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POTAMOGETON SPECIES OF THE KHOLMECH FLORA IN BELARUS

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ABSTRACT. Pliocene deposits on the right bank of the Dniepr river near the village of Kholmech in the south-eastern part of Belarus were studied for the first time by P. Dorofeev and F. Velichkevich in 1968–1970. On the basis of all the data, the Kholmech flora is estimated to contain more than 150 taxa of trees, shrubs and herbaceous plants. The genus *Potamogeton* has been chosen for an investigation similar to that undertaken for the flora of Mizerna, southern Poland (Velichkevich and Lesiak 1996). 14 extinct and 2 contemporary species of *Potamogeton* were distinguished in the Kholmech flora. The authors intend to collate all the data concerning the Kholmech flora and to prepare a monograph to be published in the near future.

KEY WORDS: *Potamogeton*, endocarps, extinct species, reference collections, flora, Belarus, Kholmech, Pliocene

INTRODUCTION

Fossil bearing Pliocene deposits on the right bank of the Dniepr river near Kholmech village in the south-eastern part of Belarus (Fig. 1) were studied for the first time by P. Dorofeev and F. Velichkevich in 1968–1970.

Several plant megafossils were excavated by washing comparatively small amounts of sediment (peat and peaty gyttja) from a layer less than 1 m thick which occurred in an outcrop directly in the river-bed, very near the centre of Kholmech village. In the first publication concerning the Kholmech flora, Dorofeev (1971) described a few new extinct species, including *Potamogeton borysthenicus* Dorof. and *P. cholmeczensis* Dorof. which featured in a most interesting list of determined herbaceous species. The presence of the following undoubtedly confirms the Pliocene age of the flora: *Salvinia tuberculata* Nikit., *Stratiotes intermedius* (Hartz) Chandl., *Caldesia cylindrica* (E.M. Reid) Dorof., *Brasenia tuberculata* C. et E.M. Reid, *Nuphar canaliculatum* C. et E.M. Reid, *Decodon globosus* (E. Reid) Nikit., *Proserpinaca reticulata* C. et E.M. Reid, *Aldrovanda eleanorae* Nikit., *Naumburgia subthyrsiflora* Nikit. and others. In the same year a more detailed paper about new Pliocene floras in Belarus was published (Dorofeev & Velichkevich 1971) in which the complete list of more than 80 taxa from Kholmech was recorded and the Middle Pliocene age of the flora confirmed.

Later on, the exposure near Kholmech was repeatedly visited by Belarussian palaeobotanists together with Dorofeev and the collection of macrofossil plant remains has been significantly enlarged. On the basis of all the data, the Kholmech flora is estimated to contain more than 150 taxa of trees, shrubs and herbs from more than 80 genera and is considered to be one of the richest Pliocene floras in Belarus.

P.I. Dorofeev was the main investigator of the Kholmech flora. He provided descriptions of many extinct species, for example from the genera *Salvinia*, *Azolla*, *Pilularia*, *Typha*, *Sparganium, Brasenia, Nymphaea, Caulinia, Scirpus* and *Ranunculus*. Most of them were published in a series of general articles on the history of genera but Dorofeev's untimely death caused work on the monograph to cease. In the last year of his life Dorofeev presented most of his Kholmech flora collection to the Palaeobotanical Museum in Minsk for safekeeping and study.

It should also be mentioned that at the beginning of the eighties (1982) T. Yakubow-

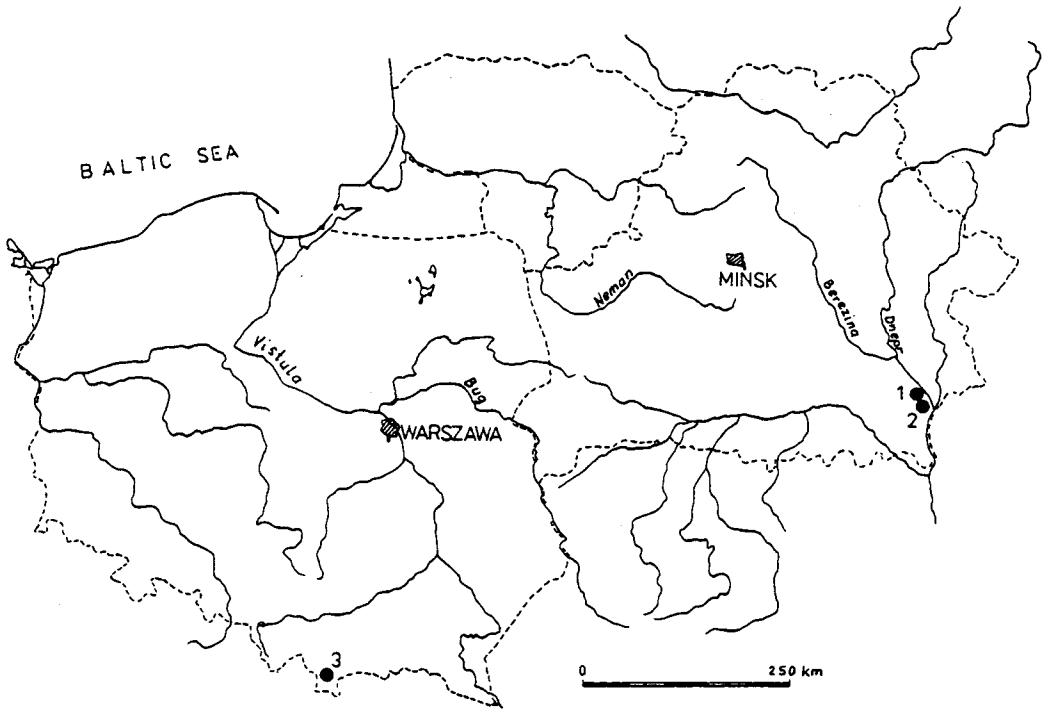

Fig. 1. Location of the sites discussed in the text: **1** – Dvorets, **2** – Kholmech, **3** – Mizerna

