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Palaeoenvironmental aspects of the genesis and early development of the Taboły mire, North-Eastern Poland

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Taboły, a large mire located in the Puszcza Knyszyńska Forest (NE Poland), was recognized as having a complex history. Numerous drillings led to a reconstructed description of its basin. Analysis of macroscopic plant remains was used to discern its subfossil vegetation and to identify the initial peat-forming plant communities. The age of selected sediment samples was dated by the radiocarbon dating. The peat-forming centre was located in a shallow depression. Peat accumulation started 11941–11537 yrs BC. The water body from Taboły was likely formed in the Allerød interstadial. The two Taboły basins differ in age, aquatic plants and initial peat-forming plant communities. The shape of the basin bottom, the age of the oldest sediments and paleoenvironmental factors induced the idea that the water body is of thermokarst genesis.

Key words: NE Poland, Puszcza Knyszyńska Forest, Late Glacial, mire, peat-forming process, thermokarst

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INTRODUCTION

Mire ecosystems have a unique feature – they preserve records of past communities in the peat. That peat archive contains macro- and microfossils which are complementary and together give a comprehensive picture of peatland development (Rydin, Jeglum, 2008). They inform also about autogenic and allotigenic changes of peatlands (Charman, 2002). Out of different palaeoecological and palaeoclimatic investigations conducted in mires, two approaches are used in this paper: the analysis of plant macrofossil remains and measuring the degree of peat decomposition. The subfossil remains of vegetation preserved in peat record the original vegetation cover during the peat deposition. More active decomposition occurs when the mire surface is dry, thus resulting in more humified peat, a darker colour and fewer identifiable remains than in peat that accumulates when the mire surface is relatively wet (Blackford, 2000).

The aim of this study was to consider the processes affecting the genesis and early development of the Taboły deposit. The possibility of the thermokarst phenomenon was also investigated. The reconstruction and succession of the Taboły subfossil vegetation had been earlier described by Drzymulska (2006).

SITE DESCRIPTION AND PRESENT-DAY ENVIRONMENT

The Taboły mire is located in the Puszcza Knyszyńska Forest Landscape Park, in the Podlasie region (North-Eastern Poland) (Fig. 1). The geological structure and some climatic features relate the Puszcza Knyszyńska Forest region to the East European territory (Kondracki, Pietkiewicz, 1967). The thickness of the Quaternary cover varies from 130 to 220 m. The relief of the area was formed during the Saalian glaciation (Musiał, 1992) which produced a number of fluvioglacial features comprising kames, kame terraces and numerous other melt-water forms. Wetlands represent more than 20% of the Puszcza Knyszyńska Forest area. There are numerous mires in the wetlands. One of the largest mires – Taboły (3500 × 1500 m) – is located in the northern part of the Forest, in the Sokołda river valley (Fig. 1). This forest nature reserve covers 307 ha. In the northern part, the Taboły mire is overgrown by subboreal bog-birch forest (*Thelypterido-Betuletum pubescentis* Czerw. 1972). The middle part of the Taboły mire is overgrown with a boreal spruce forest (*Sphagno-girgensohnii-Piceetum* Polak. 1962). *Salici-Betuletum polytrichetosum strictae* (*Salici-Betuletum* Pałcz. 1975 association) covers the southern region (Czerwiński, personal comm.).

METHODS

Sampling

Altogether 17 cores of sediments were collected using a Russian sampler. The drilling was carried out along the longitudinal and transversal transects (Fig. 2). The length of the cores varies from 80 to 600 cm. Samples for laboratory analysis were taken at 10–15-cm spacing. Each sample was fragmented to three parts: for macrofossil analysis, for ash content analysis, and for studying the peat decomposition degree. Some samples was spared for radiocarbon dating.

Analysis of plant macrofossil remains

For analysis, 50 cm^3 of deposit of each sample was used. This material was flooded with distilled water with the addition of 10% KOH aiming at a full dispersion of peat lumps. The suspensions were boiled, then washed out on 0.2 mm sieve, and peat was placed in Petri dishes. Firstly, generative remains (fruits, seeds, fruit scales) picked out from every sample of peat and gyttja were placed into dishes containing a glycerine–thymol mixture (Tobolski, 2000). These remains were identified under a stereoscopic binocular. Vegetative plant remains were identified with a light microscope only in peat. Different kinds of macrofossils were recognized, such as roots, periderm, epiderm, leaves, stems, and wood. The remains were identified accordingt to Dombrovskaya et al. (1959), Katz et al. (1965), Mauquoy, van Geel (2007). For each sample, the proportion of every taxon tissues in the total tissue mass was estimated. Peat units were distinguished using the peat classification of Tołpa et al. (1967).

