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ON NEW LOCALITIES OF MARINE MICROFOSSILS IN UPPER CENOZOIC DEPOSITS OF BELARUS

New data on microfossils from the Upper Cenozoic strata from the territory of Belarus are reported in the article. In the Radashkovichy Upland (Central Belarus), in sands, silts and clays, which are currently mapped as Middle Pleistocene, a mixed association of Upper Cretaceous and Cenozoic Foraminifera was revealed. It is suggested that the Upper Cretaceous foraminifers were reworked in the process of erosion of loose Coniacian — Maastrichtian sediments previously deposited in that region, whereas Cenozoic ones can occur in reworked sediments as well as in situ, as inhabitants of a Late Cenozoic marine basin which supposedly spread over this territory. In the judgment of the authors, any possibilities of preservation of delicate tests of Foraminifera during hypothetical glacial destruction of their host rocks seem very problematic. Another result of the present study is the discovery of an in situ association of agglutinated and calcareous tubular microscopic structures, which may belong to cold-water Foraminifers, in a site located in the eastern part of the Polesian Lowland (Dnieper river bank) in boulder clay. Their host sedimentary unit is regarded in the regional geological literature as the moraine of the Middle Pleistocene Dnieper glaciation. Perhaps this paleontological finding provides evidence of the supposed Late Cenozoic marine transgression to this region. On the basis of the studied material preliminary assumptions about paleogeographical setting and on conditions of sedimentation are suggested.

Key words: Foraminifera; marine microfossils; Upper Cretaceous; Late (Upper) Cenozoic; reworking; in situ occurrence; Belarus.

Fig. 8. Ref.: 20 titles.

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АБ НОВЫХ МЕСЦАЗНАХОДЖАННЯХ МІКРАРЭШТКАЎ МАРСКІХ АРГАНІЗМАЎ У АДКЛАДАХ ВЕРХНЯГА КАЙНАЗОЮ БЕЛАРУСІ

У артыкуле паведамляюцца новыя дадзеныя пра знаходкі мікраскапічных выкапнёвых арганічных рэшткаў з адкладаў верхняга кайназою на тэрыторыі Беларусі. Асацыяцыя мікрарэшткаў змешанага тыпу, у складзе якой фарамініферы верхняй крэйды і кайназоя, выяўлена ў межах Радашковіцкага ўзвышша (цэнтральная Беларусь) у покрыўных пясках, алеўрытах і гліністых пародах, пазначаных на дзейных геалагічных

мапах у якасці сярэднеплейстацэнавых. Выказана меркаванне, што верхнекрэйдавыя фарамініферы былі пераадкладзены ў выніку размыву слабалітыфікаванага асадку каньяцкага-маастрыхтскага ўзросту, распаўсюджанага на гэтай тэрыторыі ў мінулым. У сваю чаргу, кайназойскія фарамініферы могуць знаходзіцца таксама і ў першасным заляганні, як насельнікі познекайназойскага марского басейна, які мог быць пашыраны ў даследаваным рэгіёне. На думку аўтараў, здольнасць крохкіх панцыраў фарамініфер вытрымаць гіпатэтычную ледавіковую дэструкцыю ўмяшчальных адкладаў выглядае малаверагоднай. Другім вынікам праведзенай працы з'яўляецца адкрыццё "інсітнай" асацыяцыі трубчатых карбанатных і аглютынаваных мікрарэшткаў, якія разглядаюцца намі як верагодныя панцыры халаднаводных фарамініфер, у валунным супеску на беразе Дняпра, на ўсходзе Палескай нізіны. Умяшчальныя адклады ў рэгіянальна-геалагічнай літаратуры адносяцца да сярэдняга плейстацэну і лічацца марэнай Дняпроўскага зледзянення. Знаходка можа з'яўляцца палеанталагічным сведчаннем познекайназойскага затаплення гэтай вобласці. Прапануюцца папярэднія высновы пра палеагеаграфічныя абстаноўкі і ўмовы седыментацыі.

Ключавыя словы: фарамініферы; марскія арганічныя выкапнёвыя мікрарэшткі; верхняя крэйда; позні (верхні) кайназой; пераадкладанне; знаходжанне *"in situ"*; Беларусь.

Мал. 8. Бібліягр.: 20 назваў.

Introduction. The micropalaeontological study of some types of argillaceous sediments of Belarus, regarded by most researchers as formations of glacial genesis, that we had undertaken earlier, led to the discovery of Foraminifers and remains of other groups of marine microbiota [1]. The results obtained suggest that the studied strata contain assemblages of micro-fossils, including both elements reworked from previously existing more ancient formations and organisms that lived directly in the basins of the newest sedimentation. This is not entirely consistent with the glacial version of the formation of the enclosing sediments [2]. In particular, the good preservation of fragile microfauna excludes the repeated destructive effects of a series of glaciations, including glacial plucking of the subglacial substrate, erosion by melt water streams saturated with abrasive particles, high pressures on loose rocks from moving ice masses, which are postulated by glacial geologists. In contrast to these views, the hypothesis of water erosion under certain hydrodynamic characteristics of the aquatic environment does not conflict with the possibility of reworking of easily destroyed microfossils found in an almost intact form.

In turn, the presence of fossils of those representatives of marine microfauna that, in our opinion, lived in situ, can be considered as direct evidence of the marine genesis of some types of sediments traditionally classified as continental glacial ones. These include the mass accumulation of tubular cold-water foraminifera, which was identified in the Virynka Section of microlayered clays and silts in the north of the Polack Lowland (Figure 1) [1].

New studies, the results of which are reported in this article, allow us to supplement the previously obtained data, as well as to draw several new conclusions about the conditions of formation of the studied sedimentary units.

Material and methods. The present study is based on the methods described in our previous article [1]. Samples were taken in outcrops and quarries in order to evaluate the main lithological facies. Formation members of considerable thickness (more than 2 m) and a uniform lithological composition were sampled with combined samples weighing not less than 200 g consisting of spot samples taken along the strike and across the strike of the member. In the laboratory, after exposure to short-term heating in a solution of baking soda, a part of each sample weighting 100 g was passed through the standard set of sieves. The thinnest fraction passing the 0.25 mm sieve was collected and subsequently decanted. The remaining parts of the samples are kept intact for possible additional analyses: diatom, spore-pollen, isotope-geochemical, etc.

Fossil microobjects were selected under a binocular microscope from washed and dried sediment with a wet brush or a preparation needle and mounted with a sticky solution of sucrose on a cardboard carrier for subsequent imaging.

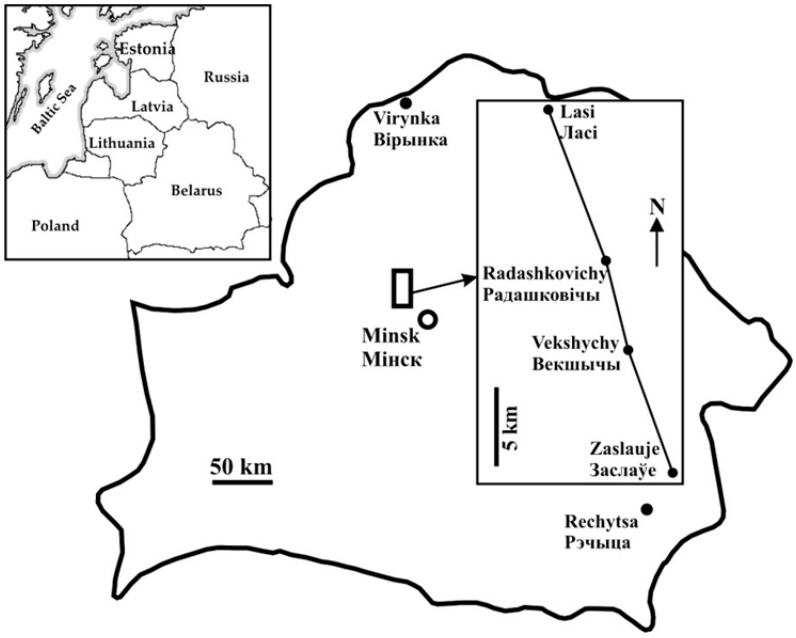

Figure 1. — Studied localities of marine microfossils in Upper Cenozoic deposits in Belarus

Малюнак 1. — Даследаваныя месцазнаходжанні мікрарэшткаў марскіх выкапнёвых арганізмаў у адкладах верхняга кайназою Беларусі

Microfossils were imaged by means of scanning electron microscopy (SEM) and also under reflected light using the OGME-P2 binocular microscope and the Sony DSC-H10 digital camera. The coordinates and absolute altitude of the studied locations are determined using the "Google Earth" service and topographic maps.

