GEOLOGIJA. 2005. T. 49. P. 29–39
© Lietuvos mokslø akademija, 2005
© Lietuvos mokslø akademijos leidykla, 2005

Palinologija • Palynology • Палинология

Diatom flora from the Zhidini section and its palaeogeographic and biostratigraphic significance

Gennady Korol

Korol G. Diatom flora from the Zhidini section and its palaeogeographic and biostratigraphic significance. *Geologija.* Vilnius. 2005. No. 49. P. 29–39.

The aim of this paper is to introduce a more precise taxonomic and ecological composition of the diatom flora studied. New diatom investigations of ancient lacustrine sediments at Zhidini (Latvia) revealed a rich diatom flora consisting of 162 species and intraspecific taxa. On the basis of diatom analysis, seven local diatom assemblage zones (LDAZ Zh570-1 – Zh570-7) have been distinguished in ancient lacustrine deposits at Zhidini, which reflect the definite sedimentation conditions in the palaeobasin during the two climatic optimums and the intermediate cold interval.

Key words: diatom algae, ecologic and geographic characteristics, systematic composition, palaeoecological conditions

Received 29 October 2004, accepted 23 December 2004.

Gennady Korol. Laboratory of Quaternary Geology, Institute of Geological Sciences, NAS of Belarus. Kuprevich str. 7, 220141 Minsk, Belarus. E-mail: khurs@ns.igs.ac.by

INTRODUCTION

Ancient lacustrine deposits (50 m) in the Zhidini site, which consist of alternating gyttja (30 m), aleurite (16.5 m) and sand (2.5 m), were studied by many geologists and palaeobotanists (Spriňgis 1961; Даниланс и др. 1964, 1973; Хурсевич, 1984; Кондратене и др. 1985; Kalniòa et al., 1996, etc.). These sediments were classified as early Middle Pleistocene (Byelovezhian, Zhidini, Turgeliai) formations.

The principal aim of this work was to define more precisely the taxonomic and ecological composition of the diatom flora studied, to establish the age and correlation criteria of this flora and to reconstruct the palaeoecological conditions of sedimentation in the ancient basin.

MATERIAL AND METHODS

In 1979, coring of the borehole 570 (Zhidini site), located in southeastern Latvia, about 16 km west of the town Kraslava, was carried out by Geological Survey of Lithuania. These sediments are underlain by Middle Devonian clay and overlain by several horizons of Pleistocene moraines. In total, 266 samples were taken for pollen and diatom analyses in the profile at Zhidini. Samples collected for diatom analysis were treated with HCl, washed with water to obtain a neutral reaction, then brought to the boil in 10% NaOH. After washing with water, the samples were treated with heavy liquid (KJ and CdJ_2) following the standard procedure, which separated diatoms from mineral sediment by centrifuging.

Diatom valves were counted in each sample up to 500 specimens. This total was used to determine the percentages of dominant and characteristic species and intraspecific taxa. The results are presented in a diatom diagram (Fig. 1), which was constructed using the TILIA computer program. A system of diatoms proposed by Round et al. (1990) has been accepted as the basis for the present publication. Besides, taxonomic transformations given in many monographic reports (Krammer, Lange-Bertalot, 1986, 1988, 1991 a, b; Диатомовые..., 1974, 1992; Lange-Bertalot, Metzeltin, 1996; Bukhtiyarova, 1999; Lange-Bertalot, 2001) were taken into consideration. The most important changes in taxonomic diatoms are applied to the genera of *Fragilaria* Lyngb. sensu lato, *Achnanthes* Bory s. l., *Navicula* Bory s. l. and *Cymbella* Ag. s. l. For example, on the basis of detailed ultrastructure investigations of diatom valves, the heterogenous genus *Fragilaria* Lyngb. s. l. was divided into six independent genera: *Fragilaria* Lyngb. s. str., *Staurosirella* Will. et Round, *Staurosira* Ehr., *Pseudostaurosira* Will. et Round, *Fragilariforma* (Ralfs) Will. et Round and *Punctastriata* Will. et Round.

Fig. 1. Location of Zhidini section in Latvia
1 pav. Þidiniø pjûvio vieta Latvijoje

Data on the ecology of species was taken from the publications noted above, as well as from the papers of Ïðîøêèíà-Ëàâðåíêî (1953), Ïîðê (1970), Äàâûäîâà (1985), Van Donn et al. (1994).

SYSTEMATIC COMPOSITION OF THE DIATOM FLORA

New diatom investigations of the lacustrine sediments at Zhidini revealed a rich diatom flora consisting of 162 species, varieties and forms belonging to 45 genera, 24 families, 13 orders and 3 classes (Table 1).

The class *Coscinodiscophyceae* was represented by 3 orders, 3 families and 6 genera containing 24 taxa (15%). Members of *Stephanodiscaceae* Makar. (4 genera, 17 species and intraspecific taxa) and *Aulacoseiraceae* Moiss. (1 genus, 6 species) families are characterized by a qualitative diversity and abundance.

The class *Fragilariophyceae* was represented by 2 orders, 2 families and 6 genera including 17 species and varieties (10.5%). The family *Fragilariaceae* (Kütz.) D. T. containing 9 genera (16 species and intraspecific taxa) occupies the leading position in the diatom composition of this class. The species of the *Pseudostaurosira* Will et Round, *Staurosirella* Will et Round and *Staurosira* Ehr. genera prevail in frequency.

The class *Bacillariophyceae* is most representative. It comprises 9 orders, 18 families and 31 genera in which 121 species, varieties and forms (74.7%) have been determined. However, the overwhelming majority of diatoms occur with not a high abundance, with the exception of the genera *Diploneis* Ehr. (8 species and 2 varieties), *Amphora* Ehr. (3 species) and *Epithemia* Bréb. (7 species and 1 variety). In the diatom composition of the class *Bacillariophyceae*, the order *Naviculales* Bessey prevails by the number of families (7), genera (11), species and intraspecific taxa (45). The genera of *Cymbella* (11 species) and *Placoneis* Mereschk. emend. Cox (7 species and intra specific taxa) are characterized by the highest diversity within the order *Cymbellales* Mann (2 families, 6 genera, 27 taxa), the genus *Epithemia* Bréb. (8 taxa) within the order *Rhopalodiales* Mann (1 family, 2 genera, 10 taxa), and the genera *Achnanthes* Bory (9 species and intraspecific taxa) and Cocconeis (9 taxa) within the order *Achnanthales* Silva (3 families, 5 genera, 26 taxa).