Analysis of decomposition degree of peat and ash content

Peat decomposition degree was described based on microscopic analysis according to Obidowicz (1990). The ratio of the completely humified peat mass to the whole peat mass

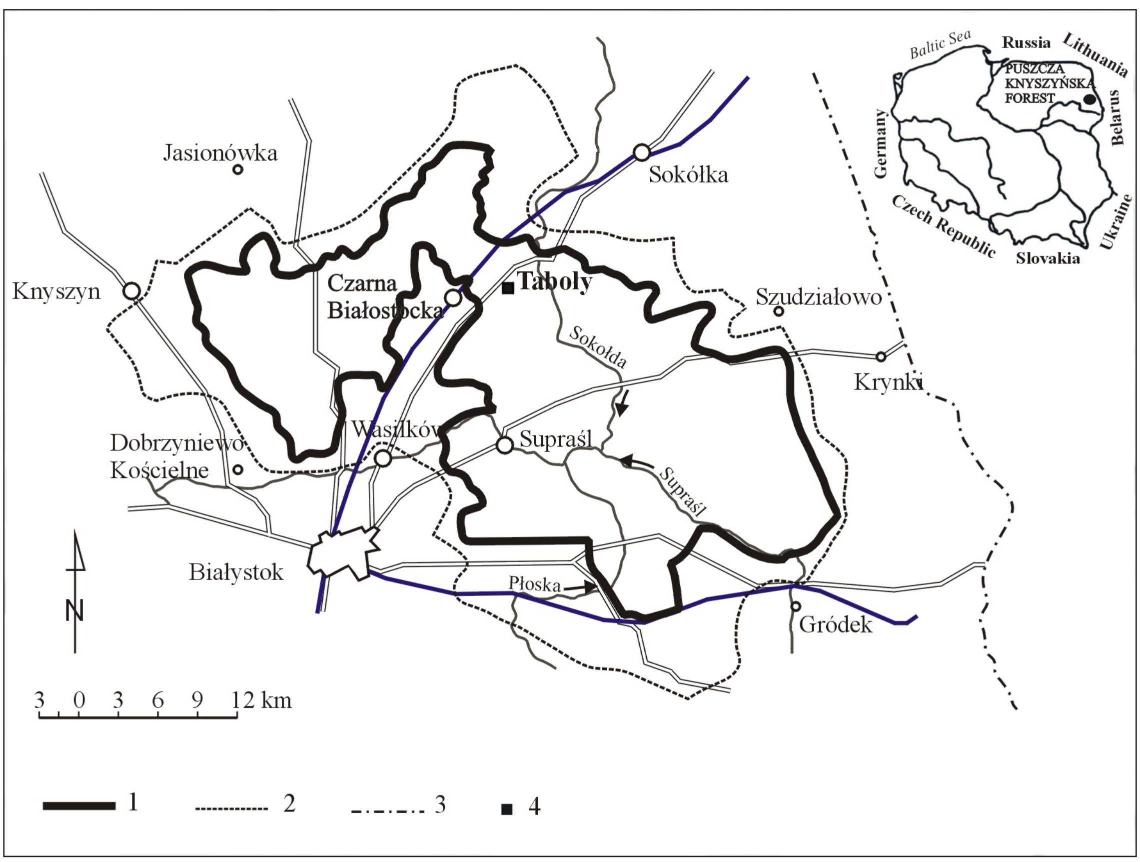

Fig. 1. Location of Puszcza Knyszyńska forest: *1* – border of the landscape park, *2* – border of the protected zone, *3* – the state border, *4* – mire studied (acc. to Drzymulska, 2006)

1 pav. Puszcza Knyszyńska miško geografinė padėtis: *1* – kraštovaizdžio parko ribos, *2* – saugomos teritorijos ribos, *3* – valstybinė siena, *4* – tirta pelkė (pagal Drzymulska, 2006)

