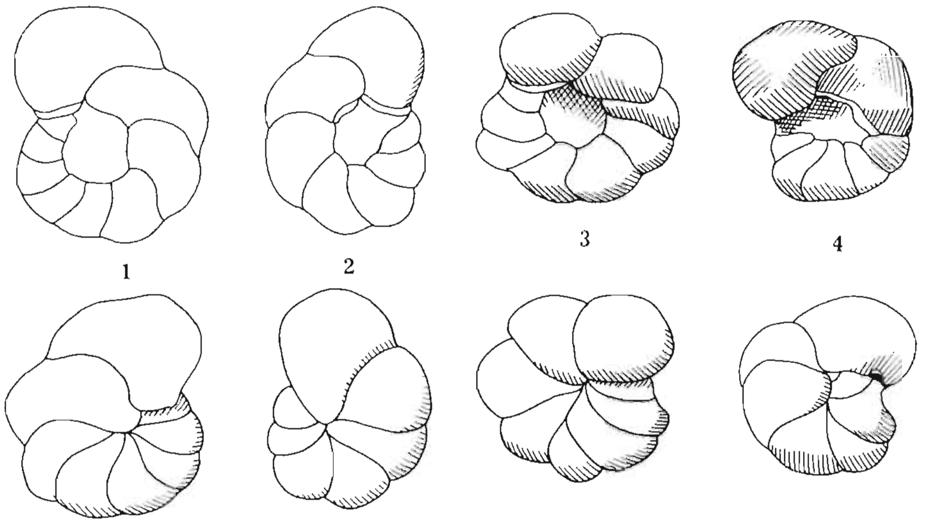

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