The studied micropaleontological material is deposited in Yu. Zaika's collection (Minsk, Belarus).

Results and discussion

Radashkovichy Upland. As a result of sampling of sand-gravel pits located along a conditional line along the axis of the Radashkovichy Upland to the north of Zaslauye area described earlier [1] the foraminifera and other organic microfossil assemblages were revealed in the localities of Viekshychy, Radashkovichy-1 and Lasi (Figure 1).

The Viekshychy Section (54°3'44.01"N, 27°11'0.50"E) is located 8.5 km northwest of Zaslauye area, north of the settlement of Viekshychy in the Minsk Region. Sampling was carried out in a sand and gravel pit on the southern slope of an elevation with an absolute altitude of about 290 m. The following formations were revealed from top to bottom under the topsoil (Figure 2).

1. White-yellow loess-type sandy loam, about 0.5 m thick.

2. Light-yellow bedded sand with interlayers of brown argillaceous sand. The bedding is intensely deformed. Thickness is up to 3.0 m.

3. Dense brown sandy loam and loam, with interlayers and lenses of gravel, pebbles, infrequent boulders of crystalline and sedimentary rocks ("till"). Thickness of the member is about 5.0 m. From its lower part sample M27 was taken, in which remnants, presumably of *Pteropoda* Cuvier and other organisms of problematic systematic position, were found.

4. Uniform interlayer of fine, argillaceous, thin-bedded sand, about 0.2 m thick.

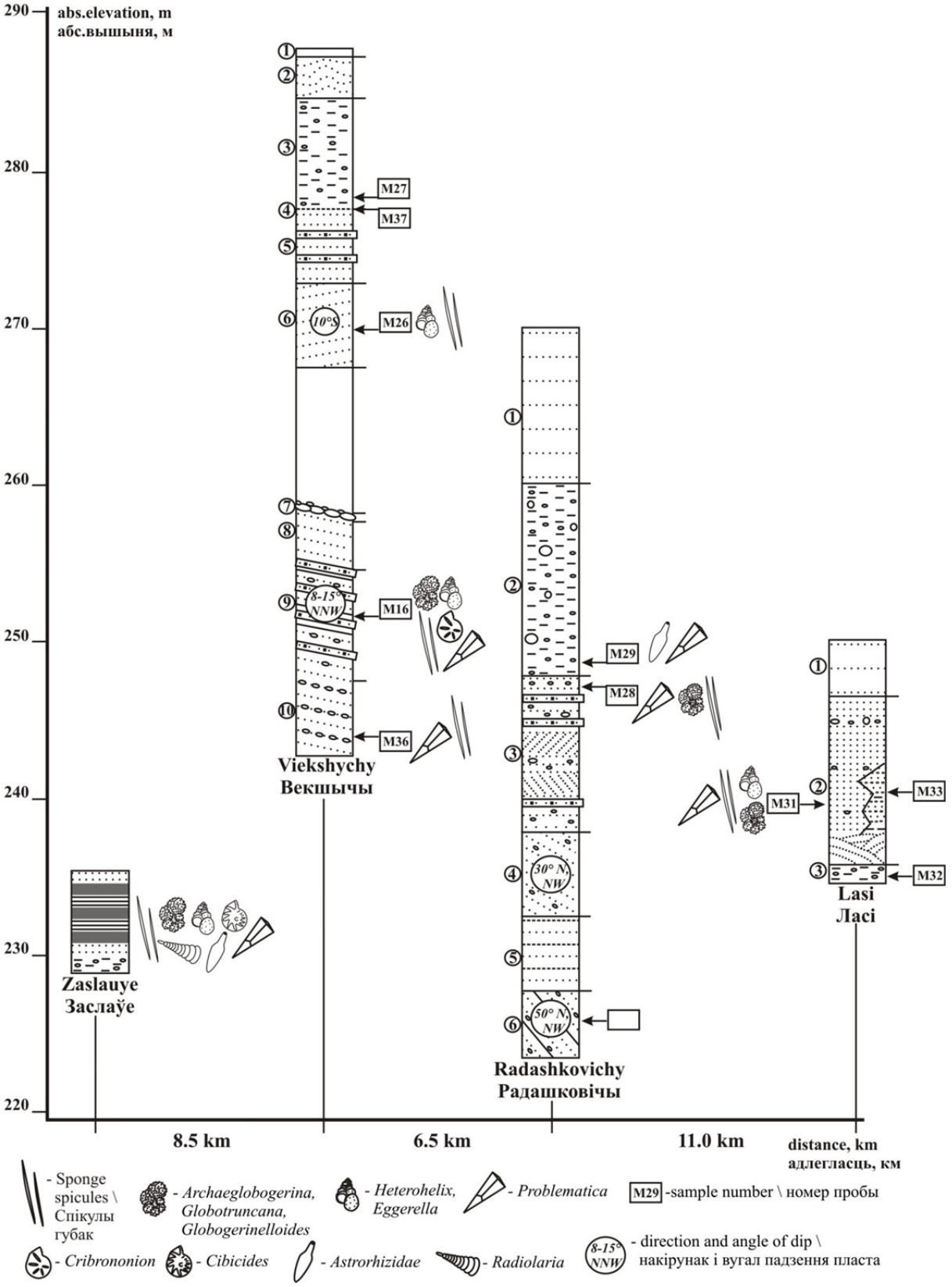

Figure 2. — Zaslauye [1]**, Viekshychy, Radashkovichy-1 and Lasi Sections (Radashkovichy Upland) with sampled localities** (layerwise description given in the text)

Малюнак 2. — Разрэзы Заслаўе [1]**, Векшычы, Радашковічы-1 і Ласі (Радашковіцкае ўзвышша), з указаннем месцаў адбору проб** (паслойнае апісанне прыведзена ў тэксце)

5. Laminated sand and gravel unit, in some intervals cemented in the form of slabs and massifs of sandstone and gravelite, with a total thickness of about 5 m. Mostly hidden by scree.

6. Fine-grained sand, thin-bedded, with thickness of about 5.0 m. The dip of the bedding is to the south at an angle of 10º. Sample M26 was taken from the lower part of the interval, in which foraminifera *Heterohelix striata* (Ehrenberg) (= *Guembelina (Pseudoguembelina) striata* (Ehrenberg)) (Figure 3, *p*) were revealed, as well as some globigerinidae-like foraminifers (Figure 4, *a*). Of them, *H. striata* (Ehrenberg) is characteristic of the Upper Cretaceous, mainly for the Coniacian-Maastrichtian. The foraminifers mentioned in the present work as *H. striata* (Ehrenberg) are probably identical to the foraminifera of Zaslauye area, which we previously referred to as *Spiroplecta* sp. [1]. In addition, sponge spicules (Figures 5, *a—e*) and microfossils of unidentified organisms (Figures 5, *l—n*) were found.

The sand interval below with a thickness of about 7—9 m is almost completely covered with talus.

7. A boulder-pebble interlayer with the uniform thickness of about 0.5 m that dips to the north-northwest at angles of 8—15º. All the underlying layers down to the bottom of the pit have the same dip. Thus, between layers 6 and 7, there is probably an angular unconformity hidden by the talus.

8. Layered sands, with streaks of gravel, pebbles and with separate boulders. The member is up to 3-4 meters thick.

9. Horizontally and diagonally layered sand and gravel with pebbles and boulders, separate intervals of which are cemented to form slabs of sandstone and gravelite about 0.5 m thick. The slabs can merge into layered cemented massifs of more than 2.0 m thick. In the middle of the unit there are thin bands of fine and silty sands grading into silt, as well as individual thin bands of brown “chocolate” silty clay. Total thickness of the member is about 6—8 м. Sample M16 was taken from a silty clay band; in the sample numerous foraminifers (Figures 3, 4), as well as sponge spicules, sometimes interconnected (Figure 5, *a*), fish teeth (Figure 5, *k*) and other microfossils (Figures 5, *f—j*, *l—n*) were found. The number of tests of Foraminifera is measured in hundreds of specimens per 100 g of sediment. Sponge spicules and foraminifers are well-preserved. The following foraminifers were identified: *Archaeglobigerina* sp. (Figures 3, *a—i*), *Globotruncana* sp. (Figures 3, *j—l*), *Heterohelix striata* (Ehrenberg) (Figures 3, *n*, *o*), *Lagena* sp. (Figure 4, *b*), *Elphidiella* sp. (Figure 4, *f*) and *Eggerella brady* (Cushman) (Figure 3, *m*). The majority of the foraminifers found are similar to the Upper Cretaceous (mainly Coniacian-Maastrichtian) foraminifera. At the same time, some of them may be characteristic of the Cenozoic, including representatives of the family *Elphidiidae* (Figures 4, *c—e*), *Elphidiella* sp. (Figure 4, *f*) and also *Cribrononion incertus* (Williamson) (Figures 4, *g—j*). The latter represents a widespread Late Cenozoic arctic-boreal species, existing until the present time. *Eggerella brady* (Cushman) also belongs to a group of foraminifers with a wide stratigraphic range from the Cretaceous to the present.