skaya joined these palaeobotanical investigations. She received several samples of fossil bearing sediments from drillings made for stratigraphical purposes in the vicinities of Kholmech, Dvorets and Artuki. She was successful in finding the same Pliocene floristic complex as had been present in the outcrop but also another, more ancient one, in which some taxa from the Miocene flora were plentiful, including *Liriodendron* cf. *geminata* Kirchh., *Myrica* cf. *minima* Negru, *Hartziella pliocenica* Szafer, *Leitneria venosa* (Ludw.) Dorof., *Comptonia* sp. and Taxodiaceae.

The composition of the Kholmech flora, transitional between the very rich and exotic floras of Western and Central Europe and the more impoverished Pliocene floras of Russia are deserving of investigation and monographic description.

One of the most interesting groups in the Kholmech flora is *Potamogeton* with numerous extinct and extant species. Most of those from the site were described by Dorofeev from the very abundant collections of fossil endocarps. This genus has been chosen by the present authors for detailed investigation similar to that undertaken for the flora of Mizerna, southern Poland (Velichkevich & Lesiak 1996). They intend to collate all the data concerning the Kholmech flora and to prepare a monograph to be published in the near future.

MATERIAL AND METHODS

More than 3700 well- preserved fossil endocarps of *Potamogeton* were studied in the collection of the Kholmech flora which is stored in the Palaeobotanical Museum of Minsk, Belarus. On the basis of this material 16 species, of which 14 are extinct, have been identified. The set of morphological features of *Potamogeton* endocarps listed in a previous similar work (Velichkevich & Lesiak 1996, p. 80, Fig. 1) was used for describing the new material. The endocarps of the Kholmech collection were compared with similar ones from different Pliocene floras of Russia, Lithuania, Belarus and Poland housed in the Museums of Minsk and Cracow.

The most typical endocarps of each species were separated, prepared and photographed under a light microscope.

SYSTEMATIC DESCRIPTIONS

Potamogeton borysthenicus Dorof.

Pl. 2 figs. 16–18

1971 *Potamogeton borysthenicus* Dorof., Dorofeev; p. 918, Fig. 1, 22.

Material: Coll. MINM-V-P1-17: 181 endocarps.

Description. The endocarps are large, 2.0–3.3 × 1.8–2.7 mm, ellipsoidal or plano-convex, thick, firm, rough. The ventral margin is slightly convex or nearly straight, keeled or occasionally rounded, and furnished with a bulge or large wart just below the middle. The lid is broad, keeled, with a crispate fringed crest. The pointed top of the lid usually reaches the base of the style, rarely leaving a small, inconspicuous shoulder. The flat nipple at the base of the lid is often preserved. The style is short, pointed and ventrally positioned, but more often absent. The stalk is very small, inconspicuous, situated laterally and obliquely inserted at the base between basal warts. The sides are slightly convex or flattened, with a broad, shallow central depression opening out on to the ventral margin above the bulge. The sides bear many small tubercles towards the apex and along the dorsal margin which is sometimes revolutely thickened. The surface of the central depression is finely pitted what is visible under greater enlargement, pale to dark brown and mat.

Comparison: The endocarps of the contemporary East-Asiatic species *P. manshuriensis* A. Benn. are fairly similar to those described above in several important diagnostic features, but they are larger and narrower, possess a less convex ventral margin and less fringed lid crest, a stout style and have practically no tubercles on the sides. Several extinct species from the same Manshuriensis group, described by Dorofeev and Velichkevich from the Pliocene and Pleistocene of Russia (Bashkirskaya) and Belarus show considerably greater differences from *P. borysthenicus* Dorof. (Dorofeev 1986, pp. 78–90, Figs 39–45).

Potamogeton longistylus Dorof.

Pl. 1 figs. 14–16

1977 *Potamogeton longistulus* Dorof., Dorofeev; p. 738, Fig. 1, 9–11.

Material: Coll. MINM-V-P1-18: 321 endocarps.

Description: The endocarps are large, 2.3–3.2 × 2.0–3.0 mm, broadly obovoid or subspherical. The ventral margin is mostly strongly convex but straight below, rounded or slightly keeled, with a small, cuneate stalk at the base. The lid is broad and conspicuously keeled, with an entire plate-like crest, sometimes broadening slightly towards the apex, but not reaching it. The rounded top of the lid or its spine, as a rule, reaches the base of the style and only seldom leaving a small false shoulder. The style is long, slender, centrally positioned, often with a thickened stigma. The sides are convex or slightly flattened, sometimes thickened and protrude along the dorsal margin, with a large, arched hole. The surface is smooth, grey-brown, slightly lustrous.