ECOLOGIC AND GEOGRAPHIC CHARACTERISTICS OF DIATOM ALGAE

The diatom flora of the lacustrine deposits studied includes the species and intraspecific taxa belonging to three ecologic groups according to habitat types: a) the group of planktonic diatoms – 18% (29 species, varieties and forms), b) the group of benthonic diatoms – 48% (78 taxa), and c) the group of epiphytic diatoms – 34% (54 taxa). However, planktonic diatom algae dominated during the whole history of palaeolake development.

The diatom flora studied as regards the salinity of water is freshwater. Among the oligohalobous members, the indifferent diatoms (116 taxa, or 72%) preferring basins with mineralization of 0.2–0.3‰ prevail in the ancient lake. The number of the halophobous represen-

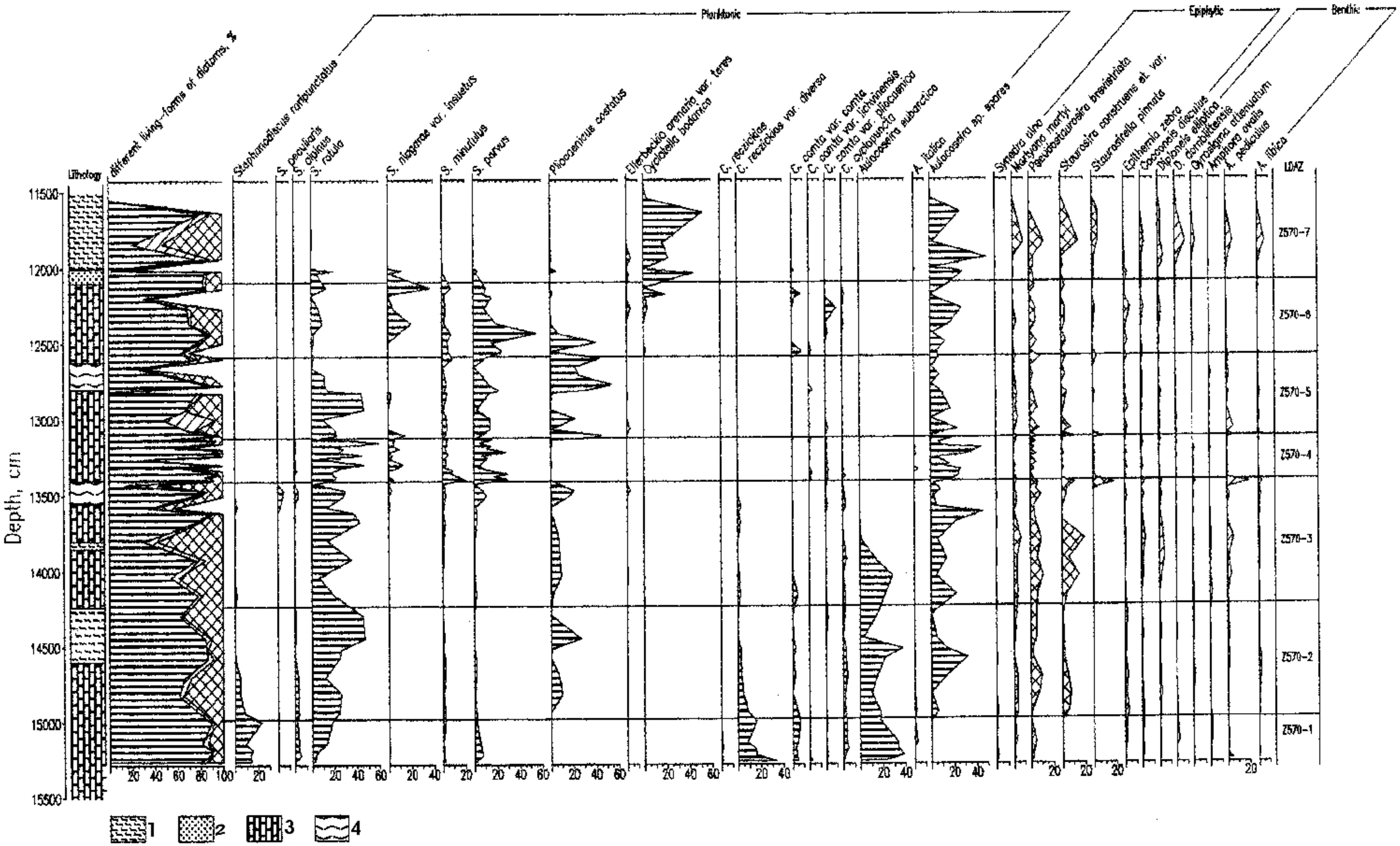

Fig. 2. Diatom biostratigraphy of the ancient lacustrine deposits at Zhidini: *1* – clayey silt; *2* – fine sand with fragments of plants; *3* – gyttja; *4* – laminated silt

2 pav. Þidiniø apylinkës senøjø eþeriniø nuosëdø diatomëjø biostratigrafija: *1* – molingas aleuritas, *2* – smulkiagrûdis smëlis su augalø fragmentais, *3* – gitija, *4* – sluoksniuotas aleuritas

Table. **Systematic composition of diatoms found in the ancient lacustrine deposits recovered in the profile at Zhidini)**
Lentelë. **Þidiniø profilio senøjø eþeriniø nuosëdø diatomëjø sisteminë sudëtis**