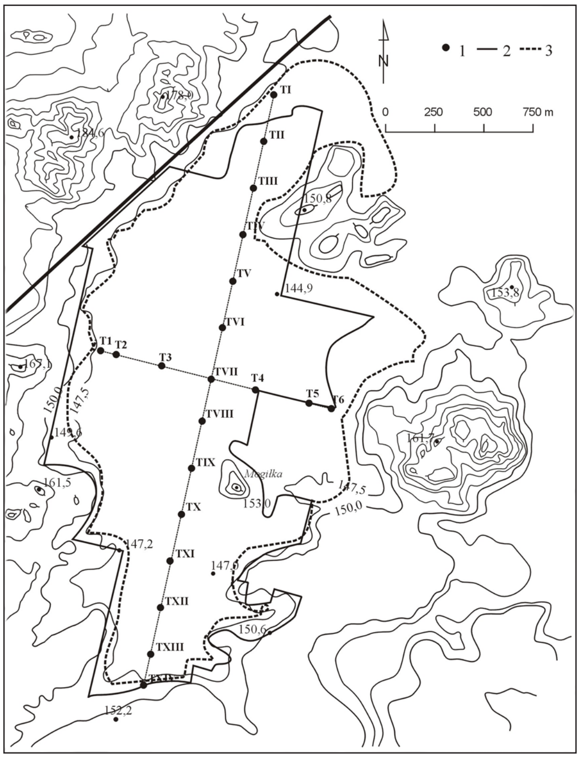

Fig. 2. Taboły mire: *1* – location of drillings, *2* – reserve border, *3* – mire border (acc. to Drzymulska, 2006)

2 pav. Taboły pelkė: *1* – gręžinio vieta, *2* – rezervato riba, *3* – pelkės riba (pagal Drzymulska, 2006)

in ten fields of vision of the microscope was estimated for each peat sample. Peat can be divided into (i) slightly decomposed (decomposition up to 25%), (ii) medium decomposed (30–40%), (iii) highly decomposed (45–60%), and (iiii) humopeat (65% and up). Ash content in sediment samples was estiamted by high-temperature incineration (600 °C).

Tables 1–3 list the recognized plant remains, units of sediments and other parameters in the bottom parts of TIV, TVII, and TIX cores. In this paper, only the Late Glacial phase of mire development is considered.

Radiocarbon dating

Selected samples of the peat were dated at the Poznań Radiocarbon Laboratory (Poznań, Poland) by the AMS radiocarbon dating method, and at the Radioanalytical Laboratory of the Institute of Hygiene and Medical Ecology in Kiev (Kiev, the Ukraine). The radiocarbon age of the samples was calibrated with CalPal-2007 ver. 1.5 online software (Danzeglocke, 2011). The chronology of the peat profiles was presented according to Litt et al. (2001) with a modification by Latałowa (2003). The radiocarbon datings are given in detail in Table 4.

RESULTS

The shallow depression in the area of the TIV and TV drillings represents the peat deposition centre of the Taboły mire

Table 1. **Plant remains, decomposition degree and ash content in the bottom part of the TIV core. A – vegetative remains (%), B – generative remains (real amount), + – minimal amount**

1 lentelė. **Augalų liekanos, durpių suirimo laipsnis ir pelenų kiekis bazinėje TIV gręžinio dalyje. A – augmenijos liekanos, B – generatyvios liekanos (tikrasis kiekis), + – minimalus kiekis**

Depth, m	Ash content, %	Peat decomposition degree, %	*Carex* cf. *elata* A	*Phragmites australis*	*Equisetum limosum*	*Scorpidium scorpioides*	*Calliergon giganteum*	*Drepanocladus* sp.	*Thelypteris palustris*	*Betula* sp.	*Alnus* sp.	*Salix* sp.	Deciduous wood	*Carex* sp.	Bryales	Indeterminable	*Carex* sp. – 2-sided nuts B	*Carex* sp. – 3-sided nuts	Lithology
3.60–3.75	15.03	5	5	10	+				15	+				60	+	10		2	CAR peat
3.75–3.90	16.62	5	+		+				10	+		+	+	25	60	5		1	BRY peat
3.90–4.05	19.08	5		+	+	+			+	+	+		+	45	45	10			CAB peat
4.05–4.20	34.42	10			+	65	+	+					+	25	5	5		3	*Scorpidium scorpioides* peat
4.20–4.35	88.42	10			+	40			+	5	+		+	30	10	15	4		CAB peat