Comparison. The endocarps of *P. planus* Nikit. from the Pliocene of the Voronyezh area in Russia (Nikitin 1957; p. 98, Pl. 2, Fig. 3) very closely resemble those described, but they are larger, with less convex sides, a smaller hole and shorter and thicker style, and often lack the basal stalk. Some other Pliocene species separated by Dorofeev into the Planus group of this genus (*P. pseudoplatanus* Dorof. et Wieliczk., *P. stylatus* Dorof. et Wieliczk. and *P. bashkiricus* Dorof.) show considerably greater differences from *P. longistylus* Dorof. than does *P. planus* Nikit. The relationships connecting all of these species with extant ones are unclear; perhaps they represent a blind alley in Neogene *Potamogeton* evolution.

Potamogeton pseudoacutifolius Dorof.

Pl. 1 figs. 11–13

1986 *Potamogeton pseudoacutifolius* Dorof., Dorofeev; p. 88, Fig. 45, 11–18.

Material. Coll. MINM-V-P1-19: 165 endocarps.

Description. The endocarps are fairly variable in size (1.7–2.6 × 1.5–2.1 mm) and shape: from plano-convex to nearly sphaerical. The walls are thick and firm. The ventral margin is convex, with a large bulge situated below the mouth of a central depression. The lid is broad, keeled, with a crispate crest at the edge and fringes on the sides of the lid along the crest. At the base of the lid a small nipple has generally been preserved. The lid extends to the base of the style, so no shoulder is present. The style is thin and centrally positioned, long when complete but more often broken off. The stalk is tiny and usually inconspicuous. The sides are slightly convex, inflated, with a

large, shallow central depression opening into a mouth at the ventral margin above a bulge, without a cavity. The surface is uniformly rough, dark brown and mat.

Comparison. The endocarps of this species from Mizerna in Poland (Velichkevich and Lesiak, 1996, Pl. 2, Figs. 12–15) mostly agree with those described above, but they are somewhat narrower, with a smaller ventral bulge, inconspicuous stalk and rather smooth lateral surfaces. The endocarps of the contemporary *P. acutifolius* Link are larger, with a slightly crispate lid crest, a thick, short but distinct stalk, nearly smooth sides and no central depression. The endocarps of the extant species *P. trichoides* Cham. et Schlecht. are similar in size but they exhibit considerably greater differences from those described above.

Potamogeton margaritae Dorof.

Pl. 2 figs. 2–4

1986 *Potamogeton margaritae* Dorof., Dorofeev; p. 46, Fig. 20, 1–16.

Material. Coll. MINM-V-P1-20 : 352 endocarps.

Description. The endocarps are medium sized, 1.9–2.8 × 1.7–2.2 mm, obovoid or broadly obovoid, compressed. The ventral margin is usually strongly convex above and straight or concave below, rounded, occasionally slightly and uniformly convex or somewhat unevenly sigmoid. The lid is narrow, keeled, with a crispate, spiny crest, preserved most frequently in the upper part of the lid. The pointed top of the lid does not reach the style base. The shoulder is short but conspicuous, raised. The style is thin, ventrally positioned and seldom preserved. The stalk is small, acute, inserted a little above the base of endocarp. The sides are flat or slightly sunken, with a deep cavity or rather large hole. The surface is smooth or fine-celled under greater enlargement, pale to dark brown, mat. Many of the endocarps are covered by a thin film-like, dark brown and lustrous epicarp.

Comparison. P. *margaritae* Dorof. belongs to the Natans group of ancient Pliocene and Upper Miocene species related to the contemporary *P. natans* L. The endocarps of the extinct species *P. peregrinus* Dorof. (Dorofeev 1986, p. 53, Fig. 23, 1–12) from another philogenetic branch of the genus *Potamogeton* (Perfoliatus) are rather similar to those described above in size and shape, but differ by having a more conspicuous plate-like or crispate lid crest, a mesocarpal excrescence in the middle of the ventral margin, and lack a shoulder.

Potamogeton rossicus Dorof.

Pl. 2 figs. 14, 15

1986 *Potamogeton rossicus* Dorof., Dorofeev; p. 52, Fig. 22, 19–25.

Material. Coll. MINM-V-P1-21: 19 endocarps.

Description. The endocarps are medium sized, 1.8–2.3 × 1.6–2.0 mm, ellipsoidal or plano-convex, compressed and bent longitudinally. The ventral margin is slightly convex, keeled, with a wedge-like excrescence in the middle or above the mouth of the central depression. The lid is narrow, with a short spiny crest. The shoulder is absent. The style is short, ventrally positioned, upright or inclined forward, usually broken off. The stalk is short, aculeolate, most often inconspicuous. The sides are flat, with a rather small central cavity or hole, sometimes with a strip of mesocarpal tissue along the dorsal margin. The surface is rather smooth or a delicately pitted, pale to dark brown, mat.