DIATOMS	Ecology				Local diatom assemblage zones						
	Biotop	Relation to water salinity	Relation to water pH	Geographical element of flora	LDAZ 1(%), (149.8–152.7 m)	LDAZ 2, (142.4–149.8 m)	LDAZ 3, (134.1–142.4 m)	LDAZ 4, (131.3–134.1 m)	LDAZ 5, (125.9–131.3 m)	LDAZ 6, (121.0–125.9 m)	LDAZ 7, (116.4–121.0 m)
Division **Bacillariophyta**											
Class **Coscinodiscophyceae**											
Subclass **Thalassiosirophycidae**											
Order **Thalassiosirales** Gles. et Makar.											
Family **Stephanodiscaceae** Makar.											
Genus **Stephanodiscus** Ehr.											
S. alpinus Hust.	p	i	i	a	0–5	0.4–3	0–3	0–2.2			
S. minutulus (Kütz.) Cl. et Möller	p	i	lb	c	0–2	0–2	0–2.6	0–20	1–9	1–8	0–1
S. niagarae var. *insuetus* Khurs. et Log.	p	–	–	–	0–1	+	0–3	0–10	0–15	0–37.4	0–12
S. parvus Stoermer et Håkansson	p	i	lb	c	0–2	0–2	0.5–11	2–30	1–22	10–25	0–3
S. peculiaris Khurs.	p	–	–	–			0–5				
S. raripunctatus Khurs. et Log.	p	–	–	–	9–23	0.6–9	0–2.2				
S. rotula (Kütz.) Hendey	p	i	lb	c	2.5–18	12–47	2.2–42	8–60	0–46.2	0–13.2	0–20
Genus **Cyclotella** Kütz. ex Bréb.											
C. bodanica Eul.	p	i	i	b						0–19	0–52
C. cyclopuncta Håkansson et Carter	p	i	i	b	0–4.5	0–4	+	0–2.2		0–2	
C. reczickae Khurs. et Log.	p	–	–	–	1						
C. reczickae var. *diversa* Khurs. et Log.	p	–	–	–	8–33	0–9	0–3.2	+			
C. comta (Ehr.) Kütz. var. *comta*	p	i	l	c	3–7	0–5	0–4.5	+	+	0–9	+
C. comta var. *lichvinensis* Jouse	p	i	l	–	+	+	+		0–2	0–3	0–1.5
C. comta var. *pliocaenica* Krasske	p	i	l	–	+	+	+	+	+	0–9.4	
C. distinguenda Hust.	p	hl	l	b	+	+					
Genus **Pliocaenicus** Round et Håkansson											
P. costatus (Log., Lupik. et Khurs.) Flower, Ozornina et Kuzmina	p	i	c	b		0–26.4	0–21	0–2	0–55	0–40	0–5
Genus **Cyclostephanos** Round											
C. dubius (Fricke) Round	p	i	lb	b	+	+	+			+	
Subclass **Coscinodiscophycidae**											
Order **Paraliales** Crawf.											
Family **Paraliaceae** Crawf.											
Genus **Ellerbeckia** Crawf.											
E. arenaria (Moore et Ralfs) Crawford	b	i	l	b			0–1	0–2.6		0–3.4	0–3.6
Order **Aulacoseirales** Moiss. et Makar.											
Family **Aulacoseiraceae** Moiss.											
Genus **Aulacoseira** Thw.											
A. ambigua (Grun.) Sim.	p	i	l	c	+		+	+	+		
A. distans (Ehr.) Sim.	p	i	c	c							
A. granulata (Ehr.) Sim.	p	i	l	c	+		+			+	+
A. italica (Ehr.) Sim.	p	i	l	c	+	+	+	+	+	+	0–1.4
A. subarctica (O. F. Müll.) Haworth	p	i	l	c	18–38	3–37	0–29				
Aulacoseira sp. (СпоРы)	p	–	–	–	+	0–32	2.2–46	3–37	1–23.4	1–28	0–50
Class **Fragilariophyceae**											
Subclass **Fragilariophycidae**											
Order **Fragilariales** Silva											

Family **Fragilariaceae** (Kütz.) D. T.											
Genus **Fragilaria** Lyngb.											
F. capucina Desm.	p	i	l	c							+
F. Crotonensis Kitt.	p	hl	l	b	+						
F. vaucheriae (Kütz.) J. B. Petersen	e	i	l	b	+						
Genus **Asterionella** Hassal											
A. formoza Hassal	p	i	l	c	+	+	+	+		+	+
Genus **Staurosirella** Will. et Round											
S. pinnata (Ehr.) Will. et Round	e	i	l	b		+	0–18	0–11	+	0–2.2	0–5.2
S. lapponica (Grun. in V. H.)	e	i	l	c		+	+				
Will. et Round											
S. leptostauron (Ehr.) Will. et Round	e	i	l	b	+	+		+			
Genus **Staurosira** Ehr.											
S. construens (Ehr.) Will. et Round	e	i	l	c	+	1–7	0–20	0–2.2	0–13.2	0.2–4.4	0–15
var. *construens*											
S. construens var. *binodis* (Ehr.) Grun	e	i	l	c	+	+	+		+		+
S. *construens* var. *venter* (Ehr.) Hamilton	e	i	l	c		0–3	2				
Genus **Pseudostaurosira** Will. et Round											
P. brevistriata (Grun. in V. H.)	e	i	l	c	0–4.5	2.2–10	3–11	0–5.4	0–9	0–6.6	0–13
Will. et Round											
Genus **Martyana** Round in Round, Crawf., Mann											
M. martyi (Herib.) Round	e	i	l	b	0–2.2	0–3.5	0–7	0–2.2	1–4	0.5–3	0–10
Genus **Synedra** Ehr.											
S. acus Kutz.	p	i	l	b		+					
S. capitata Ehr.	p	i	l	c				+			
S. parasitica (W. Sm) Hust.	e	i	l	–							+
S. ulna (Nitzsch.) Ehr.	e	i	l	c	+	+	+	+	+	+	+
Order **Tabellariales** Round											
Family **Tabellariaceae** Kütz.											
Genus **Tabellaria** Ehr.											
T. fenestrata (Lyngb.) Kütz.	p	hb	c	b						+	
Class **Bacillariophyceae**											
Subclass **Eunotiophycidae**											
Order **Eunotiales** Silva											
Family **Eunotiaceae** Kütz.											
Genus **Eunotia** Ehr.											
Eunotia sp.											+
Class **Bacillariophyceae**											
Subclass **Bacillariophycidae**											
Order **Mastogloiales** Mann											
Family **Mastogloiaceae** Mer.											
Genus **Aneumastus** Mann et Stick., Crawf., Mann											
A. tusculus (Ehr.) Mann et Stickle	b	i	lb	c	+	+	+	+			
A. tusculus (Hust.) f. minor Hust.	b	i	lb	c	+		+			+	+
Genus **Mastogloia** Thw. ex W. Sm.											
M. smithii Thw.	–	i	–	–	+	+					
Order **Cymbellales** Mann											
Family **Roicospheniaceae** Chen et Zhu											
Genus **Rhoicosphenia** Grun.											
R. abbreviata (Ag.) L.-B.	b	m	l	c		+	+		+	+	+
Family **Cymbellaceae** Grev.											
Genus **Placoneis** Mereschk. emend. Cox											
P. dicephala (Ehr.) Mereschk	b	i	l	c							+
P. elginensis (Greg.) Cox	b	i	i	c		+	+	+			
P. elginensis f. exigua (Greg.) Bukht.	b	i	i	c			+				+
P. gastrum (Ehr.) Mereschk	b	i	l	c	+	+	+	+		+	
P. placentula (Ehr.) Hein. var *placentula*	b	i	l	c							+
P. placentula f. *latiuscula* (Grun.) Bukht.	b	i	l	c		+					
P. placentula f. *rostrata* (Mayer.) Bukht.	b	i	l	b					+		+
Genus **Cymbella** Ag.											
C. aequalis W. Sm.	e	i	i	–	+						
C. affines Kütz.	e	i	i	b	+	+					+