Table 2. **Plant remains, peat decomposition degree and ash content in the bottom part of the TVII core. A – vegetative remains (%), B – generative remains (real amount), + – minimal amount**

2 lentelė. **Augalų liekanos, durpių suirimo lygis ir pelenų kiekis bazinėje TVII gręžinio dalyje. A – augmenijos liekanos (procentinė dalis), B – generatyvios liekanos (tikrasis kiekis), + – minimalus kiekis**

Depth, m	Ash content, %	Peat decomposition degree, %	*Phragmites australis* – epiderm A	*Equisetum limosum* – rhcizoderm, roots	cf. *Scorpidium scorpioides*	*Drepanocladus sp.*	*Calliergon giganteum*	Sphagnum *sec. Squarrosa*	*Dryopteris* – tissues	*Betula* sp. – periderm	*Alnus* sp. – periderm	Deciduous wood	Carex sp. – radicles	*Cyperaceae* – epiderm	*Sphagnum sec.* Palustria	*Sphagnum* sp.	Bryales	Indeterminable	*Nitella* sp. – oospores B	Characeae – oospores	*Potamogeton panormitanus* – stones	*Potamogeton fifliformis* – stones	Potamogeton friesii – stones	*Hippuris vulgars* – fruits	*Myriophyllum spicatum* – fruits	*Carex vesicaria* – nuts	*Carex riparia* – nuts	*Carex rostrata* – nuts	*Betula humilis* – nuts	Betula sec. Albae – nuts	Carex sp. – 2-sided nuts	*Carex* sp. – 3-sided nuts	Lithology
4.10–4.20	8.33	5		+		+	35						45				5	15						1				140				1	CAB peat
4.20–4.30	40.32	20		10			5		+	+	+	+	60		+	+	15	10		64	2		1			5	1	5					CAR peat
4.30–4.40	48.68	10	5	5	+		+	+	+	+		+	70	+	+	+	10	10		113					1			1		4	1	6	
4.40–4.50	78.87	–																	2													9	calcareous gyttja
4.50–4.60	83.55	–																		5				1					2			2	
4.60–4.70	88.95	–																												1		2	lacustrine chalk
4.70–4.80	91.54	–																													3	2	
4.80–4.90	91.66	–																124			2											5	

(Fig. 3A). A community of calciphilous moss *Scorpidium scorpioides* was found in the mineral substratum (13926–13636 cal. yrs BP). *Cariceto-Bryaleti* peat (CAB) and *Scorpidium scorpioides* peat were deposited there (Table 1). The characteristic feature of the bottom peat samples is a conspicuous amount of sand (high ash content, Table 1).

The peat investigated in the drilling TV area is as old as 13899–13618 cal. yrs BP (Fig. 3A) and at the T4 core 13693–13420 cal. yrs BP old (Fig. 2). Sedge-moss and moss communities were the initial phytocoenoses there, overlying the mineral substratum. Remains of shrubby birches (*Betula nana* and *Betula humilis*) were also recognized in the sediment. *Bryaleti* peat (BRY) and *Cariceti* peat (CAR) were described in the bottom part of the deposit in these sites.

At the turn of the Younger Dryas and the Preboreal periods (10040–9454 cal. yrs BC), *Caricetum rostratae phragmitetosum* subassociation dominated in the TV drilling area. This phytocoenosis deposited *Cariceto-Phragmiteti* peat (CAP). The earlier place of peat accumulation, from the Younger Dryas, was located at the TIII point (11979–11633 cal. yrs BP) (Fig. 3A). Tall sedge rushes formed *Cariceti* peat (CAR) there. The Taboły mire developed in the Late Glacial under conditions of a high groundwater level (see slightly decomposed peat in Tables 1–3).