10. Horizontally, obliquely and diagonally layered sands, with interlayers and lenses of gravel, pebbles and boulders, sometimes cemented into sandstone and gravelite. The unit thickness above the bottom of the pit is about 4 m. In a sample M36 taken 2.5 meters above the pit bottom numerous sponge spicules and some skeletal debris were found. In the gravel fraction there are some apparently reworked fossils, including a tiny specimen of solitary Scleractinian coral.

The Radashkovichy-1 Section (54°7'19.45"N, 27°10'4.79"E) is located in the Maladziechna District of the Minsk Region, 6.5 km north of the Viekshychy Section, and is characterized by absolute altitudes of 255—280 m, exposed from the south by the pit mine.

The following sedimentary units were revealed from top to bottom under the topsoil (Figure 2).

1. Light-colored loess-like deposits, grading downward to white-gray sand with pebbles and small boulders. Total thickness is about 10 m.

2. Brown sandy loam (“till”) with a large number of boulders and pebbles, with interlayers and lenses of clay sands. Total thickness is up to 15 m. In sample M29, taken directly above the bottom of the sequence, an association of microfossils was encountered, which, similar to the upper sandy loam unit in the Viekshychy Section, included supposed pteropods and problematic organic forms, as well as single tubular agglutinating foraminifera of the family *Astrorhizidae* (Figure 4, *k*).

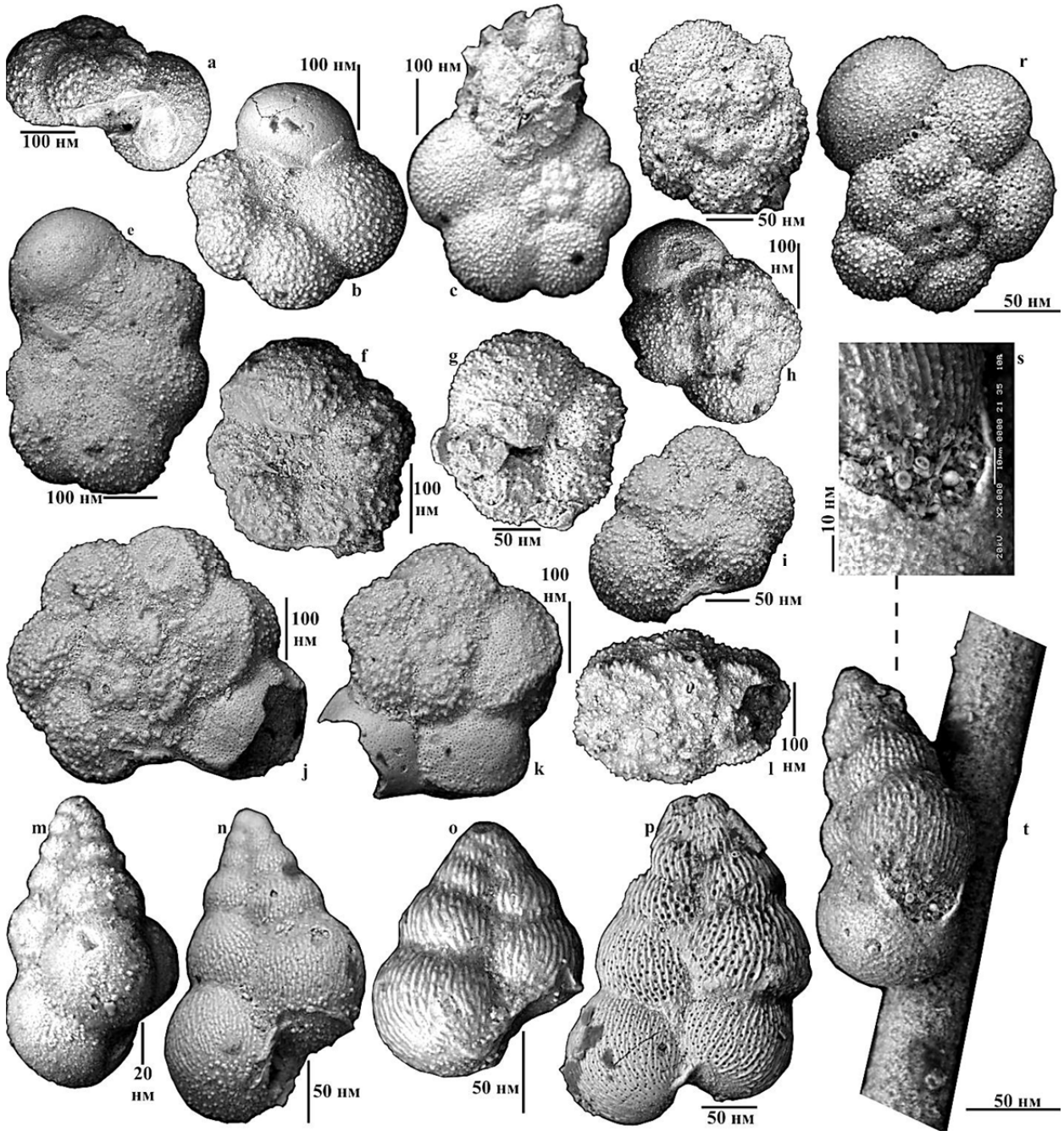

Figure 3. — Upper Cretaceous foraminifers of the Viekshychy, Radashkovichy-1 and Lasi Sections (Radashkovichy Upland): *Archaeglobigerina* sp.: ***a—i*** (sample M16, Viekshychy), ***h*** (sample M28, Radashkovichy), ***r*** (sample M31, Lasi); *Globotruncana* sp.: ***j—l*** (sample M16, Viekshychy); *Eggerella brady* (Cushman): ***m*** (sample M16, Viekshychy); *Heterohelix striata* (Ehrenberg): ***n, o*** (sample M16, Viekshychy), ***p*** (sample M26, Viekshychy), ***s, t*** (sample M31, Lasi), ***t*** — test of *H. striata* attached to sponge spicule, ***s*** — aperture of same test filled with nannofossils

Малюнак 3. — Фарамініферы верхняй крэйды з разрэзаў Векшычы, Радашковічы-1 і Ласі (Радашковіцкае ўзвышша): *Archaeglobigerina* sp.: ***a—i*** (узор М16, Векшычы), ***h*** (узор М28, Радашковічы), ***r*** (узор М31, Lasi); *Globotruncana* sp.: ***j—l*** (узор М16, Векшычы); *Eggerella brady* (Cushman): ***m*** (узор М16, Векшычы); *Heterohelix striata* (Ehrenberg): ***n, o*** (узор М16, Векшычы), ***p*** (узор М26, Векшычы), ***s***, ***t*** (узор М31, Ласі), ***t*** — панцыр *H. striata*, прымацаваны да спікулы губкі, ***s*** — вусце таго ж экзэмпляра, запоўненае нанафасіліямі