Comparison. This species belongs to the Perfoliatus group of *Potamogeton* and together with other related Pliocene and Eopleistocene species (*P. pliocenicus* Dorof., *P. peregrinus* Dorof., *P. sivkovense* Dorof., *P. perfoliatus* Wieliczk. and others) shows kinship with the contemporary *P. perfoliatus* L., particularly its Canadian variety, var. *gracilis* Fries.

Potamogeton praenatans Dorof.

Pl. 1 figs. 1, 2

1986 *Potamogeton praenatans* Dorof., Dorofeev; p. 46, Fig. 19, 4–12.

Material. Coll. MINM-V-P1-22: 17 endocarps.

Description. The endocarps are medium sized, 2.2–3.1 × 1.9–2.5 mm, broadly obovoid to nearly ovoid, thick and firm. The ventral margin is uniformly convex, blunt to rounded. The lid is broad, slightly keeled, smooth or with an inconspicuous crispate crest in its upper part.

The top of the lid reaches the apex of the endocarp. The shoulder is short or absent. The stalk is in most cases obscure. The sides are strongly to moderately convex with a deep cavity or pit in the centre. The walls are thick with a nearly smooth surface, pale to dark grey-brown and mat.

Comparison. It is most likely that this extinct species from the Natans group of *Potamogeton* is an intermediate ancestor of the contemporary *P. natans* L. The endocarps of the later species from the Middle Pleistocene interglacial flora of Minichi (western Belarus), for example, very closely resemble those described above, but are narrower, with less thick walls, more conspicuous shoulder, crispate lid crest, and lack the cavity in the side walls. Present-day endocarps of *P. natans* L. show considerably greater differences from the described ones, principally in the shape of the lid and cavity.

Potamogeton obtusus Dorof.

Pl. 1 figs. 6, 7

1986 *Potamogeton obtusus* Dorof., Dorofeev; p. 97, Fig. 50, 11–20.

Material. Coll. MINM-V-P1-23: 21 endocarps.

Description. The endocarps are medium sized, 2.1–2.7 × 1.6–2.1 mm, obovoid, compressed. The ventral margin is variable, strongly convex in the upper part, sometimes weakly and uniformly convex throughout or even nearly straight, often with a small spine at the mouth of the central depression. The lid is keeled and furnished with a crispate or fringed crest. The blunt pointed top of the lid in most cases extends to the base of the style or leaves a short raised shoulder. The style is aculeolate, ventrally positioned, frequently broken off.. The stalk is very small, inconspicuous. The sides are flat or slightly inflated, with a broad and shallow central depression. The surface is smooth, grey-brown and mat.

Comparison. *P. obtusatus* Dorof., another extinct species from the same group, the next to be dealt with here, and abundant in the Kholmech flora has endocarps similar in many respects to those described above, but they are on average smaller, with a filamentous style centrally positioned and a rounded top of the lid. The endocarps of the contemporary *P. obtusifolius* Mert. et Koch found for example in different Eemian interglacial floras of Belarus, are larger, inflated, with a distinct fringed crest on the lid and lack the ventral spine.

Potamogeton obtusatus Dorof.

Pl. 2 figs. 10–12

1986 *Potamogeton obtusatus* Dorof., Dorofeev; p. 97, Fig. 50, 1–10.

Material. Coll. MINM-V-P1-24: 164 endocarps.

Description. The endocarps are medium sized, 1.6–2.3 × 1.5 × 1.9 mm, broadly obovoid, ellipsoidal to ovoid. The ventral margin is slightly but uniformly convex, rounded, and usually furnished with a small ventral spine in the mouth of the central depression. The lid is keeled, with a toothed crispate crest. The rounded top of the lid reaching the base of the style. The style is thin, filamentous, with a disc-like stigma, centrally positioned, upright or inclined towards the ventral margin. The stalk is aculeolate, usually conspicuous. The sides are convex to slightly flattened, sometimes sunken, with a large shallow central depression, without cavity. The walls are rather thin but firm, and possess a uniformly rough to nearly smooth surface which is pale to dark brown, mat.

Comparison. The numerous endocarps of P. *obtusatus* Dorof. from Mizerna (Velichkevich & Lesiak 1996, p. 81, Pl. 1, Figs 5–9) almost completely match the ones described above, but differ in having a less conspicuous lid crest. The endocarps of the contemporary *P. obtusifolius* Mert. et Koch from different interglacial floras of Belarus (Dorofeev 1963, Velichkevich 1973) are on average larger, with more convex sides, fringed lid crest and a very small but distinct shoulder.

Potamogeton palaeorutilus Dorof.

Pl. 2 figs 5, 6

1986 *Potamogeton palaeorutilus* Dorof., Dorofeev; p. 103, Fig. 53, 1–9.

Material. Coll. MINM-V-P1-25: 40 endocarps

Description. The endocarps are small, 1.6–1.9 × 1.1–1.4 mm, elongate, inflated. The ven-

tral margin is convex in the upper or middle part, lacking any processes. The lid is thick, broad, rounded, its pointed top falling short of the apex. The shoulder is very short or absent. The style and stalk are inconspicuous. The sides are strongly convex and lack a central depression. The walls are thick and robust.