Table (continued)
Lentelës tæsinys

C. amphicephala Näg.	e	i	i	b					+		
C. angustata (W. Sm.) Cl.	e	i	l	a					+		
C. aspera Ehr. H. Perag	e	i	l	a		+		+			
C. cistula (Hemp.) Kirchner	e	i	l	b		+	+	+			
C. diluviana (Kras.) Flor.	b	i	l	c		+	+		+		
C. ehrenbergii Kütz.	e	i	i	b	+	+	+	+		+	+
C. helvetica Kütz.	e	i	l	b		+					
C. leptoceoros (Ehr.) Grun.	e	i	l	c	+	+	+	+		+	+
C. parvula Krasske	e	i	i	–	+						0–6
Genus **Encyonema** Kütz.											
E. minuta (Hilse ex Rabenh.) Mann in Round, Crawf.	e	i	i	c	+	+	+			+	+
E. elginense (Kram.) Mann	e	i	l	c		+	+	+	+		+
Family **Gomphonemataceae** (Kütz.) Grun.											
Genus **Gomphonema** (Ag.) Ehr.											
G. acuminatum var. *coronatum* (Ehr.) W. Sm.	e	i	l	b	+						+
G. angustatum Kütz.	e	i	l	b	+	+	+				
G. clavatum Ehr.	e	i	i	c		+					
G. olivaceum var. *olivaceum* (Horn.) Daw. ex Ross et Sims	b	hl	lb	c			+		+		
G. truncatum Ehr.	e	i	l	b			+				
Genus **Reimeria** Koc.et Stoer.											
R. sinuata (Greg.) Koc.et Stoer.	e	hl	i	b		+	+	+	+	+	+
Order **Achnanthales** Silva											
Family **Achnanthaceae** Kütz.											
Genus **Achnanthes** Bory											
A. borealis A. Cl.	e	i	i	–					+	+	+
A. conspicua Mayer var. *conspicua*	e	i	l	b	+						
A. conspicua var. *brevistriata* Hust.	e	hl	–	b	+						
A. dispar Cl.	e	hl	–	–			+				
A. exigua Grun. var. *exigua*	e	i	l	c			+				
A. exigua var. *heterovalvata* Krasske	e	i	l	c			+				
A. striata Skv. et Meyer var. *rostrata* Scab.	e	hl	–	–			+				
Genus **Karayevia** Round et Bukht.											
K. clevei (Grun.) Bukht. var. *clevei*	b	hl	l	b	+		+	+	+	+	+
K. clevei var. *rostrata* (Hust.) J. C. Kingston	b	hl	l	b	+	+	+	+	+	+	+
K. laterostrata (Hust.) J. C. Kingston	b	hl	l	b			+		+		
Genus **Planothidium** Round et Bukht.											
P. calcar (Cl.) M. B. Edlund	e	i	l	b		+	+		+	+	+
P. lanceolatum (Breb.) Bukht. var. *lanceolatum*	b	i	l	c	+						+
P. lanceolatum var. *elliptica* (Cl.) Bukht.	b	i	l	a		+	+	+	+	+	+
P. lanceolatum var. *haynaldii* Bukht.	b	i	i	c		+					
P. oestrupii (A. Cl.) M. B. Edlund	e	i	i	–					+	+	+
P. rostratum (¨strup) Round et Bukht.	b	i	l	c			+				+
Family **Cocconeidaceae** Kütz.											
Genus **Cocconeis** Ehr.											
C. disculus (Schum.) Cl. var. *disculus*	e	i	l	c	0–1	+	0–3	0–1	0–1	0–2.2	0–3
C. disculus var. *diminuta* (Pant.) Sheshukova	e	i	l	c	+	+	+	+		+	+
C. neothumensis Kram.	e	i	l	–	+	+	+	+	+	+	+
C. pediculus Ehr.	e	hl	l	c						+	
C. placentula Ehr. var. *placentula*	e	i	l	c		+	+		+	+	+
C. placentula var. *euglypta* (Ehr.) Grun.	e	i	l	c	+	+	+	+		+	+
C. placentula var. *Intermedia* (Herib. et Perag) Cl.	e	i	l	c						+	
C. placentula var. *lineata* (Ehr.) Van Heurck	e	i	l	b		+	+				
C. skvortzowii (Skvortsov) Sheshukova-Poretskaya	e	–	–	–		+	+	+		+	+
Family **Achnanthidiaceae** Mann											
Genus **Achnanthidium** Kütz.											