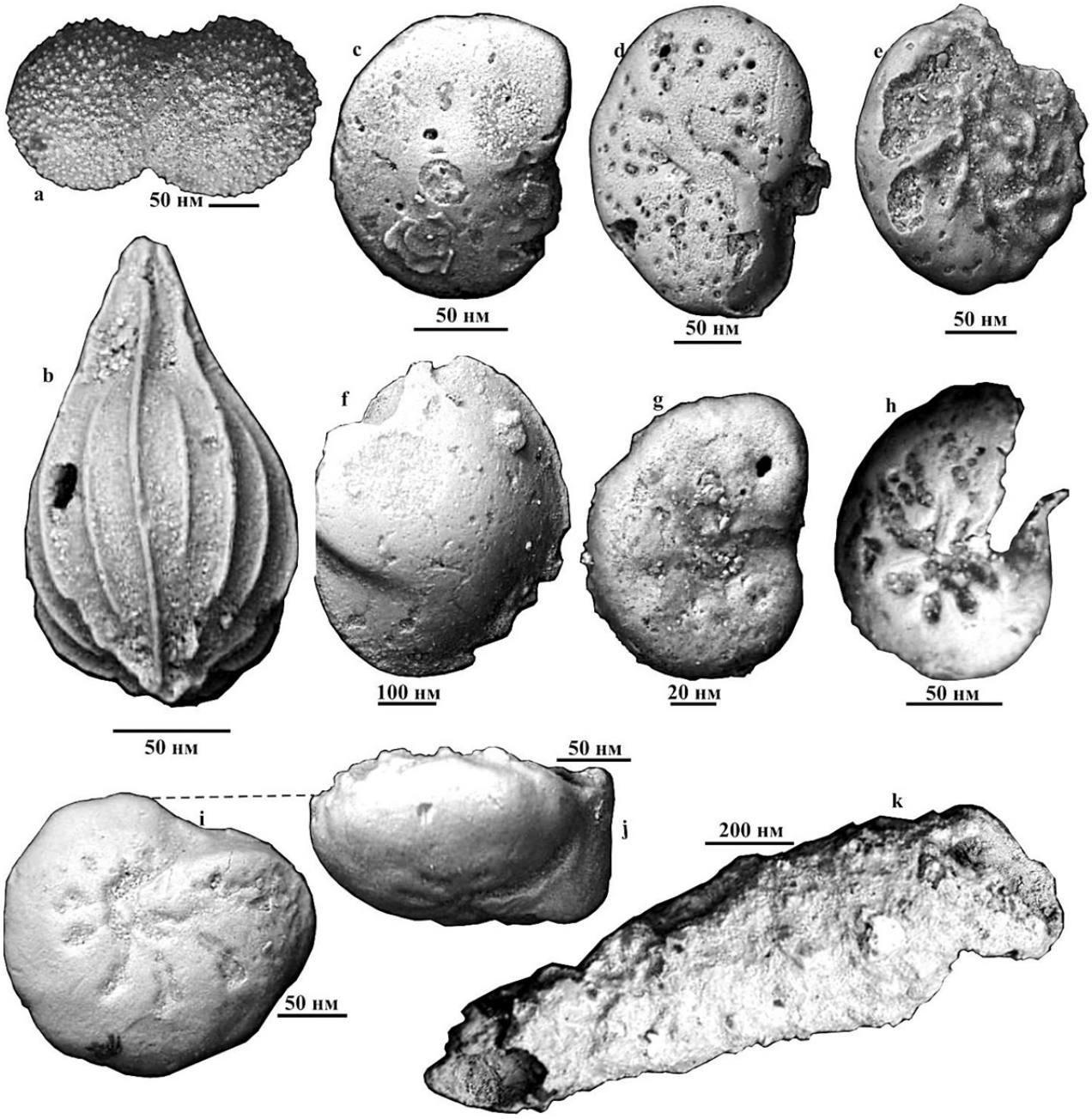

Figure 4. — Cenozoic and Upper Cretaceous Foraminifera from the Viekshychy and Radashkovichy-1 Sections (Radashkovichy Upland): ***a*** *— Globigerinidae* inc. gen. (sample M26, Viekshychy); ***b*** *— Lagena* sp. (sample M16, Viekshychy); ***c—e*****:** *Elphidiidae* inc. gen. (sample M16, Viekshychy); ***f*** *— Elphidiella* sp. (sample M16, Viekshychy), ***g—j*** *— Cribrononion incertus* (Williamson) (sample M16, Viekshychy); ***k*** *— Astrorhizidae* inc.gen. (sample M29, Radashkovichy-1)

Малюнак 4. — Фараміниферы кайназоя і верхняй крэйды з разрэзаў Векшычы і Радашковічы-1 (Радашковіцкае ўзвышша): ***a*** *— Globigerinidae* inc. gen. (узор М26, Векшычы); ***b*** *— Lagena* sp. (узор М16, Векшычы); ***c—e*****:** *Elphidiidae* inc. gen. (узор М16, Векшычы); ***f*** *— Elphidiella* sp. (узор М16, Векшычы), ***g—j*** *— Cribrononion incertus* (Williamson) (узор М16, Векшычы); ***k*** *— Astrorhizidae* inc. gen. (узор М29, Радашковічы)

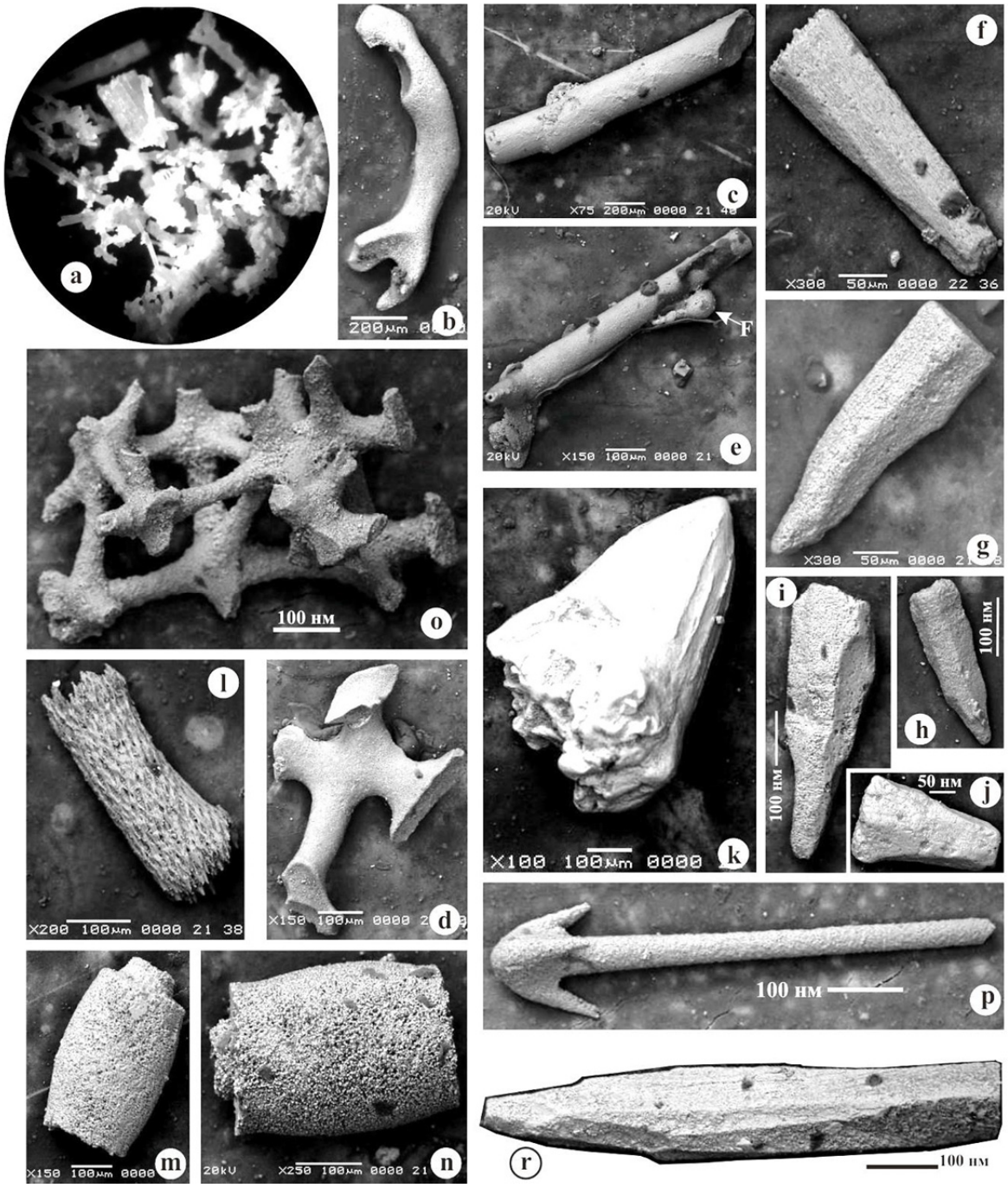

Figure 5. — Microfossils from the Viekshychy, Radashkovichy-1 and Lasi Sections (Radashkovichy Upland): *Porifera*: ***a*** (sample M16, Viekshychy) and ***o*** (sample M31, Lasi) — fragments of *Hexactinellid* sponge skeletons, ***b***—***e*** (sample M26, Viekshychy) — skeletal elements, ***e*** — spicule with attached foraminifera test (F), ***p*** — tetraxonal spicule (*Demospongiae*, sample M31, Lasi); bony fish (*Osteichthyes*): ***k*** — tooth (sample M16, Viekshychy); problematic microfossils (*Problematica*): ***f, h, j*** (sample M16, Viekshychy), ***g, i, l*** (sample M28, Radashkovichy), ***m, n*** (sample M16, Viekshychy — small laminae on surfaces of the microfossils are mineral particles of enclosing sediment), ***r*** — (sample M31, Lasi)