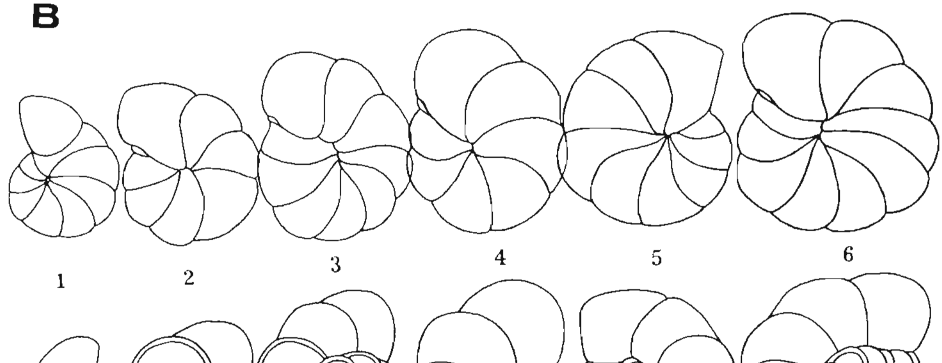

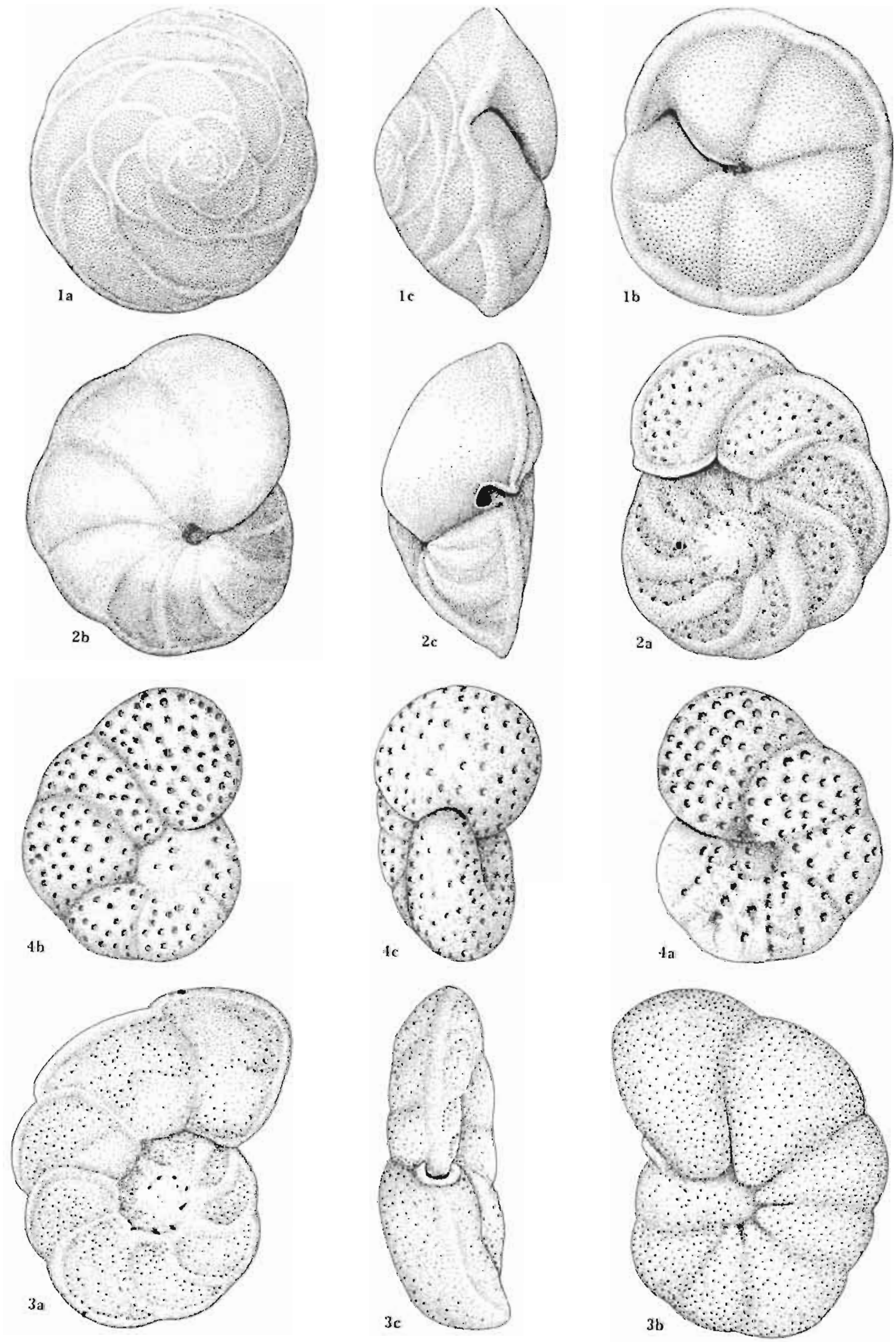
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