Comparison. The endocarps of the *P. palaeorutilus* Dorof. type collection from the Upper Pliocene of the Tambovskaya area in Russia are completely identical to our specimens. The endocarps of *P.* cf. *rutilus* Wolfg. from Mizerna (Velichkevich & Lesiak 1996, p. 85, Pl. 3, Figs 17–19) are larger, with the slender, fairly long style and distinct aculeate stalk. The endocarps of the contemporary P. *rutilus* Wolfg. from the Pleistocene deposits of Belarus are similar in size but are narrower, with a nearly straight ventral margin and acute or obtuse apex and base.

Potamogeton cholmeczensis Dorof.

Pl. 1 figs 3–5

1971 *Potamogeton cholmeczensis* Dorof., Dorofeev; p. 919, Pl. 1, Figs 9–14

Material. Coll. MINM-V-P1-26: 1783 endocarps.

Description. The endocarps are medium to small, 1.5–2.3 × 1.2–1.9 mm, mostly narrow, obovoid, bent longitudinally, compressed. The ventral margin is unevenly sigmoid and slightly keeled , sometimes with a wedge-like mesocarpal excrescence above the mouth of the central depression. Mesocarpal tissue is also often preserved on the upper part of the ventral margin and occasionally in the pit of the central depression. The lid is narrow, keeled, with a small crispate crest, frequently preserved only in the upper part. The pointed top of the lid reaches the base of the style, the shoulder is absent. The style is elongate, thin, acute, thickened stigma only rarely present, arising from or near to the ventral margin, inclined towards the dorsal. The stalk is short, aculeolate, often inconspicuous. The sides are flat or slightly convex, with a large arched cavity opening into a mouth at the ventral margin above the base of the stalk. The walls are thin but firm, their surface is granulate, red-brown or pale brown where fragments of mesocarpal tissue remain.

Comparison. The relationship of this species to contemporary ones is unclear. Apart from the Kholmech flora, characteristic endocarps of *P. cholmeczensis* Dorof. were determined by Dorofeev in the Pliocene of the Tambovskaya and Ryazanskaya regions in Russia. In the younger Pliocene (or Eopleistocene) flora of the Dvorets site, a few kilometres from Kholmech, this species is absent (Velichkevich 1990).

Potamogeton simplex Dorof.

Pl. 1 figs. 8–10

1986 *Potamogeton simplex* Dorof., Dorofeev; p. 99, Fig. 51, 27–36.

Material. Coll. MINM-V-P1-27: 582 endocarps.

Description. The endocarps are small, 1.4–1.8 × 1.2–1.4 mm, obovoid, often narrow, slightly bent longitudinally. The ventral margin is weakly to moderately convex in the upper part and nearly straight or concave below, rounded or slightly keeled. The lid is furnished with a toothed or nearly smooth crest, its top reaching the base of the style which is short, aculeolate, rarely with stigma, centrally positioned and often broken off. The stalk is short and inconspicuous. The sides are slightly convex and flattened, with a broad shallow central depression opening out on to the mouth of the ventral margin. The walls are rather thick, firm but the Kholmech collection contains many endocarps of this species possessing thin walls; maybe they are immature.

Comparison. The relationship of this characteristic extinct species with contemporary ones is unclear, but Dorofeev (1986) maintained that some features of *P. obtusifolius* Mert. et Koch and *P. pusillus* L. could be seen in the morphology of *P. simplex* Dorof.. In our opinion the latter species has no features in common with *P. obtusifolius* Mert. et Koch, but there is a possibility that it belongs to the Pusillus group of *Potamogeton*.

Potamogeton* cf. *parvulus Dorof.

Pl. 2 fig. 8

1986 *Potamogeton parvulus* Dorof., Dorofeev; p. 110, Fig. 55, 18–28.

Material. Coll. MINM-V-P1-28: 12 endocarps.

Description. The endocarps are very small, 1.2–1.5 × 0.9–1.3 mm, plano-convex to nearly spherical, compressed. The ventral margin is strongly convex in the upper part or unevenly sigmoid, rounded. The lid is thin, smooth, its pointed top reaching the base of the short, centrally positioned style. The thickened stigma is sometimes preserved. The stalk is very small, inconspicuous, often absent. The sides are flat or slightly convex, with a deep cavity or pit in the centre. The surface is rough, delicately pitted, pale brown and mat.

Comparison. The endocarps of this species forming the type collection from the Upper Pliocene flora of Dvorets on the Dniepr (Velichkevich 1990, p. 46, Pl. 10, Figs. 3–5) agree with our few poorly preserved specimens in most important diagnostic features but are more uniform in size.

Potamogeton panormitanoides Dorof.

Pl. 2 fig. 7

1986 *Potamogeton panormitanoides* Dorof., Dorofeev; p. 107, Fig. 54, 2–8.

Material. Coll. MINM-V-P1-29: 6 endocarps.

Description. The endocarps are very small, 1.2–1.5 × 1.0–1.2 mm, elongate, obovoid. The ventral margin is strongly convex in the upper part or unevenly sigmoid, rounded. The lid is smooth, its pointed top reaching the apex of the endocarp; the shoulder is very small or absent. The style is inconspicuous, and the short trigonous stalk is rarely preserved. The sides are slightly convex, with or without a pit-like central depression. The surface is smooth, pale brown, slightly lustrous.