Малюнак 5. — Выкапнёвыя арганічныя мікрарэшткі з разрэзаў Векшычы, Радашковічы-1 і Ласі (Радашковіцкае ўзвышша): *Porifera*: ***a*** (узор М16, Векшычы), ***o*** (узор М31, Ласі) — фрагменты шкілетаў *Hexactinellida*, ***b***—***e*** (узор М26, Векшычы) — шкілетныя элементы, ***e*** — спікула з прымацаванай фарамініферай (F), ***p*** — тэтраксонная спікула (*Demospongiae*, узор М31, Ласі); касцявыя рыбы (*Osteichthyes*): ***k*** — зуб (узор М16, Векшычы); праблематычныя мікрарэшткі (*Problematica*): ***f, h, j*** — узор М16 (Векшычы), ***g, i***, ***l*** — узор М28 (Радашковічы-1), ***m, n*** (узор М16, Векшычы — дробныя пласцінкі на паверхнях мікрафасілій з'яўляюцца мінеральнымі часцінкамі асадку), ***r*** — (узор М31, Ласі)

3. Subhorizontal and cross-laminated sands, with intervals of clay sands, layers and lenses of boulders, pebbles and gravel. Laminated sandstone slabs and gravelite massifs are observed. The total thickness of the stratum is about 10 m. Sample M28 was taken from near its top, and contain a few foraminifera *Archaeglobigerina* sp. (Figure 3, *h*), resembling foraminifers known from Coniacian and Santonian strata of Belarus.

4. Layered sands with gravel interlayers, occurring with angular unconformities with respect to overlying and underlying intervals. The dip is towards the north and northwest at an angle of 30º. Thickness is about 5 m.

5. Brown, horizontally layered clayey sands with gravel and small boulders. Thickness is about 5 m.

6. White, layered, fine sand with streaks of fine gravel, dipping to the north and northwest at an angle of 45—50º. Bands of brown "chocolate" silty clay are found inside the unit. In a sample taken from the silty clay no microfossils were revealed. The part of this unit exposed in the pit has a thickness of about 5 m.

The Lasi Section (54°12'25.62"N, 27° 4'46.71"E) is located near the railway station of the same name, 11 km north-northwest of the Radashkovichy-1 Section. It is confined to an elevation with absolute altitudes of about 250 m, exposed by quarrying. The following sedimentary units were revealed from top to bottom under the topsoil (Figure 2).

1. Loess-like sandy loam, strongly sandy at the bottom of the interval, with traces of post-depositional sediment flow. The member is up to 2 m thick.

2. Complex sandy unit, represented by subhorizontally- and diagonally-layered light yellow sand with interlayers of gravel, with lenses of pebbles, which laterally transform into sand-gravel mixtures with a high content of boulders, as well as clayey brown moraine-like carbonate sand and gravel deposit. The lamination in the upper intervals of the sequence is intensively deformed in some places. The total thickness of the stratum is about 10 m. Sample M31 was taken from the bottom of yellow layered sands at a depth of about 8 m, in which numerous sponge spicules were found, including interconnected ones (Figures 5, *o*, *p*), single foraminifera tests, including *Archaeglobigerina* sp. (Figure 3, *r*) and *Heterohelix striata* (Ehrenberg) (Figures 3, *s*, *t*) and also problematic microfossils (Figure 5, *r*). All the collected microfossils are well-preserved.

Sample M33 was taken from the clayey sand and gravel moraine-like deposits at a depth of about 5 m, in which problematic tubular microfossils, presumably algae, were found.

3. Red-brown sandy loam and loam. Only the top of the unit was exposed by a quarry.

To generally characterize Zaslauye [1], Viekshychy, Radashkovichy-1 and Lasi localities, it can be noted that among the foraminifers identified in these sections, Coniacian to Maastrichtian (Upper Cretaceous) representatives prevail. Some of the Foraminifera found are known in the Cenozoic and also occur in recent basins: *Cribrononion incertus* (Williamson) and *Eggerella brady* (Cushman). Zaslauye area is somewhat distinguished by the presence of radiolarians, as well as problematic *Astrorhizidae* foraminifers, not revealed in the other sections. In the Radashkovichy-1 section, the *Astrorhizidae* are represented by single specimens, and their preservation is significantly different from those in Zaslauye.

Based on the number of specimens of foraminifera in the samples, the Viekshychy Section is distinguished by the abundance of tests in layers of thin and micro-layered silty clay and fine sand. In contrast, in sand samples from Radashkovichy-1 and Lasi Sections, foraminifera are rare. This contrast reflects the geological situation in the areas where the relevant sections are located. In Viekshychy and Zaslauye the Upper Cenozoic sandy-clayey strata are underlain by Cretaceous (Cenomanian-Turonian) formations, while in the area of the Radashkovichy-1 and Lasi Sections the underlying formations are Devonian [3].

Traces of deformation of sediments and the presence of angular unconformities may indicate events of post-sedimentary seismic and tectonic impact on the deposits.

Polesian Lowland: microfossils from boulder clay ("till") of the Rechytsa-1 Section. The Section is located on the right bank of the Dnieper River in Rechytsa, Gomel Region. Absolute elevations of the locality are about 118—120 m. The following strata are exposed in the river bank for 1.0 km, from top to bottom.

1. Recent topsoil, up to 1.0 m thick.
2. Fine and medium sand, light yellow, about 1.0—1.5 m thick.
3. Brown massive boulder clay (sandy loam or "till"), with inclusions of a small number of boulders, pebbles and gravel particles, with frequent randomly scattered round nodules of sandy loam composition. About 5—7 m of sandy loam is exposed at the water's edge in the river (Figure 6). Member 3, exposed along the bank of the river, is referred in literature to the Middle Pleistocene and is considered to be a moraine of the Dnieper Glaciation [4].