A. minutissimum (Kütz.) Czarn.	b	i	i	c		+					
Order **Naviculales** Bessey											
Suborder **Neidiineae** Mann											
Family **Diadesmidaceae** Mann											
Genus **Luticola** Mann											
L. mutica (Kütz.) Mann	b	hl	c	b			+				
L. cohnii (Hilse) Mann	b	hl	c	b						+	+
Family **Cavinulaceae** Mann											
Genus **Cavinula** Mann et Stickle											
C. jentzschii (Grun.) Lange-Bertalot	b	i	l		+	+	+	+			+
C. lacustris var. *apliculata* (¨ strup) Bukht.	b	i	c	b							+
C. pseudoscutiformis (Hust.) Mann et Stick.	b	i	l	a		+			+	+	+
C. scutelloides (W. Sm.) Lange-Bertalot	b	i	lb	b	+	+	+	+	+	+	+
Suborder **Sellaphorineae** Mann											
Family **Sellaphoraceae** Mereschk.											
Genus **Sellaphora** Mereschk.											
S. bacilliformis Grun.	b	hb	i	c				+			
S. bacillum Ehr. (Mann)	b	i	l	b							+
Genus **Fallacia**											
F. subhamulata (Grun.) Mann	b	hl	c	–							+
Family **Pinnulariaceae** Mann											
Genus **Pinnularia** Her.											
P. borealis Ehr.	b	i	i	a							+
P. intermedia (Lag.) Cl.	b	hl	c	–			+				
P. viridis (Nitzsch.) Ehr.	b	i	i	c							+
Genus **Caloneis** Cl.											
C. bacillum (Grun.) Cl.	b	i	l	b		+	+	+		+	+
C. silicula var. *truncatula* Hust.	b	i	l	b							+
C. schumanniana (Grun.) Cl. var. *schumanniana*	b	i	lb	c							+
C. schumanniana var. *biconstricta* (Grun.) Reich	b	i	lb	c							+
Suborder **Diploneidineae** Mann											
Family **Diploneidaceae** Mann											
Genus **Diploneis** Ehr.											
D. domblittensis (Grun.) Cl. var. *domblittensis*	b	i	i	b	0–2	0–1	+	0–1	0–1	0–2	0–9
D. domblittensis var. subconstricta A. Cl.	b	i	i	b						+	
D. elliptica (Kütz.) Cl. var. *elliptica*	b	i	l	c	0–1	0–2	0–5	0–1.6	0–2.2	0–2.2	0–5
D. elliptica var. *ladogensis* Cl.	b	i	i	c		+	+	+			+
D. interrupta (Kütz.) Cl.	b	–	–	–							+
D. finnica (Ehr.) Cl.	b	hl		b							+
D. marginestriata Hust.	b	i	i	b	+		+			+	+
D. oblongella (Nag.) A. Cl.	b	hl	l	b			+				+
D. ovalis (Helse) Cl.	b	hl	i	b	+	+	+			+	
D. smithii (Breb.) Cl.	b	hl	lb	c							+
Suborder **Naviculineae** Hend.											
Family **Naviculaceae** Kütz.											
Genus **Navicula** Bory											
N. cari Ehr.	b	hl	l	c	+						
N. Capitatoradiata Germain	b	hl	l	c					+		
N. cryptocephala Kütz.	b	i	l	c			+				
N. hasta Pant.	b	–	–	–			+	+		+	
N. oblonga Kütz.	b	hl	l	c		+	+				
N. radiosa Kütz.	b	i	i	b	+		+				
N. oppugnata Hust.	b	i	lb	–	+		+				
N. platystoma Ehr.	b	i	–	b							+
N. meniscus Schum.	b	hl	l	c					+		
N. rotunda Hustedt	b	–	–	–	+					+	
N. tripunctata (O. F. Müll.) Bory	b	i	lb	b						+	+
N. viridula Kütz.	b	i	lb	c					+		
N. vulpina Kütz.	b	i	–	b				+			
Genus **Hippodonta** L.-B., Metzeltin, Witk.											
H. costulata (Grun.) L.-B., Metz., Witk.	b	hl	l	b		+				+	+

Table (continued)
Lentelės tęsinys

Genus **Gyrosigma** Hassal											
G. acuminatum (Kütz.) Rabenh.	b	i	l	b			+				+
G. attenuatum (Kütz.) Rabenh.	b	i	l	c	+	0–1.4	+	0–1.2	+	0–1.2	0–3.5
G. spenceri (Quek.) Grif. et Henf.	b	i	l	c			+		+		
Family **Stauroneidaceae** Mann											
Genus **Stauroneis** Ehr.											
S. smithii Grun.	b	i	l	b							+
Order **Thalassiophysales** Mann											
Family **Catenulaceae** Mer.											
Genus **Amphora** Ehr.											
A. ovalis (Kütz.) Kütz.	b	i	l	c	+	+	+	+	+	+	0–2
A. libyca Ehr.	b	i	l	c	+	+	0–2.5	0–4	+	+	0–6.6
A. pediculus (Kütz.) Grun.	b	i	l	c	0–4	1	0–20	+	0–6	0–1	0–6
Order **Bacillariales** Hend.											
Family **Bacillariaceae** Ehr.											
Genus **Hantzschia** Grun.											
H. amphioxys (Ehr.) Grun.	b	i	i	c							+
Genus **Tryblionella** W. Sm.											
T. angustata (W. Sm.) Smith	b	i	l	b	+						
Genus **Nitzschia** Hassal											
N. amphibioides Hust.	b	i	l	b			+				
N. fonticola Grun. in Cl. et Moll.	b	i	l	b				+			+
N. recta Hantzsch.	b	i	l	b	+						
Order **Rhopalodiales** Mann											
Family **Rhopalodiaceae** (Karst.) Top. et Oks.											
Genus **Rhopalodia** O. Müll.											
R. gibba (Ehr.) O. Mull. var. *gibba*	b	i	lb	b	+	+					
R. gibba var. *parallela* (Grun.) Herb et Perag.	b	i	l	b	+						
Genus **Epithemia** Bréb.											
E. adnata (Kütz.) Bréb.	e	i	lb	c	+	0.4–2.5	0.4–1.6	0–2.2	0–3	0–6	0–3.4
E. argus Kütz.	b	i	i	b		+					
E. hyndmannii W. Sm.	e	–	–	b						+	+
E. frickei Kram.	b	hl	i	b	+		+		+	+	
E. sorex Kütz.	b	hl	lb	b	+	+	+	+		+	+
E. turgida (Ehr.) Kütz. var. *turgida*	e	hl	lb	b	+		+			+	+
E. turgida var. *granulata* (Ehr.) Brun.	e	hl	lb	b	+						
E. goeppertiana Hilse	b	hl	l	b		+					
Suborder **Surirellales** Mann											
Family **Surirellaceae** Kütz.											
Genus **Cymatopleura** W.Sm.											
C. elliptica (Breb.) W. Sm.	e	i	l	b		+	+		+		+
C. solea (Breb.) W. Sm.	b	hl	i	–	+						

p – planktonic, b – benthic, e – epiphytic (life form groups); hb – halophobous, i – indifferent, hl – halophilous, m – mesohalobous, (–) – unknown ecology (salinity groups); c – acidophilous, i – indifferent, l – alkaliphilous, lb – alkalibiontic, (–) – unknown ecology (pH – groups); c – cosmopolitan, b – boreal, a – arcto-alpine, (–) – unknown biogeographic group (biogeographic groups). Relative abundance of taxa is shown by their minimum and maximum percentage in the probe of every lake; occurrence of taxa by single specimens is shown by symbol "+".
p – planktoninės, b – bentosinės, e – epifilinės (aplinkos formø grupės), hb – halofobinės, i – indiferentinės, m – mezohalobinės, (–) – neþinomos ekologinės (druskingumo) grupės, c – acidofilinės, i – indiferentinės, l – alkalifilinės, lb – alkalibiotinės (–) – neþinomos (pH grupės); c – kosmopolitinės, b – borealinės, a – arktinės--alpinės, (–) – neþinomos biogeografinės (biogeografinės) grupės. Taksonø minimalus ir maksimalus procentinis santykinis gausumas nurodytas kiekvieno eþero nuosėdø mėginiuose; taksonø paplitimas pavieniuose mėginiuose nurodytas simboliu „+".