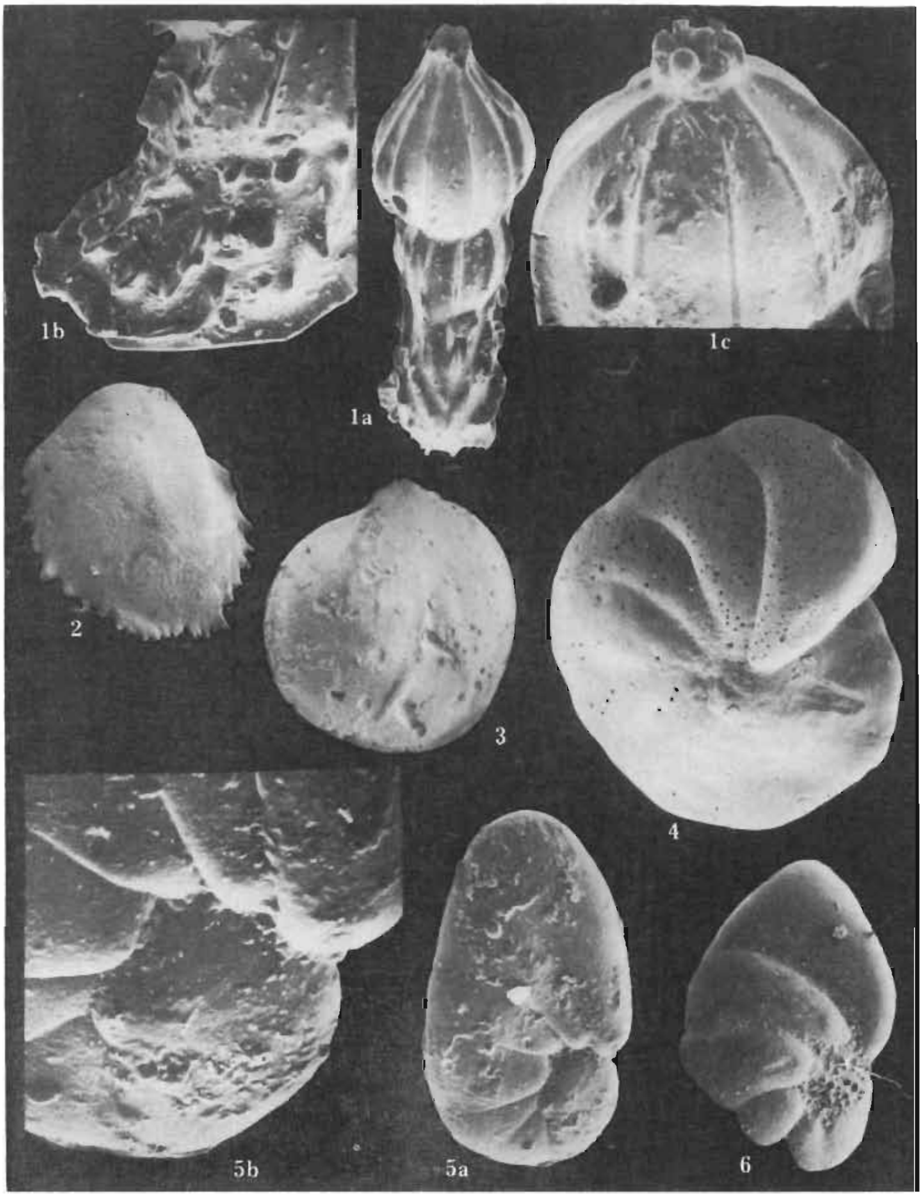
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