A lake stage is noted in the development of the Taboły mire. A shallow water body, filled with lacustrine sediments, existed in the central part of the mire (in its contemporary form). It consisted of two basins (northern – TVII and southern – TIX) divided by a mineral step (TVIII) (Fig. 3A). Both lake basins vary in age. The beginning of lacustrine sediment accumulation in the region of TVII was related to the Alleröd interstadial (13016–12776 cal. yrs BP) (Fig. 3A). A compatible event was not dated in the southern basin (TIX), and the age of the oldest peat sample dates to the younger half of the Alleröd (12743–12651 cal. yrs BP) (Fig. 3A).

The northern basin of the water body transformed into a mire at the turn of the Late Glacial and the Holocene. The southern part of the lake disappeared in the later part of the Alleröd. At the same time, the peat-forming process started in the shallow water environment (TVIII, Fig. 3A). The bottom sample is dated to 12853–12716 cal. yrs BP.

The *Caricetum rostratae* association was the initial peat-forming phytocoenosis in the northern basin (TVII), whereas in the vicinity of the TIX profile the depression was overgrown by sedge-brown moss and brown moss with shrubby birch communities.

Table 3. **Plant remains, peat decomposition degree and ash content in the bottom part of the TIX core. A – vegetative remains (%), B – generative remains (real amount), + – minimal amount, v – presence in sediment**
3 lentelė. **Augalų liekanos, durpių suirimo lygis ir pelenų kiekis bazinėje TIX gręžinio dalyje. A – augmenijos liekanos, B – generatyvios liekanos (tikrasis kiekis), +–minimalus kiekis, v – yra nuosėdose**

Depth, m	Ash content, %	Peat decomposition degree, %	*Equisetum limosum* A	*Menyanthes trifoliata* – epiderm	*Sphagnum sec. Subsecunda*	*Calliergon giganteum*	*Thelypteris palustris* – tissues	*Pinus sylvestris* – peridem	*Betula* sp.	*Carex* sp.	*Cyperaceae* – epiderm	*Sphagnum* sp.	*Bryales*	Diatoms	Indeterminable	*Nitella* sp. – oospores B	*Potamogeton panormitanus* – stones	*Potamogeton friesii* – stones	*Potamogeton cf. alpinus* – stones	*Potamogeton* sp.	*Myriophyllum spicatum* – fruits	*Myriophyllum alternifolium* – fruits	*Batrachium* sp.	*Carex vesicaria* – nuts	*Carex* cf. *pseudocyperus* – nuts	*Viola palustris* – seeds	*Betula humilis* – nuts	*Betula nana* – nuts	*Betula sec. Albae* – nuts	*Cares* sp. – 2-sided nuts	*Carex* sp. – 3-sided nuts	Lithology
4.20–4.35	4.65	5	+	10						55			35		+																	CAB peat
4.35–4.50	4.54	5	+	10						20			70		+																	BRY peat
4.50–4.60	46.15	20	10							65		+	20		5								1	52								CAR peat
4.60–4.70	48.19	25	+				+	+		30	5	10	20		35	8		2	1		2		2	23			1			1		CAB peat
4.70–4.80	52.74	25			+		15		+	20	15	5	15		30	11							1	2								
4.80–4.90	53.08	25							+	5		10	75		10	6									6			1				BRY peat
4.90–5.00	60.42	20		5	5					25	5		50		10	23											3					CAB peat
5.00–5.10	59.04	25		+	5		5			30	+	5	35		20	2				1								1				
5.10–5.20	72.66	25			+		5	+	+	40	10	+	30		15	36									2							
5.20–5.30	67.14	25		+						25	+	+	70		5																	BRY peat
5.30–5.40	60.08	25				+	+		+	30	+		60		10													1	2		2	
5.40–5.50	63.59	20		+			5	+		25	+	+	60		10									7			4	4	2			
5.50–5.60	53.93	–														2				1			1		1	1	1	1		1	1	medium-detritus gyttja
5.60–5.70	87.83	–																					2									
5.70–5.80	92.72	–												v		1	2	3					4									calcareous gyttja
5.80–5.90	93.30	–												v		13		5				1	3							1	1	
5.90–6.00	91.48	–												v		54	1					4	10									lacustrine chalk

Table 4. **Radiocarbon dating of Taboły sediments**
4 lentelė. **Taboły nuosėdų radiokarboninis datavimas**