tatives – inhabitants of fresh waters with the maximum concentration of salts up to 0.2‰ doesn't exceed 2%. The halophilous species, living usually in fresh water but reaching the final development in water with salinity of 0.4–0.5‰ make up 20%. Twelve taxa (6%) belong to the group of diatoms of unknown ecology.

According to the pH requiremens, the alkaliphilous and alkalibiontic members (104 taxa, or 64%) prevail in the composition of the diatom flora. The group of indifferent diatoms (29 taxa) makes up 18%. The acidophylous members play not an appreciable role in the composition of the diatom flora (8 taxa, or

4%). 21 taxa, or 10%, form a group of diatoms of unknown ecology in respect to water pH.

Diatom algae of the profile studied belong to three biogeographic groups. Among them, the boreal diatoms (65 taxa, or 40%) and cosmopolitan species (62 taxa, or 38%) are represented almost in equal proportions. Cold-water species of the arcto-alpine group are represented by 6 taxa and make 4%. The belonging of 29 species and intraspesific taxa (18%) to one or another biogeographic group of diatoms is not clear.

RESULTS

The overall profile of diatom abundance and changes in the species composition allowed to identify seven local diatom assemblage zones (LDAZ Zh1 – LDAZ Zh7) in the lacustrine sediments at Zhidini (in the depth interval of 115.0–152.7 m), which reflect the definite palaeoecological sedimentation conditions in the palaeobasin (Fig. 1).

LDAZ Zh570-1 (149.8–152.7 m) is characterized by a high content of planktonic species in the profile: *Aulacoseira subarctica* (O. Müll.) Haworth (up to 38%), and *Stephanodiscus rotula* (Kütz.) Hendey (2.5–18%). At the same time, such diatoms typical of the Byelovezhian Interglacial of Belarus as *Cyclotella reczickae* var. *diversa* Khurs.et Log. (8–33%), *Stephanodiscus raripunctatus* Êhurs. et Log. (9–23%) and *Cyclotella reczickiae* Churs.et Log. var. *reczickae* (1%) reached the maximum abundance. The benthic and epiphytic species were not numerous (up to 20% in total spectra), suggesting the existence of a relatively deep, transparent, mesotrophic palaeobasin at that time.

LDAZ Zh570-2 (142.4–149.8 m) is identified by the appearance of the cold-water planktonic species *Pliocaenicus costatus* (Log., Lupik. et Khurs.) Flower, Ozornina et Kuzmina (up to 26.4%) and *Aulacoseira* sp. (spores) (up to 32%). At present, *Pliocaenicus costatus* inhabits mainly ultraoligotrophic lakes of East Siberia (Flower et al., 1998). In addition, high percentages of the planktonic taxa *Stephanodiscus rotula* (Kütz.) Hendey (12–47%) and *Aulacoseira subarctica* (up to 37%) have been noted. Members of *Cyclotella* occur in smaller numbers: *C. reczickiae* var. *diversa* (up to 9%), *C. comta* (Ehr.) Kütz. var. *comta* (up to 5%), *C. cyclopuncta* Hakansson et Carter (up to 4%). The content of epiphytic representatives increased up to 35%. Changes noted in the composition of the diatom community indicate that the paleolake was of the oligotrophic type.

LDAZ Zh570-3 (134.1–142.4 m) is characterized by the repeated alternations in the proportions of diatoms belonging to the various ecological groups. The amount of planktonic diatoms ranged from 30 to 85%, benthic 1–25% and epiphytic 10–50%. The qualitative composition of the diatom flora was the richest (up to 90 taxa) in the complete history of the lake development. The planktonic species are represented by a high quantity of *Stephanodiscus rotula* (up to 47%), *Aulacoseira* sp. (spores) (up to 46%) *Aulacoseira subarctica* (up to 29%) and *Stephanodiscus peculiaris* Êhurs. (5%). *Pseudostaurosira brevistriata* (3–11%), *Staurosira construens* with varieties (up to 20%) and the cold-water species *Martyana martyi* (up to 7%) dominated in the periphyton. Among the benthic diatoms, a peak of *Amphora pediculus* (Kütz.) Grun. (20%) is observed at the end of the zone. These data testify to the unstable environment conditions and fluctuations of water level in the paleobasin or the pollution of the core sample.

LDAZ Zh570-4 (131.3–134.1 m) is marked by an essential increase in the content of various *Stephanodiscus* species (*S. rotula* up to 60%, *S. parvus* Stoermer et Håkansson up to 30%, *S. minutulus* (Kütz.) Cl. et Möller up to 20% and *S. niagarae* var. *insuetus* Êhurs. et Log. up to 10%) and a decrease in the amount of *Pliocaenicus costatus* to the minimum. The *Aulacoseira* sp. (spores) makes up 10–37%. The benthic and epiphytic species were not numerous (up to 10% in total). This diatom community reflects the eutrophic regime of a deep-water ancient lake.

LDAZ Zh570-5 (125.9–131.3 m) is defined by a new raise of the cold-water planktonic species *Pliocaenicus costatus* (up to 55%, maximum abundance in the profile). The number of benthic and epiphytic species increased up to 29% and 23%, respectively. The trophic status of the palaeobasin changed towards oligotrophy.

LDAZ Zh570-6 (121.0–125.9 m) is distinguished by the abundance and diversity of the *Stephanodiscus* species (up to 83.6% in total), represented by the highest frequency of *S. parvus* Stoermer et Håkansson (55%), *S. niagarae* var. *insuetus* Êhurs. et Log. (37%), etc. The content of *Cyclotella comta* et var. increased up to 21.4%. The amount of the *Aulacoseira* sp. (spores) constitutes 1–28%. This diatom community indicates an improvement of palaeoecological conditions in the palaeolake.