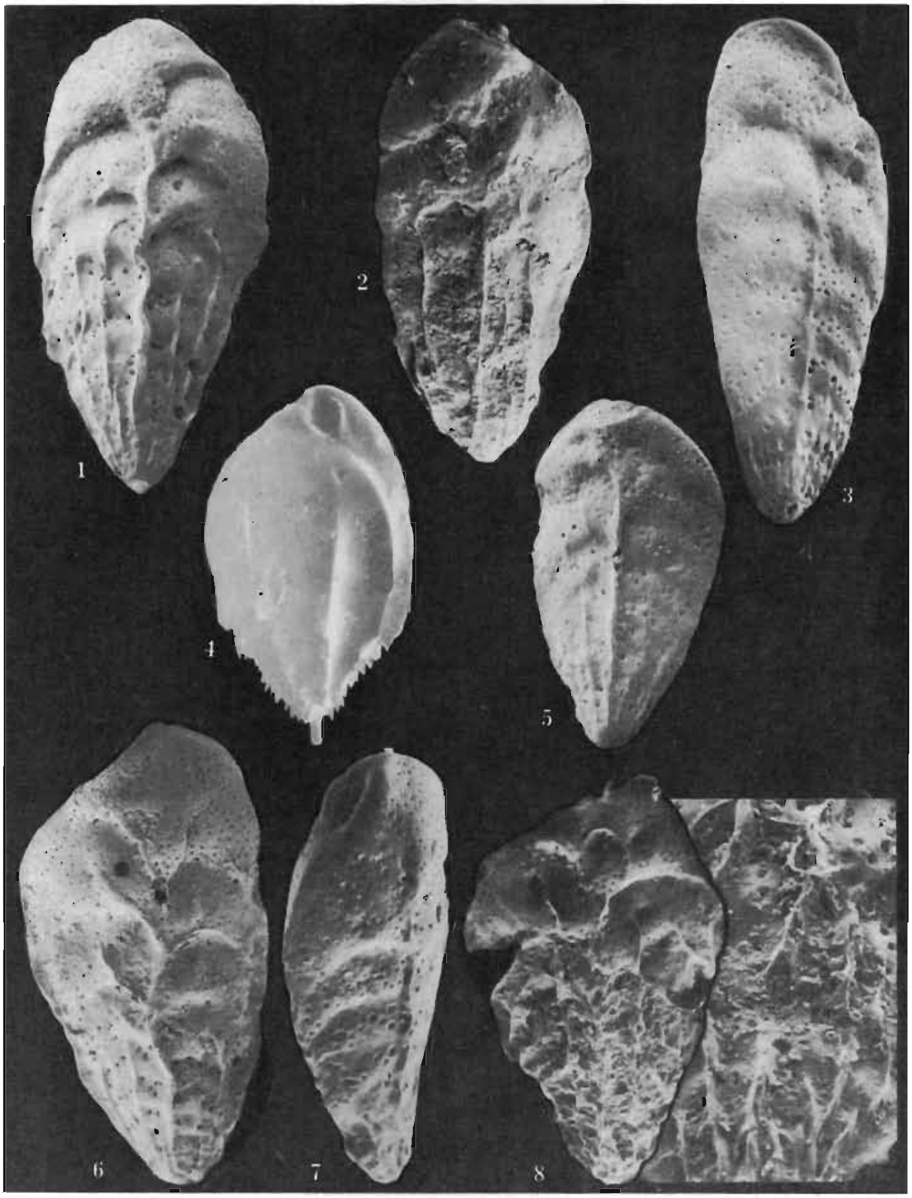
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