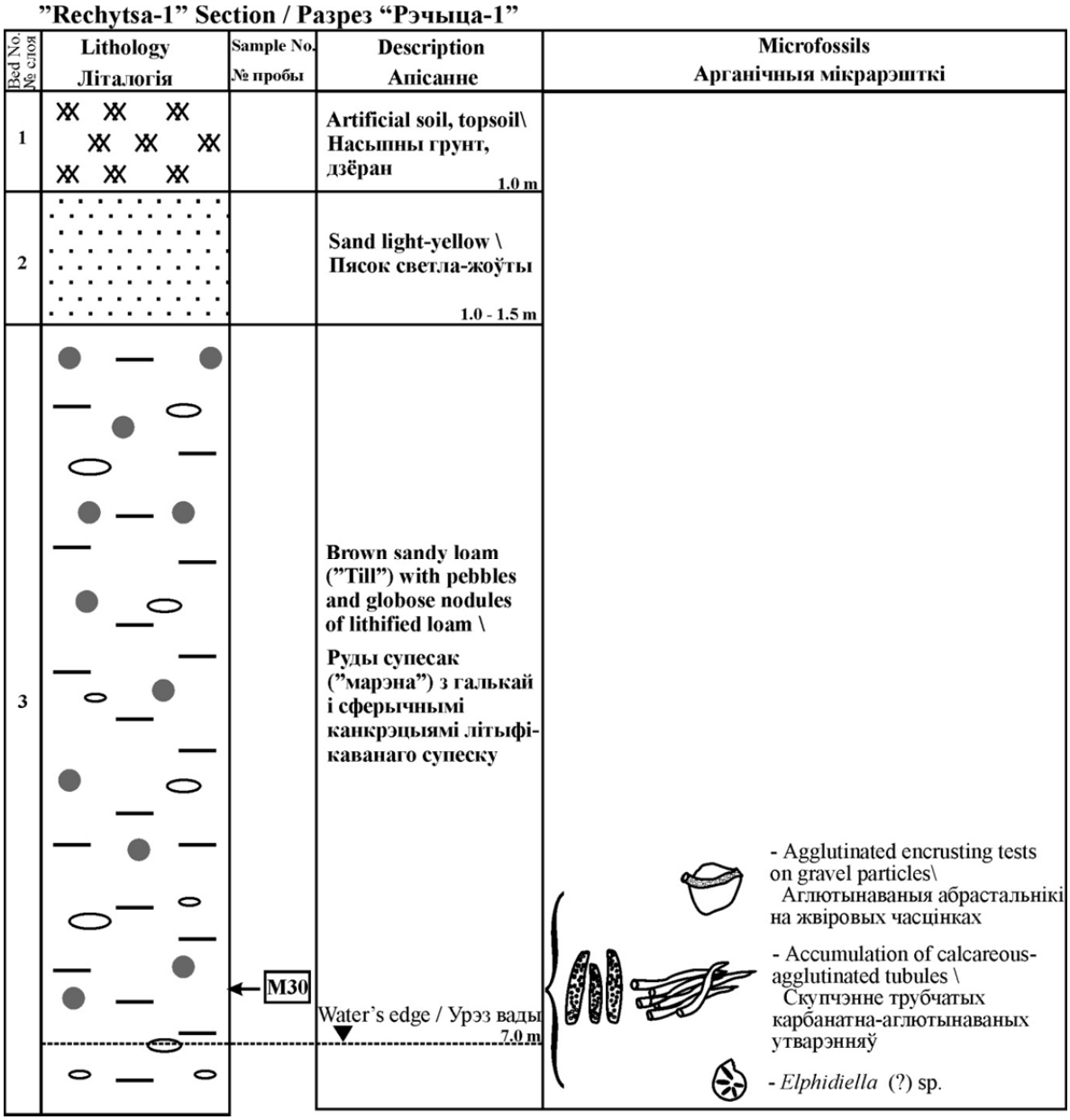

Figure 6. — Rechytsa-1 Section, Polesian Lowland (layerwise description given in the text)

Малюнак 6. — Разрэз Рэчыца-1, Палеская нізіна (паслойнае апісанне прыведзена ў тэксце)

The sampling of sedimentary unit 3 was carried out in a clay pit located at the base of the river bank (52°22'31.60"N, 30°25'0.22"E). The sample M30 revealed fragments of agglutinating microscopic formations resembling foraminifers of the genus *Tolypammina* Rhumbler and *Rhabdammina* M. Sars (Figures 7, *a*—*e*), as well as single tests of *Elphidiella* sp. (Figure 8, *k*). Encrustation of grains of coarse sand and gravel by *Tolypammina* sp. is observed (Figures 7, *b*; 8 *g*, *h*). Although the belonging of some of the collected specimens to the foraminifera is debatable, recent foraminifera having similar tests that encrust ice-rafted pebbles have been reported in the literature from cold-water seas of high latitudes [5]. Many of the revealed calcareous-agglutinating tubules are characterized by a multilayer wall that includes a relatively complex internal calcareous layer (Figures 7, *c*; 8, *a*—*e*) outside of which occurs a zone of agglutinated particles, cemented by calcareous substance (Figures 8 *c*, *i*, *j*). A similar "cellular" structure of the inner part of test is typical for some representatives of the family *Diffusilinidae* Loeblich et Tappan. The tubules in sample M30 form labyrinthine aggregations covered on the outside by a common layer of silt and fine sand grains.

In addition to the above-described forms, pteropods (?) and organisms of unidentified systematic affiliation were found in sample M30, identical to microfossils of the sandy loams ("tills") of the above-described Viekshychy, Radashkovichy-1 and Lasi Sites. Their preservation may indicate that they are reworked, in contrast to the tubular formations (? foraminifera), the *in situ* occurrence of which seems undoubted.

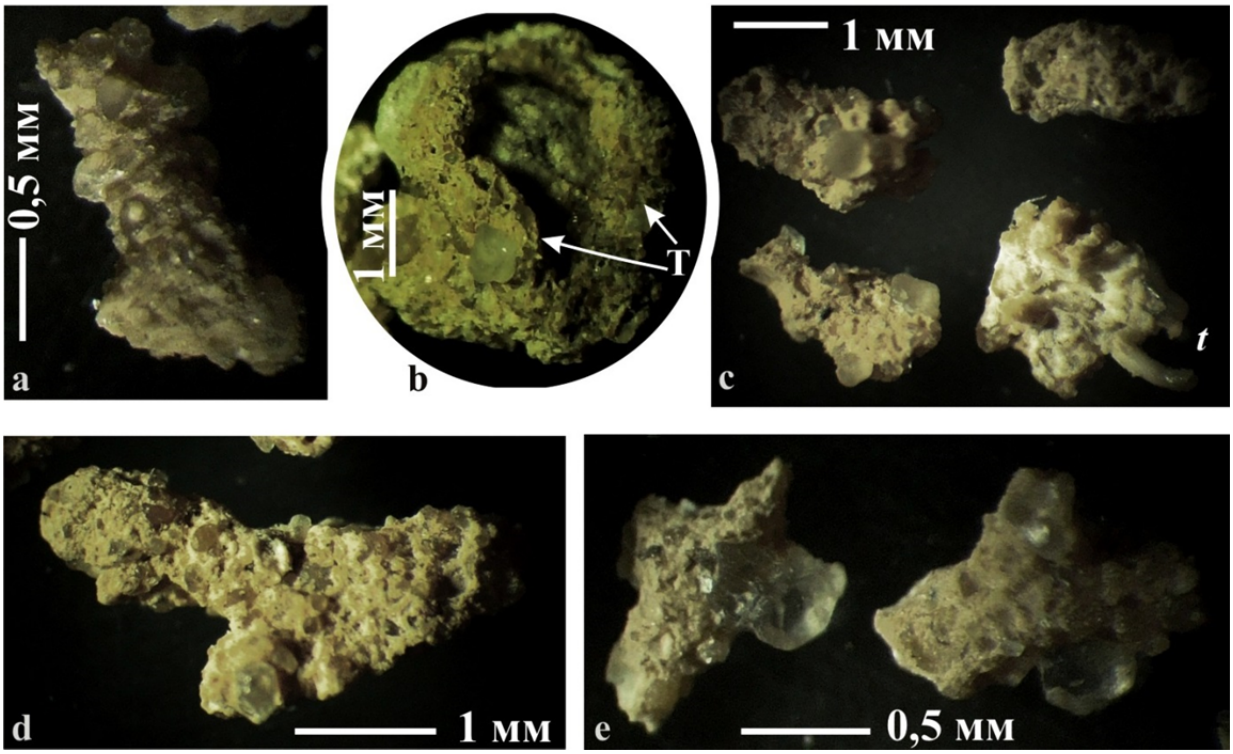

Figure 7. — Agglutinating tubular formations (? foraminifers) from boulder clay ("till") of the Rechytsa-1 Site, Polesian Lowland (sample M30): *a*, *d*, *e* — fragments of agglutinated tubules (probably *Rhabdammina* sp.); ***b*** — probable encrusting *Tolypammina* sp. (T) on gravel particle; ***c*** — probable fragments of *Rhabdammina* sp. and aggregation of calcareous tubules (t)

Малюнак 7. — Аглютынаваныя трубчатыя ўтварэнні (? фараміниферы) з валунных супескаў («марэны») месцазнаходжання Рэчыца-1, Палеская нізіна (узор М30): *a*, *d*, *e* — фрагменты аглютынаваных трубчатых утварэнняў (верагодна, *Rhabdammina* sp.); ***b*** — верагодна, панцыр *Tolypammina* sp. (T), які абрастае жвіровую часцінку; ***c*** — верагодна, фрагменты *Rhabdammina* sp. і скупчэнне карбанатных трубчатых утварэнняў (t)