LDAZ Zh570-7 (115.0–121.0 m) is characterized by the dominancy in the diatom community of the following cold-water species: among the planktonic members – *Cyclotella bodanica* var. *borealis* (up to 52%) and *Aulacoseira* sp. (spores) (50%); among the benthic taxa – *Diploneis dombittensis* (Grun.) Cl. var. *dombittensis* (9%), *Amphora pediculus* (Kütz.) Grun. (6%), etc. An increase of epiphytic diatoms (*Martyana martyi* (Herib.) Round (10%), *Pseudostaurosira brevistriata* (Grun. in V. H.) Will. et Round (13%) and *Staurosira construens* et var. (18%)) is observed in this zone. The data above suggest an oligotrophic regime at the end of the lake development.

Generally, the diatom succession studied in the Zhidini-570 section may be characterized as follows: *Cyclotella reczickiae* var. *diversa, Stephanodiscus raripunctatus, Aulacoseira subarctica* → *Aulacoseira* sp. (spores), *A. subarctica, Stephanodiscus rotula, Pliocaenicus costatus* → *Aulacoseira* sp. (spores), *Stephanodiscus rotula, Staurosira construens* et var., *Pseudostaurosira brevistriata, Martyana martyi* → *Stephanodiscus rotula, S. parvus, S. minutulus, S. niagarae* var. *insuetus* → *Pliocaenicus costatus* → *Cyclotella bodanica* var. *borealis, Aulacoseira* sp. (spores), *Staurosira, Pseudostaurosira, Martyana.* It reflects the repeated change of palaeoecological conditions in the ancient lake during sedimentation. Moreover, the planktonic diatom community with various taxa of *Stephanodiscus, Cyclotella* and *Aulacoseira* reflects on the deep-water character of the ancient lake.

DISCUSSION

Based on pollen and diatom analyses, the continuous lacustrine sedimentary sequence at Zhidini was deposited during two climatic optima of the Zhidini Interglacial (*sensu lato*) separated by a cold interval, as well as in the beginning of the early Letizha Glaciation.

The planktonic diatom community of the first warm interval (149.8–152.7 m) was represented by an abundant occurrence of the extinct members of Cyclotella *reczickiae* var. *diversa* Khurs. et Log. and *Stephanodiscus raripunctatus* Khurs. et Log. But *Cyclotella reczickiae* Khurs. et Log. var. *reczickae* was not numerous. All three extinct taxa were occurred also in the profiles of the Byelovezhian Interglacial at Krassnaya Dubrova (in the depth interval of 40.2–45.1 m) (Хурсевич, Логинова, 1986; Khursevich, 1999), Ytvez (Рылова, Хурсевич, 1989; Величкевич и др., 1997) and Borki (Якубовская и др., 1991). The second warm interval in the profile at Zhidini (131.3–134.1 m) includes a considerable content and diversity of the *Stephanodiscus* species: *S. niagarae* var. *insuetus* Êhurs. et Log. *S. rotula* (Kütz.) Hendey, *S. parvus* Stoermer et Håkansson, *S. minutulus* (Kütz.) Cl. et Möller and others. The same extinct species, especially the abundant *Stephanodiscus niagarae* var. *insuetus*, were characteristic of the Byelorussian profiles at Krassnaya Dubrova. The intermediate cold interval (134.1–149.8 m) was represented by the domination of relatively cold-water species of *Pliocaenicus costatus* (Log., Lupik. et Khurs.) Flower, Ozornina et Kuzmina, *A. subarctica* (O. F. Müll.) Haworth, *Aulacoseira* sp. (spores) and of the widespread taxon of *Stephanodiscus rotula* (Kütz.) Hendey. All three intervals mentioned above can be correlated with the Byelovezhian and Mogilevian Interglacials divided by the Nizhninian Glaciation on the territory of Belarus.

Cyclotella comta var. *pliocaenicus* and C. *comta* var. *lichvinensis* belong to Pliocene relicts and *Cyclotella reczickiae* et var. *diversa, S. niagarae* var. *insuetus* and *S. raripunctatus* to early and middle Pleistocene extinct members. Therefore, all these extinct taxa are biostratigraphically valuable markers found in the ancient lacustrine deposits at Zhidini.

The Zhidini Interglacial lake sediments can be correlated with the Ferdynandovian Interglacial deposits in Poland (Хурсевич и др., 1990; Marciniak 1990; Marciniak, Lindner, 2003) and the coeval sediments of the Muchkapian Interglacial in Russia (Анциферова, 1991, 2001).

ACKNOWLEDGEMENTS

I cordially thank Dr. G. K. Khursevich for help and valuable comments. Thanks are also due to Ms. S. Fedenya for useful discussions on the frustule morphology of fossil species.

References

Bukhtiyarova L. 1999. Diatoms of Ukraine Inland waters. Kyiv M. G. Kholodny Institute of Botany. 133 p.

Flower R. J., Ozornina S. P., Kuzmina A., Round F. E. 1998. *Pliocaenicus* taxa in modern and fossil material mainly from Eastern Russia. *Diatom Research*. ***13***(*1*). 39–62.

Kalniòa L., Juðkevics V., Seglinð V. 1996. Pleistocene stratigraphy at Zhidini site, southeastern Latvia. *PACT **50***. Belgium. 31–40.

Khursevich G. K. 1999. Diatom communities from the Middle Pleistocene deposits of Belarus. Proceedings of the 14th International Diatom Symposium (Mayama Sh., Idei M., Koizumi I., eds.). Koenigstein: Koeltz Scientific Books. 591–601.

Krammer K., Lange-Bertalot H. Bacillariophyceae. Süsswasser flora von Mitteleuropa. Stuttgart; Jena: Gustav Fischer Verlag, 1986. Band 2/1. 876 p.; 1988. Band 2/3. 536 p., 1991a. Band 2/3. 576 p.; 1991b. Band 2/4. 437 p.

Lange-Bertalot H. 2001. Navicula *sensu stricto*. 10 genera separated from Navicula *sensu lato*. Frustulia. *Diatoms of Europe*. ***2***. A. R. G. Gantner Verlag K. G. 526 p.

Lange-Bertalot H., Metzeltin D. 1996. Oligotrophie-Indicatoren 800 taxa repräsentativ rei diverse Seen-Typen. *Iconographia Diatomologica*. ***2***. Konigstein: Koeltz Scientific Book. 390 p.