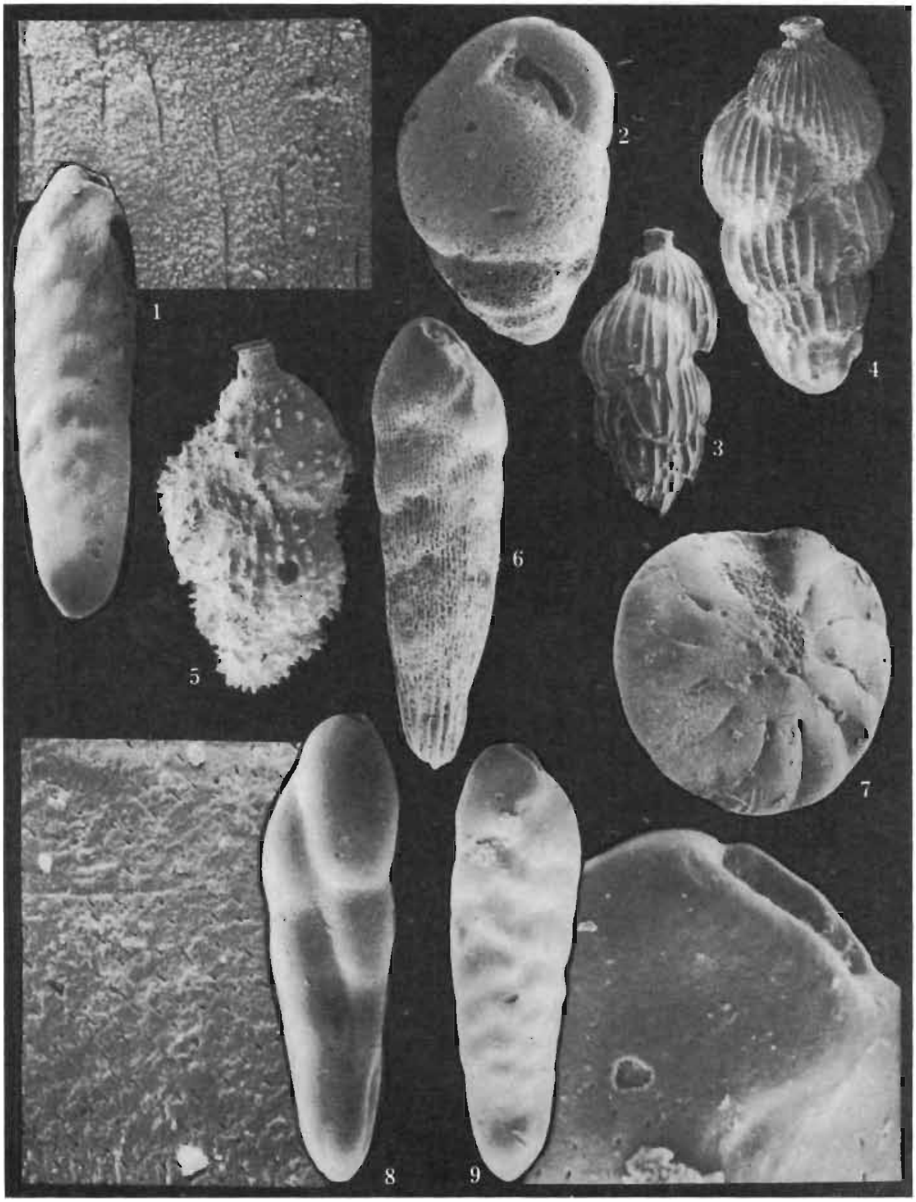

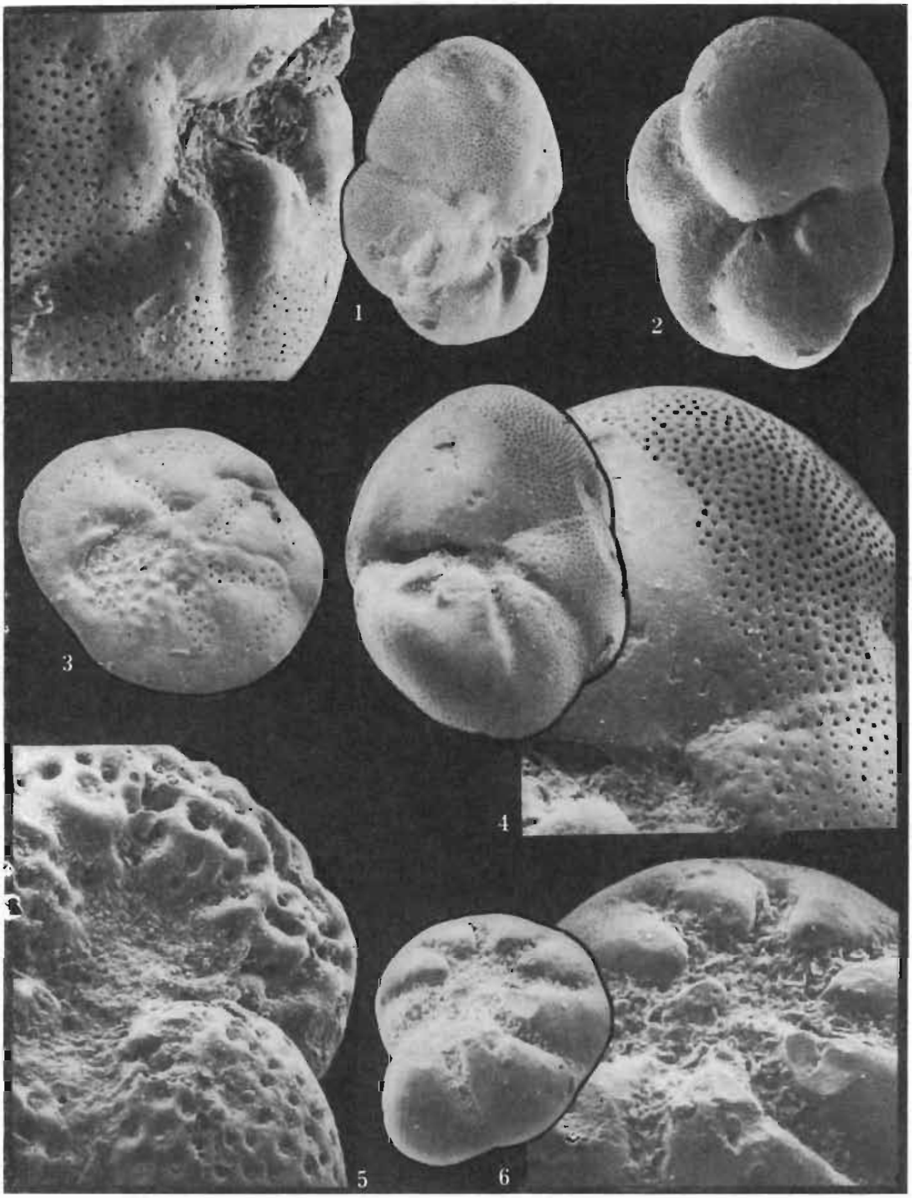