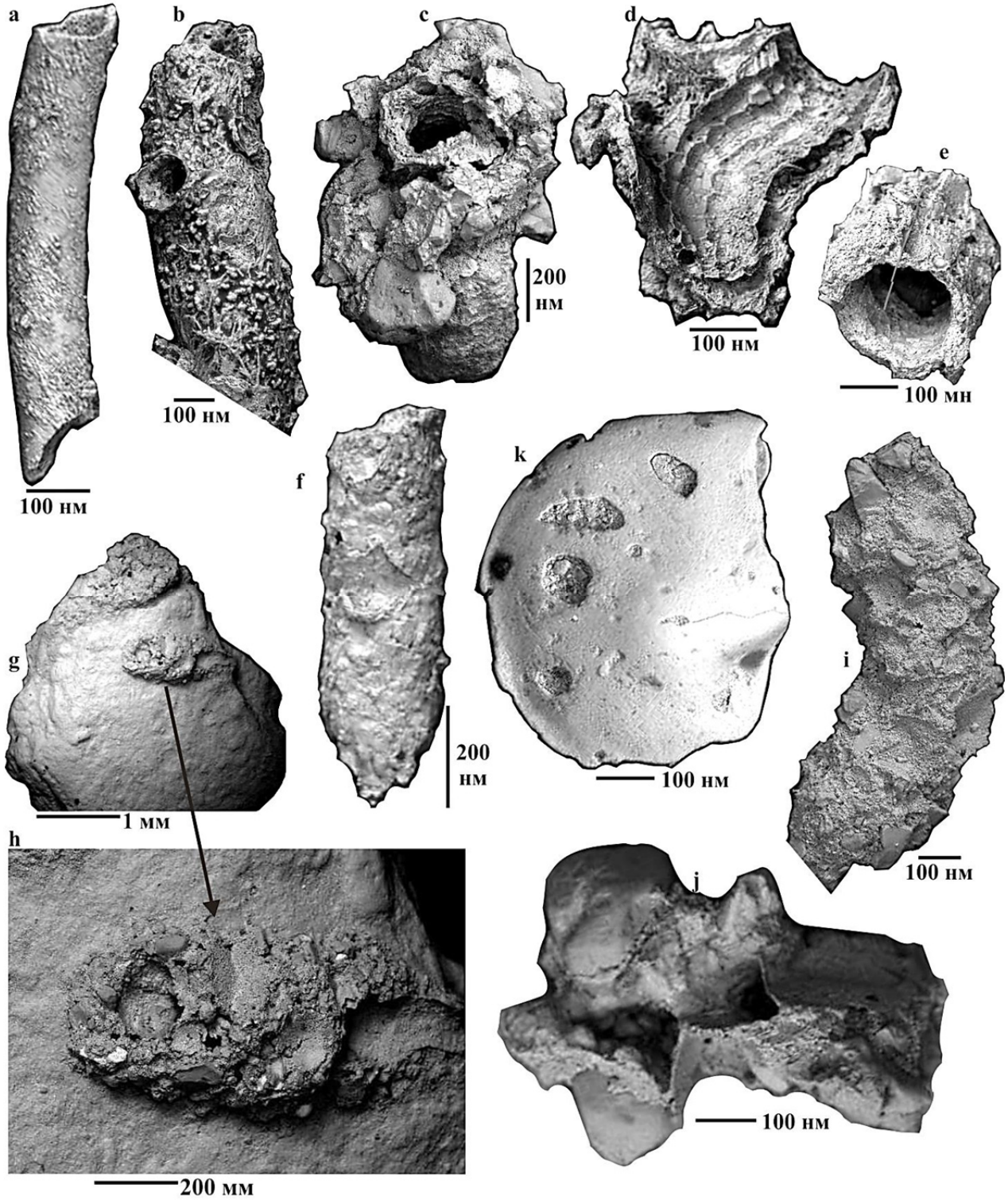

Figure 8. — Microfossils from boulder clay ("till") of the Rechytsa-1 Site, Polesian Lowland (sample M30): ***a***, ***b***, ***e***, ***f*** — fragments of calcareous tubules (foraminifera ?); ***c***, ***i***, ***j*** — fragments of calcareous tubules (foraminifera ?) with agglutinated particles; ***d*** — inner surface of a dichotomous fragment of a calcareous tubule; ***g***, ***h*** — encrusting *Tolypammina* sp. on a gravel particle; ***k*** — *Elphidiella* sp.

Малюнак 8. — Мікрарэшткі з месцазнаходжання Рэчыца-1, Палеская нізіна (узор М30): ***a***, ***b***, ***e***, ***f*** **—** фрагменты карбанатных трубчатых утварэнняў (? панцыры фараміниф ер); ***c***, ***i***, ***j*** **—** фрагменты карбанатных трубчатых утварэнняў (? панцыры фараміниф ер) з аглютынаванымі часцінкамі; ***d*** — унутраная паверхня дыхатамічнага фрагмента карбанатнага трубчатага ўтварэння; ***g***, ***h*** — форма *Tolypammina* sp., якая нарастае на жвіровую часцінку; ***k*** — *Elphidiella* sp.

Reworked and in situ occurrence. These data complement the information we have previously reported [1], and indicate that "moraine" and "glacial-fluvial" sequences in Belarus at various hypsometric levels often contain marine microfossils, which can be either reworked or *in situ*, in some cases occurring together.

The Radashkovichy Upland, as well as the whole Minsk Upland System, is considered by proponents of the glacial concept to be an area of complexly-arranged glacial marginal forms [4]. Accordingly, the material composing them, with various reservations, is considered as largely allochtonous, incorporated by glaciers along their path, and partly mixed with local material [6]. In contrast to such notions, the data obtained by us are consistent with the hypothesis about the prevailing autochthonous origin of clay, silt and partly sand fractions of these sediments, as well as microfossils found in these strata, as supported by the following pieces of evidence:

– *The presence of assemblages of Upper Cretaceous foraminifera of similar geological age and taxonomic composition in several locations of Upper Cenozoic sandy, silty and argillaceous formations over a distance of more than 25 km.* Moreover, since in the northern sections — Radashkovichy-1 and Lasi — the foraminifera are the rarest, it can be assumed that the source of the material was not located to the north of the mentioned locations and, accordingly, the microfossils were not moved from this direction by hypothetical glaciers.

– *Fine preservation of foraminifera tests, their mass accumulations in separate intervals.* It is doubtful that the fragile foraminifers could withstand multiple glacial effects. These effects would have included the destruction of the original Cretaceous sediments and the deposits of preceding glaciations, in which the tests would have been included, and the subsequent erosion by glacial-fluvial flows containing suspension of mineral particles. It should be noted that according to the current stratigraphic schemes of Quaternary formations of Belarus [7], the region in which the studied sections are located, was subjected to no less than four glaciations during the Pleistocene. Some published sources indicate an even greater number of glaciations. Additional effects would have occurred during their secondary stages which could have included oscillatory movements as well as motion of glacial lobes. Therefore, additional active plucking and sediment-destructive activity are postulated [2].

When considering glacial transport, it is necessary to take into account the facts that the possibility of transporting fragile objects by recent continental glaciers, as well as the ability of microscopic fossils to remain intact inside moving glaciers, are not confirmed and are the subjects of discussion [8]. These problems are, as a rule, ignored by the proponents of the glacial theory, who *a priori* declare all the facts of occurrence of marine micro- and macrofossils in the Quaternary strata on the continents to be a result of glacial reworking.

– *The geological age of the Cretaceous foraminifera in the locations of Zaslauye and Viekshychy is slightly younger than that of the Cenomanian-Turonian bedrock strata, which occur in this area.* Accordingly, the revealed microfossil associations could have come from autochthonous formations that stratigraphically and structurally occurred directly above these bedrock strata in the past and which were later eroded. The estimated age of the hypothetical destroyed strata is the Coniacian — Maastrichtian Stages of the Upper Cretaceous and, possibly, the Paleogene and Neogene. Consequently, the clay, silt and fine sand fractions may be the products of water erosion and reworking of the previously existing indigenous bedrock formations of the corresponding age. In contrast to the glacial hypothesis, the deposition of the enclosing sandy and clay formations by water does not contradict the possibility of erosion and redeposition of loose Upper Cretaceous and Paleogene sediments containing foraminifera tests, while preserving them in good condition.

Unlike the fine fractions of the sediment, the coarse clastic material encountered in the described sections may be to varying degrees allochthonous, brought by floating ice, as is currently observed in the Arctic basins.

Along with the foraminifera, the assemblages of microfauna that we established are also characterized by sponge spicules. At least some of the spicules have an Upper Cretaceous age, since they are used by Upper Cretaceous foraminifera as an agglutinated material (Figures 3, *t*; 5, *e*).

Especially remarkable is the detection of calcareous and agglutinated tubular microscopic formations in the area of the "Dnieper glacial moraine" in southeastern Belarus (Rechytsa-1 site, Figures 1, 7, 8), which we interpret as benthic foraminifera, with some degree of doubt. In our opinion, the association identified here includes mainly specimens that were not reworked from older strata. This, along with the good preservation of fragile tubules, is indicated by the encrustation of sediment particles by *Tolypammina* sp. Glacial transport of these encrusted gravel particles does not correspond with the ability of the encrusting tests to remain intact.