Marciniak B. 1990. Dominant diatoms in the interglacial lake sediments of the Middle Pleistocene in Central and Eastern Poland. *Hydrobiologia*. 253–258.

Marciniak B., Lindner L. 2003. Diatoms and geology of the Ferdynandovian Interglacial lake sediments in Poland (in Polish with English summary). *Botanical Guidebooks*. ***26***. 199–215.

Round F. E. & Hakansson H. 1992. Cyclotelloid species from a diatomite in the Harz Mountains, Germany, including Pliocaenicus gen. Nov. *Diatom Research*. ***7***. 109–125.

Round F. E., Crawford R. M., Mann D. G. 1990. The diatoms. Biology and morphology of genera. Cambridge: Cambridge University. 747 p.

Spriňgis K. 1961. Pleistocene deposits, in Latvijas PSR geologija. Riga. 114–175 (in Latvian).

Van Dam H., Mertens A., Sinkeldam J. 1994. A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands. *Netherlands J. Agnat. Ecol.* ***28***. 117–133.

Анциферова Г. А. 1991. Флора диатомей нижнеплейстоценовых межледниковых (мучкапских) отложений. *Альгология*. ***1***(*1*). 104–108.

Анциферова Г. А. 2001. Эволюция диатомовой флоры и межледникового осадконакопления центра Восточно-Европейской равнины в неоплейстоцене. *Труды научно-исследовательского института геологии Воронежского государственного университета*. Вып. 2. Воронеж: изд-во Воронеж. ун-та. 198 с.

Величкевич Ф. Ю., Хурсевич Г. К., Рылова Т. Б., Литвинюк Г. И. 1997. К стратиграфии среднего плейстоцена Беларуси. *Стратиграфия. Геологическая корреляция*. ***5***(*4*). 68–84.

Даниланс И. Я. 1973. Четвертичные отложения Латвии. Рига: Зинатне. 312 с.

Даниланс И. Я., Дзилна В. Я., Стелле В. Я. 1964. Разрез Жидини. *Вопросы четвертичной геологии*. Ч. 3. Рига: Изд. АН Латвийской ССР. 63–140.

Давыдова Н. Н. 1985. Диатомовые ваодоросли – индикаторы экологических условий в городе. Л: Наука. 243 с.

Диатомовые водоросли СССР (ископаемые и современные). 1974. Т. 1. Л.: Наука, 403 с.

Диатомовые водоросли СССР (ископаемые и современные). 1992. Т. II, вып. 2. СПб.: Наука. 125 с.

Кондратене О. П., Хурсевич Г. К., Логинова Л. П. 1985. Биостратиграфическое обоснование возраста озерной толщи разреза Жидини. *Проблемы плейстоцена*. Мн.: Наука и техника. 86–101.

Логинова Л. П., Лупикина Е. Г. Хурсевич Г. К. 1984. О новом представителе рода Cyclostephanos Round и его стратиграфическом значении. *Доклады АН БССР*. ***35***(*3*). 262–265.

Порк М. И. 1970. Об экологии диатомовых водорослей в озерах Эстонии. *Уч. зап. Тартус. ун–та*. 338–352.

Прошкина-Лавренко А. И. 1953. Диатомовые водоросли – показатели солености воды. Диатомовый сборник. Л: Изд. ЛГУ. 186–205.

Рылова Т. Б., Хурсевич Г. К. 1989. Растительность и диатомовая флора нового разреза беловежского межледниковья Белоруссии. *Доклады АН БССР*. ***33***(*11*). 1025–1027.

Хурсевич Г. К. 1984. Стратиграфия плейстоценовых отложений Прибалтики по данным диатомового анализа. *Палеогеография и стратиграфия четвертичного периода Прибалтики и сопредельных районов*. Вильнюс: Изд. АН Литовской ССР. 122–130.

Хурсевич Г. К., Логинова Л. П. 1986. Возраст и палеогеографические условия формирования древнеозерных отложений Речицкого Приднепровья. *Плейстоцен Речицкого Приднепровья Белоруссии*. Минск. 76–142.

Хурсевич Г. К., Пршибыловска-Ланге В., Логинова Л. П. 1990. Об одновозрастности диатомовых флор плейстоценовых разрезов Красная Дуброва (БССР) и Фердинандов (ПНР). *Доклады АН БССР*. ***34***(*2*). 179–183.

Якубовская Т. В., Хурсевич Г. К., Рылова Т. Б. 1991. Новые данные о стратотипе беловежского межледниковья. *Доклады АН БССР*. ***35***(*3*). 262–265.

Genadijus Korolis

ÞIDINIØ PJÛVIO DIATOMËJØ FLORA IR JOS PALEOGEOGRAFINË BEI STRATIGRAFINË REIKÐMË

Santrauka

Þidiniø græþinio Nr. 570 (Latvija) eþeriniø nuogulø (apatinis pleistocenas) iðsamø diatomëjø floros kompleksà sudaro 162 rûðys ir vidurrûðiniai taksonai. Toks iðsamus ðio græþinio diatomëjø floros sàraðas spaudai pateiktas pirmà kartà. Jame atsispindi ne tik sisteminë sudëtis, bet ir ekologinë geografinë taksonø priklausomybë. Remiantis atliktø tyrimø duomenimis daroma iðvada, kad tirtos nuogulos susiklojo Þidiniø (Beloveþo) tarpledynmeèio paleobaseine. Nustatytos paleobaseino raidos stadijos. Taigi tyrinëtos diatomëjø liekanos turi biostratigrafinæ ir paleogeografinæ reikðmæ.

Геннадий Король

ДИАТОМОВАЯ ФЛОРА РАЗРЕЗА ЖИДИНИ И ЕЕ ПАЛЕОГЕОГРАФИЧЕСКОЕ И БИОСТРАТИГРАФИЧЕСКОЕ ЗНАЧЕНИЕ

Резюме

В настоящей работе впервые приведен полный систематический состав диатомовой флоры разреза Жидини с учетом новейших номенклатурных изменений. Список включает 162 вида и внутривидовых таксона. В нем отражены систематический состав, эколого-географическая характеристика диатомей. Исследованиями подтвержден вывод о жидиньском (беловежском) (в широком смысле) возрасте отложений, содержащих остатки диатомей, показано их палеогеографическое и биостратиграфическое значение.