Comparison. The endocarps of the *P. panormitanoides* Dorof. type collection from the Middle Pleistocene of the Tambovskaya region in Russia are similar to ours in their basic diagnostic features but differ from them in possessing a short, centrally positioned style and a more conspicuous central depression. The endocarps of this species from the different interglacial floras of Belarus, for example from the Middle Pleistocene flora of Minichi, very closely resemble the ones decribed above. Two characteristic endocarps of this species have recently been separated in the flora of Mizerna (Velichkevich & Lesiak 1996, p. 86, Pl. 3, Figs 23, 24). It should be emphasized that the endocarps of *P. panormitanoides* Dorof. possesss some clear characteristic morphological features which preclude their confusion with those of any other *Potamogeton* species with small endocarps.

Potamogeton* cf. *pectinatus L.

Pl. 2 fig. 13

Material. Coll. MINM<-V-P1-30: 1 endocarp.

Description. The endocarp is fairly large, 2.9 mm long and 2.5 mm wide, thick, inflated, broadly obovoid in shape, without style or stalk. The ventral margin is uniformly convex, rounded, slightly thickened in the middle. The lid is short, somewhat arched, broad, flattened, with a low plate-like keel. The rounded top of the lid falls far short of the base of the style. The shoulder is long, raised, in length approximately equal to the one half of the width of the endocarp. The sides are strongly convex, with a small inconspicuous central depression. The surface is rough, dark brown, slightly lustrous.

Comparison. The endocarps of the contemporary *P. pectinatus* L. are very variable in shape and size, but one can find among them specimens completely identical to that described above. The endocarps of *P. praepectinatus* Negru, described from the Miocene of Moldova (Negru 1972, pp. 71, 72, Pl. 6, Figs. 17–19) have the same shape but on average are smaller, more compressed, with a short and conspicuous style.

Potamogeton crispus L.

Pl. 2 fig. 9

Material. Coll. MINM-V-P1-31: 1 endocarp.

Description. The endocarp is 2.8 mm long and 2.1 mm wide, ovoid, compressed, partially deformed. The ventral margin is strongly convex, keeled, with an obtuse angled protrusion in the middle part. The lid is short, keeled and furnished with a small crest, and a nipple at the base. The top of the lid does not reach the base of the style, but the shoulder is absent. The apex of the endocarp is wedge-like, flat-

tened. The stalk is inconspicuous. The sides are sunken, with a large central depression, and are slightly thickened at the base. The surface is rough, dark brown and mat.

Only one endocarp of this type is represented in the whole Kholmech collection, so it is very difficult to be certain of the taxonomy of our specimen. It could match perfectly the contemporary *P. crispus* L., but it is also possible that this endocarp belongs to some extinct named species, like *P. palaeocrispus* Dorof., described from the Middle Pleistocene of the Ukraine (Dorofeev 1986, p. 76, Fig. 38, 1–11).

Potamogeton cf. ***felixi*** Dorof.

Pl. 2 fig. 1

1986 *Potamogeton felixi* Dorof., Dorofeev; p. 38, Fig. 15, 1–6.

Material. Coll. MINM-V-P1-32: 1 endocarp.

Description. The endocarp is medium sized, 2.3 × 2.0 mm, ovoid, inflated. The ventral margin is strongly convex, rounded, with a small tubercled stalk in the lower part. The lid is keeled, with an inconspicuous toothed crispate crest; the shoulder is absent. The style is long and rather stout, acute, centrally positioned and upright. The sides are strongly convex, with a small deep cavity and small basal wart.

Comparison. The endocarps of the *P. felixi* Dorof. type collection from the Late Pliocene flora of Dvorets in Belarus are larger, more elongate, with a wedge-like base. In Dorofeev's opinion the East-Asiatic P. *fryeri* A. Benn. might be the contemporary analogue of this extinct species.

CONCLUSIONS

The Kholmech flora was laid down and has been preserved in a small, thick layer of fossil bearing sediment. In its floristic composition it provides an accurate picture of the marsh and water plant assemblages which were characteristic for the southern part of Belarus at the end of the Late Pliocene or beginning of the Upper Pliocene. Preliminary species lists were published by Dorofeev and Velichkevich in the seventies but they did not provide a complete picture of the ancient character of the Kholmech flora. The most abundant macrofossils in the collection which had been at the author's disposal represented species at least 45% of which were extinct. Nearly all the species of *Potamogeton* listed are extinct . On one hand this points to the fact that the macrofossil investigations concerning some families of the Kholmech flora, notably Chenopodiaceae, Caryophyllaceae, Polygonaceae, Ranunculaceae and Lamiaceae had not been thorough enough, but on the other hand, it indicates different rates of evolutionary change in some taxa of Pliocene floras. Among 16 species of *Potamogeton* from the Kholmech flora there are only 2 which could be referred to contemporary European species, i.e. *P. pectinatus* L. and *P. crispus* L. It must be stressed that they were determined on the basis of single endocarps. All other species were represented by an abundance of endocarps. It is very difficult to assert their affiliation to contemporary species without a thorough knowledge of their full morphological variability, but that such an affiliation exists cannot be excluded. The remains present in greatest quantity in the Kholmech flora were those of *P. cholmeczensis* Dorof., *P. simplex* Dorof., *P. longistylus* Dorof. and *P. margaritae* Dorof., which do not have any connections with contemporary species, but were widely distributed in the Pliocene of the East European plain. Less abundant are the remains of species which were probably immediate ancestors of contemporary European or East-Asiatic species, like *P. acutifolius* Link, *P. trichoides* Cham. et Schlecht., *P. obtusifolius* Mert et Koch, *P. natans* L., *P. rutilus* Wolfg. and *P. manshuriensis* A. Benn.. The extensive presence of species like *P. pseudoacutifolius* Dorof., *P. obtusus* Dorof., *P. obtusatus* Dorof. *P. praenatans* Dorof., *P. palaeorutilus* Dorof. and *P. borysthenicus* Dorof. provide a basis for the statement that the beginning of the emergence of the above- mentioned contemporary species as fully distinct taxa should be associated with stages of the Pliocene or even the Eopleistocene. For the great discrepancy in age between the Kholmech flora and the neighbouring Upper Pliocene flora of Dvorets means that these two floras have only a few inconsequential *Potamogeton* species in common: *P. parvulus* Dorof., *P. felixi* Dorof. and *P. obtusatus* Dorof.. The Kholmech flora shares with the Pliocene flora of Mizerna, southern Poland,