Core number	Sample depth, cm	Laboratory number	Dated material	^{14}C age BP	Cal. yrs BP acc. to CalPal 1.5 online software Danzeglocke et al., (2011) 68% probability	Chronostratigraphy acc. to Litt et al. (2001) modified by Latałowa (2003)
TIV	422	Poz-2885	Peat	11880 ± 60	13926–13636	Meiendorf / Oldest Dryas / Bölling
TV	425	Poz-2965	Peat	11850 ± 60	13899–13618	Meiendorf / Oldest Dyas / Bölling
T4	385	Poz-2883	Peat	11670 ± 50	13693–13420	Oldest Dryas / Bölling / Older Dryas
TVII	485	Ki-10401	Lacustrine chalk	10940 ± 120	13016–12776	Alleröd
TVIII	385	Poz-2981	Peat	10810 ± 50	12853–12716	Alleröd
TIX	545	Poz-2972	Peat	10710 ± 50	12743–12651	Alleröd
TIII	385	Poz-3119	Peat	10160 ± 60	11979–11633	Younger Dryas
TV	365	Poz-3118	Peat	10120 ± 60	11927–11517	Younger Dryas / Preboreal

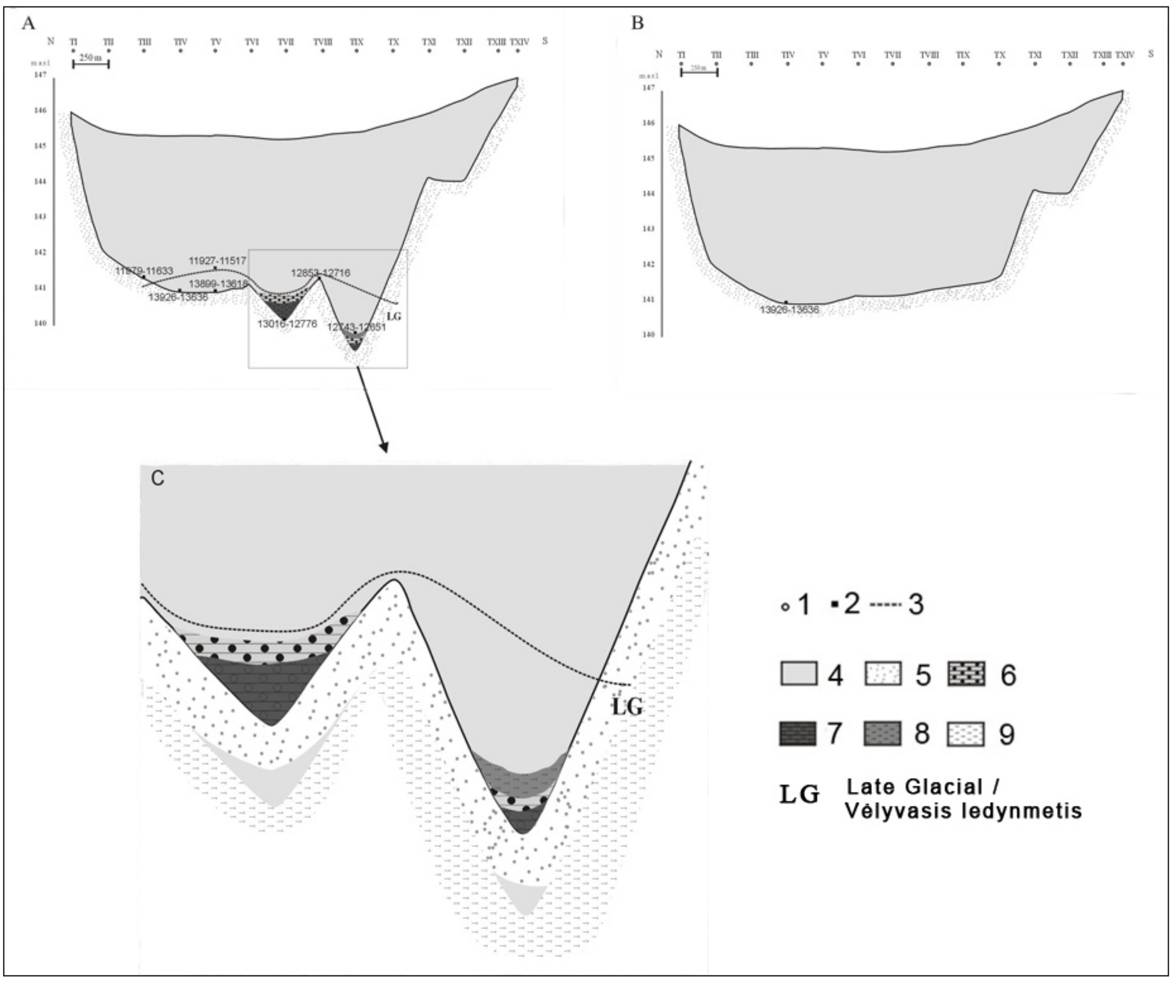

Fig. 3. Taboły mire. *A* – longitudinal section, *B* – suggested bottom of the Taboły basin until Allerød, *C* – hypothetical presence of the Eemian biogenic sediments under the mineral bottom of Taboły. *1* – location of drilling, *2* – ^{14}C dating, *3* – border of chronozones, *4* – peat, *5* – sand, *6* – calcareous gyttja, *7* – lacustrine chalk, 8 – medium-detritus gyttja, *9* – possibly Eemian lacustrine sediments

3 pav. Taboły pelkė. *A* – meridianinis profilis, *B* – prognozuojamas Taboły baseino dugnas iki aleriodo, *C* – prognozuojamos Emio biogeninės nuosėdos po Taboły baseino mineraliniu substratu; *1* – gręžinio vieta, *2* – ^{14}C datavimas, *3* – chronozonų riba, *4* – durpės, *5* – smėlis, *6* – karbonatinga gitija, *7* – ežerinė klintis, *8* – vidutinė detritinė gitija, *9* – galimos Emio ežerinės nuosėdos

DISCUSSION

Initiation of peat-forming process

The peat-forming process in the Taboły mire could be a result of warming during the Meiendorf phase (or in the Bölling, see Table 4). This period (Litt et al., 2001) was the reason for the gradual melting of ground ice blocks filling in the depressions. The presence of calcium was caused by the gradually disappearing permafrost. These two factors led to the groundwater circulation, and calcium was transported out by leaching from the glacial deposits. The same process, characteristic of the Late Glacial mires, was described by Żurek (2000) in the neighbouring Stare Biele. The prominent inflow of mineral material was probably a result of the low density of