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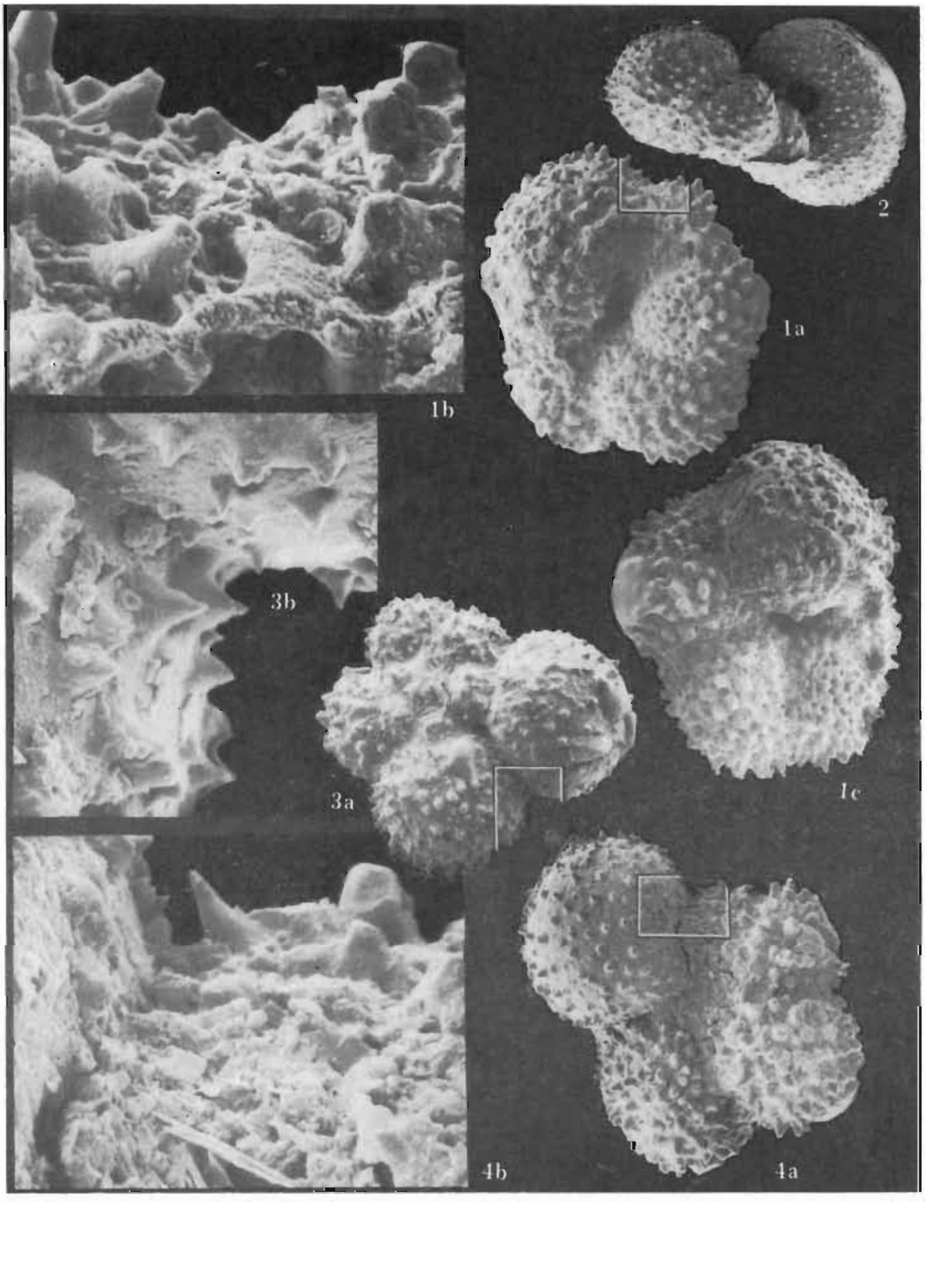
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