only 3 *Potamogeton* species, namely *P. pseudoacutifolius* Dorof., *P. obtusatus* Dorof. and *P. panormitanoides* Dorof.. This illustrates the enormous difference between these two floras in respect of their *Potamogeton* composition. The creation of the Mizerna flora probably occurred during the interval from the Upper Miocene to the beginning of the Pleistocene, and therefore the Middle Pliocene floristic complex of Kholmech flora age is very poorly represented in Mizerna. The two floras, from Mizerna and Kholmech, call for both taxonomic and stratigraphic revision, necessary for their detailed correlation.

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PLATES

Plate 1

1–16. *Potamogeton*, endocarps, Kholmech, × 15

1–2. *P. praenatans* Dorof.

3–5. *P. cholmeczensis* Dorof.

6–7. *P. obtusus* Dorof.

8–10. *P. simplex* Dorof.

11–13. *P. pseudoacutifolius* Dorof.

14–16. *P. longistylus* Dorof.

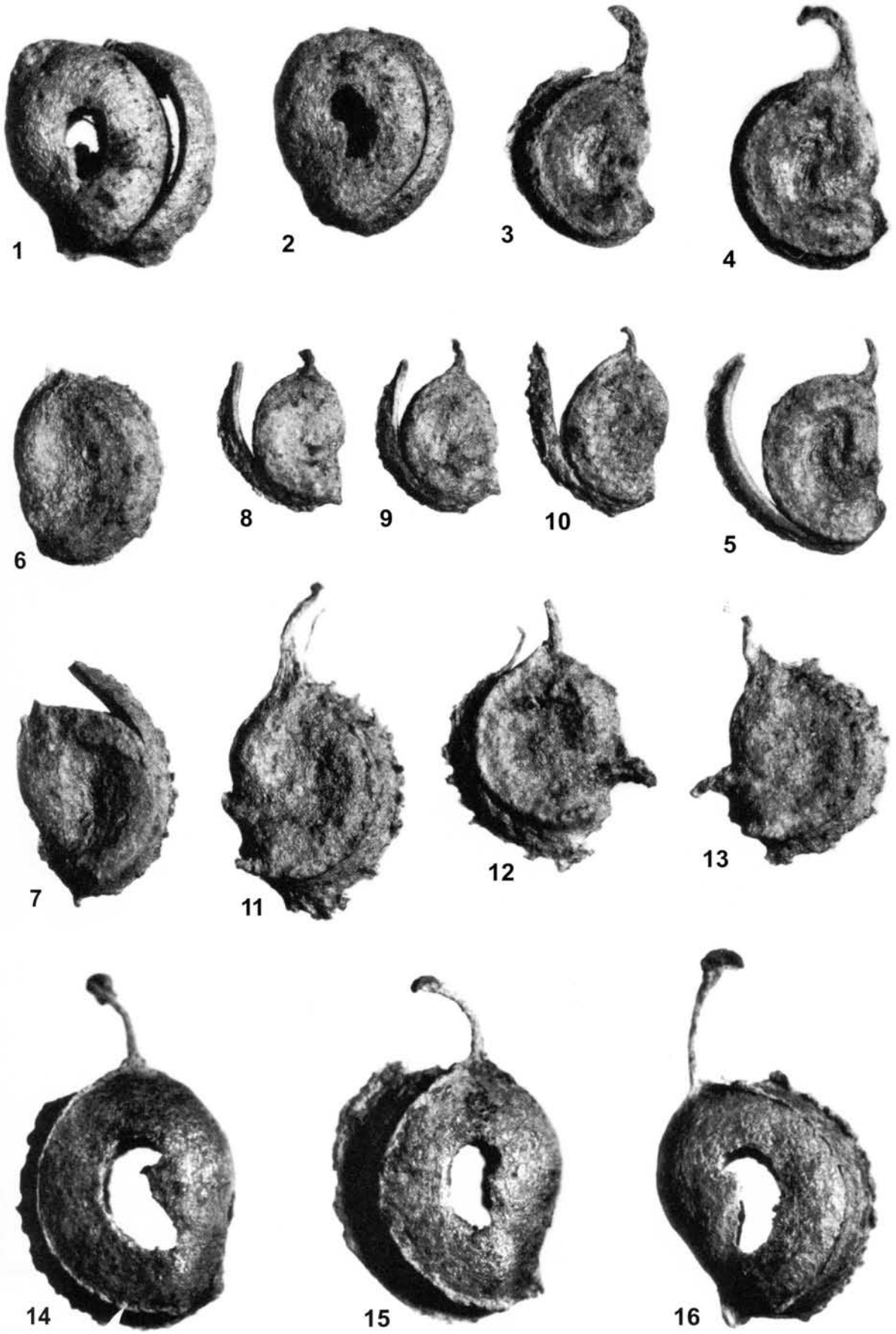
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Plate 2