Taking into account the finding of tubular foraminifera in the microlayered clays of the Virynka Section in the north of the Polack Lowland [1] located 430 km north-northwest of Rechytsa (Figure 1), the Rechytsa-1 locality, in the southeast of the Polesian Lowland, is of particular interest. In both cases, the intervals containing the tubular foraminifera are confined to a comparable absolute height: about 122 m (Virynka) and about 118—120 m (Rechytsa). To date, there are no sufficient grounds to confidently consider this fact as an indication of their stratigraphic equivalence, which, however, cannot be ruled out. Such a conclusion would contradict the glacial stratigraphic scheme, according to which the boulder clay stratum ("till") on the Dnieper River in Rechytsa should be attributed to the Middle Pleistocene, whereas the laminated clays on the Virynka River should be attributed to the Upper Pleistocene [7]. Additional detailed research will be required to clarify the stratigraphic interrelation of the mentioned sections, including further micropaleontological study of the Upper Cenozoic sediments. In the subsequent consideration of this problem, it is also necessary to note the fact that Virynka and Rechytsa-1 sections are located on opposite sides of the Baltic Sea and Black Sea watershed.

Preliminary assumptions on depositional environments. In our opinion, the Radashkovichy Upland at some stage of its development in the Late Cenozoic could have been a zone of sand bars or islands surrounded by shallow waters in a seasonally freezing marine basin. The sandy-aleuritic and argillaceous fractions are mainly formed as a result of erosion of local Upper Cretaceous and younger loose rocks, while allochthonous boulder and pebble material found in large amounts at some intervals could have been brought by floating ice. The presence of an angular unconformity in the Viekshychy and Radashkovichy-1 Sections, as well as the alternation of horizontally layered units with separate horizons with intensive distortion of bedding may indicate a periodically occurring tectonic activation of the area of the future Radashkovichy Upland. Thus, the formation of the composite Cretaceous-Cenozoic assemblage of foraminifera can be explained by the reworking of Upper Cretaceous and Paleogene microfossils and the simultaneous inclusion of Cenozoic foraminifera. The latter include *Cribrononion incertus* (Williamson) and *Eggerella brady* (Cushman), which could have inhabited the basin during the Late Cenozoic transgression. It is important to note that *Cribrononion incertus* (Williamson) is among ecologically tolerant forms and can be found not only in normal sea conditions, but also in brackish shallow hydrodynamically active environments [8].

If the above-described tubular and encrusting forms indeed belong to foraminifers, the Rechytsa-1 Site apparently is among locations of the Late Cenozoic marine microfossils which are the most distant from the modern marine basins known in Eastern Europe. Hypotheses about the sea flooding of this part of the Polesian Lowland have already been suggested by some specialists. In particular, I. G. Pidoplichko [9] acknowledged the presence of a brackish strait connecting the supposed joint Pliocene-Pleistocene the White Sea and the Baltic Sea basins and the hypothetical Dnieper-Donets system of lakes. I. L. Kuzin [10] substantiated the existence in the valley of the Dnieper River of the strait between the supposed North European and joint the Black Sea and the Caspian Sea basins, formed at least in the Early Pliocene. Our data do not yet allow us to answer

the question of the time of flooding of this area; however, they can be a paleontological confirmation of the above hypotheses.

Concerning sedimentation conditions in the Rechytsa Site, the following tentative assumptions can be made. Recent representatives of *Tolypammina* and *Rhabdammina* are able to inhabit a wide range of environments with different salinity and depths [11—15], which causes their non-specificity as paleoecological and paleohydrological indicators. According to T. G. Lukina [16], the recent *Tolypammina vagans* (Brady) representatives were revealed in the Arctic Ocean at depths of 27—5 278 m, in the Atlantic Ocean at 290—3 220 m, in the Pacific Ocean at 200—6 916 m, in the Atlantic sector of the sub-Antarctic at 105—267 m (Falkland Islands region) and at 26—4 041 m (South Georgia Island), and in the Pacific sector of the Antarctic to a depth of 3 200—3 400 m. The living conditions of the "*Rhabdammina* fauna" also vary significantly as it is widespread from oceanic depressions to lagoon and brackish near-coastal environments [17—19]. Mass accumulations of agglutinating foraminifera are very characteristic of cold-water basins, including the northern and southern polar and subpolar shallow waters. Therefore, despite the fact that domination of agglutinating foraminifera in fossil assemblages can be a secondary phenomenon caused by the dissolution of calcareous tests of foraminifera of the initial community [20], we do not find a contradiction with the assumption about the marine nature of enclosing sandy loams ("moraines" or "tills") and about their having been formed in the cold sea basin. The lack of bedding and the random placement of pebbles and boulders may indicate a comparatively calm hydrodynamic environment and the entry of coarse material with floating ice. Moreover, the intensive movement of gravel and larger clastic particles by movements of the near-bottom water would probably prevent the settling of encrusting foraminifers and would lead to their destruction.

Conclusion. The information above is considered as an indication of the need to revise the existing ideas about the paleogeographic conditions and sedimentation factors that led to the formation of the Upper Cenozoic surficial deposits in the territory of Belarus and neighboring regions of Eastern Europe. As part of the paradigm of continental glaciation dominant in Quaternary geology, the microfaunistic (foraminiferal) study of the Upper Cenozoic strata of Belarus had previously been regarded as meaningless and was newer carried out purposefully. Among other reasons, this led to the construction of stratigraphic charts for Quaternary sediments based on the principles of glacial stratigraphy, which can now be challenged. Our study revealed the presence of reworked and, probably, in situ foraminifera in the Upper Cenozoic strata of Belarus. The excellent preservation of reworked foraminifera tests contrasts with the hypothesis of multiple destructive glacial erosion. In situ specimens even more do not agree with the glacial theory. At the same time, the belonging of some of the tubular agglutinating forms described above to foraminifera must be regarded as not definitively established and requiring additional confirmations. In these regards, further micropaleontological studies of the Upper Cenozoic formations are needed and should be supplemented by a wider array of other methods.

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Паведамляецца пра новыя знаходкі выкапнёвых арганічных мікрарэшткаў з верхнекайназойскіх адкладаў Беларусі (Радашковіцкае ўзвышша, Палесская нізіна). Марскія мікрарэшткі з Радашковіцкага ўзвышша прымеркаваны да пясчана-алеўрытавых утварэнняў і прадстаўлены фарамініферамі, губкамі і некаторымі іншымі групамі. Іх узрост ацэньваецца як верхнякрэйдавы і кайназойскі. Гэтая асацыяцыя складаецца пераважна з пераадкладзеных мікрафасілій, вымытых з парод адпаведнага ўзросту, якія маглі існаваць у тым жа раёне, а таксама ўключае формы, для якіх можна меркаваць існаванне *in situ* ў познекайназойскім марскім басейне. Выключна добрая захаванасць верхнякрэйдавых фарамініфер не стасуецца з версіяй пра шматразовае зледзяненне даследаванага раёна і, адпаведна, інтэнсіўную дэструкцыю адкладаў ледавікамі. Трубчатыя аглютынаваныя і вапнавыя формы, якія з некаторым сумненнем таксама разглядаюцца аўтарамі як фарамініферы, знойдзены на Палескай нізіне (разрэз Рэчыца-1 на правым беразе Дняпра) і прымеркаваны да валунных супескаў. Гэтая асацыяцыя мікрарэшткаў знаходзіцца ў першапачатковым заляганні, на што ўказвае, у прыватнасці, прысутнасць меркаваных фарамініфер-абрастальнікаў на пясчана-жвіровых часцінках. Ледавіковае перамяшчэнне такіх часцінак у складзе марэны не пакінула б магчымасці для захавання на іх паверхнях крохкіх мікрафасілій. Такім чынам, разрэз Рэчыца-1 можа лічыцца другім з вядомых на беларускай тэрыторыі месцазнаходжанняў трубчатых аглютынаваных фарамініфер, пасля нядаўняга адкрыцця месцазнаходжання на р. Вірынка ў Полацкай нізіне. Абодва гэтыя разрэзы маюць амаль аднолькавае гіпсаметрычнае становішча — каля 120 м над сучасным узроўнем мора, аднак размяшчаюцца па розныя бакі Балта-Чарнаморскага водападзелу. Аўтары лічаць, што атрыманыя звесткі могуць быць дадатковымі доказамі раней выказанай гіпотэзы аб утварэнні шэрагу тыпаў адкладаў, якія традыцыйна лічацца ледавіковымі, у марскіх умовах.

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