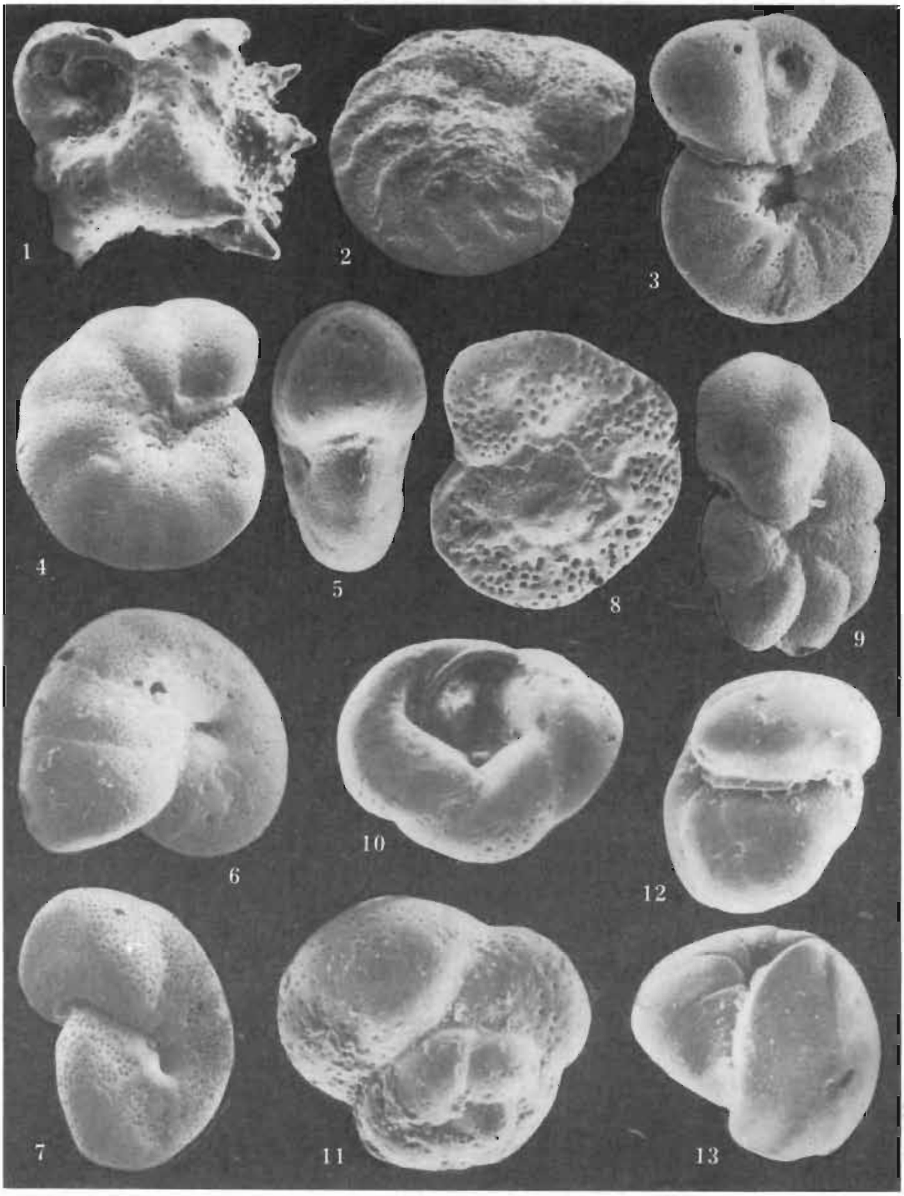
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