1–18. *Potamogeton*, endocarps, Kholmech, × 15

1. *P.* cf. *felixi* Dorof.

2–4. *P. margaritae* Dorof.

5–6. *P. palaeorutilus* Dorof.

7. *P. panormitanoides* Dorof.

8. *P.* cf. *parvulus* Dorof.

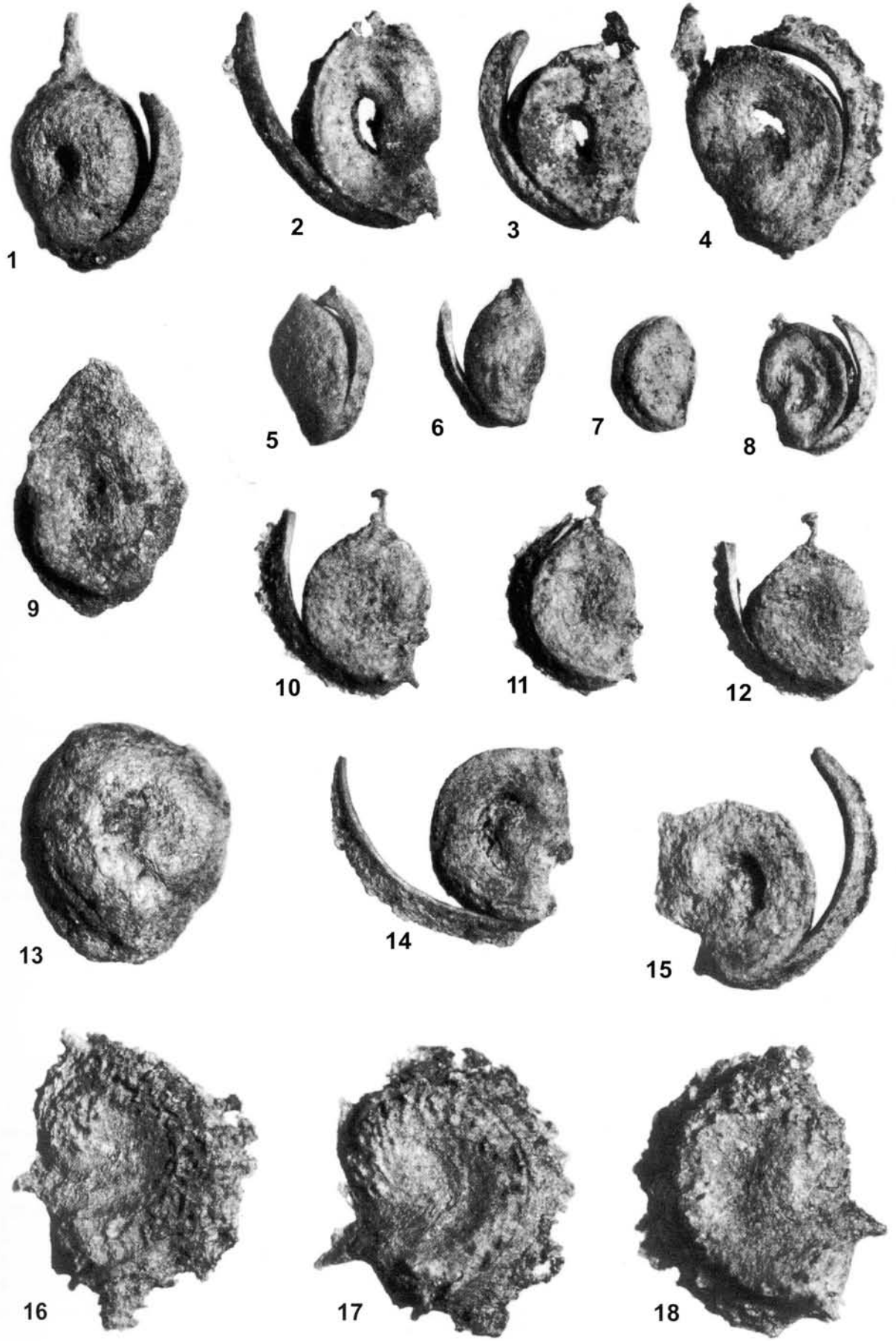
9. *P. crispus* L.

10–12. *P. obtusatus* Dorof.

13. *P.* cf. *pectinatus* L.

14–15. *P. rossicus* Dorof.

16–18. *P. borysthenicus* Dorof.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