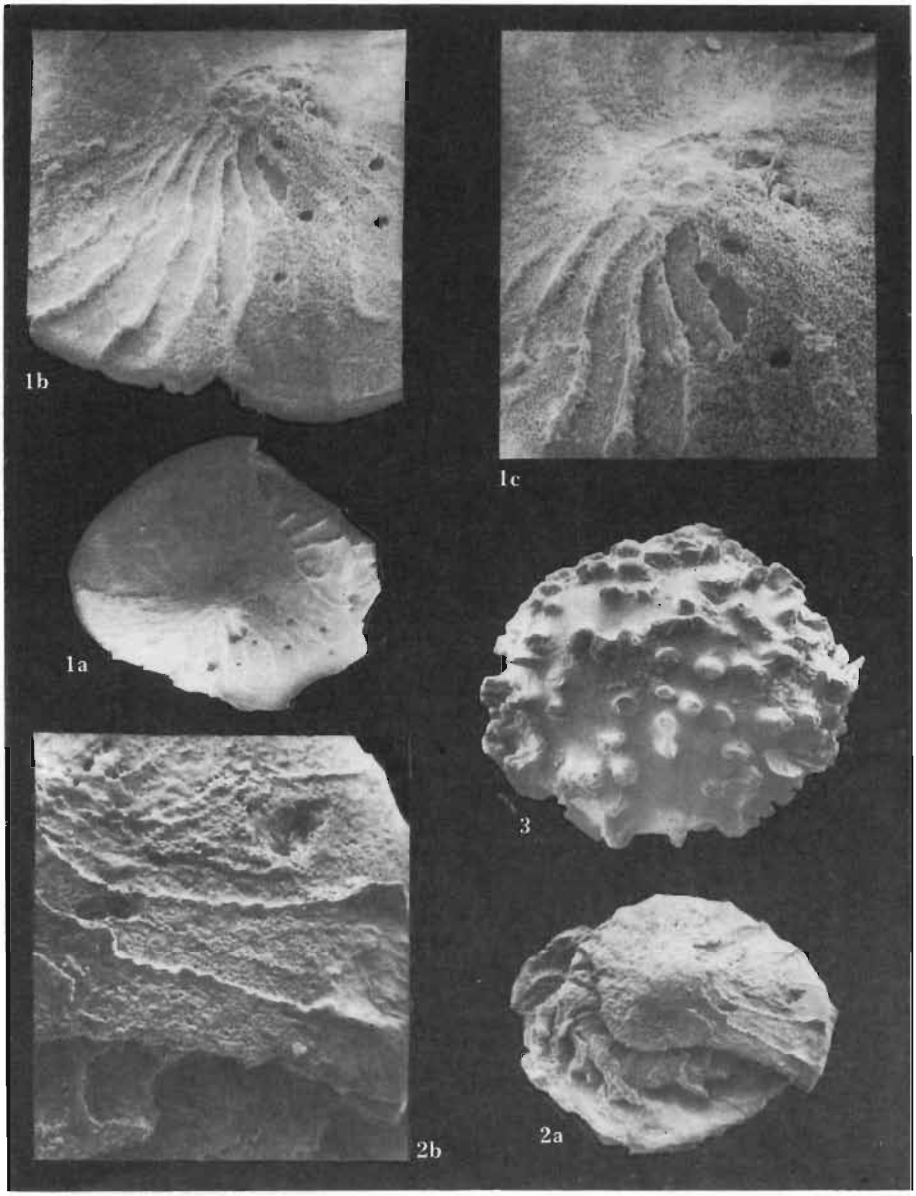
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