vegetation. Therefore, wind and the surface washes carried sand from the surrounding kames to the hollows in which the peat was depositing. This phenomenon was described by Żurek (1992) in the surrounding Machnacz mire. *Scorpidium scorpioides* was an initiator of the peat-forming process also in the Biebrza River valley (Oświt, 1991) and was recognized as an important component of subfossil plant communities in the Rabinówka deposit (Gródek–Michałowo basin) (Drzymulska, 2004). This moss species is also known as the initiator of the postglacial peat-forming process in the territory of the Nadilmeńska Lowland in Northwestern Russia (Bogdanovskaja-Gjenef, 1969).

The high groundwater level in the Late Glacial caused the domination of moss communities in the landscape. The inflow of external groundwater was abundant, but without long-drawn surface stagnation or surface washes (Oświt, 1977; Żurek, 1993). In the Younger Dryas, or even in the Alleröd, communities of rushes occurred, probably with tall sedges (*Magnocaricion* alliance). Such an occurrence could be connected also with a permanent high water level in the mire.

Initiation of the peat forming process in what was not the deepest depression was described in Taboły, and this description is contradictory to Ivanov's thesis (1975). According to Ivanov, peat starts accumulating in the deepest depressions and gradually leads to ground levelling. However, peat could also be formed in the summit part of elevations and could then move slowly downwards as described by Solem (1986) in drumlins of Central Norway.

THERMOKARST

In the course of deliberation concerning the development of a water body in the Taboły mire, a new hypothesis referring to its genesis is proposed. The hypothesis is inspired by the shape of the Taboły melt basin. The presence of two distinct depressions (localities of TVII and TIX drillings) suggest that the process of biogenic sediment deposition started exactly where the hollows were located (Ivanov, 1975). A comparison of the age of sediments of TVII and TIX profiles and TIV core contradict the possibility mentioned above. The bottom sediment of TIV profile was recognised to be the oldest. Until the Allerød, the bottom of the basin in the area of TVII and TIX drillings has been different, probably without hollows (Fig. 3B). An abrupt climate warming following a prolonged cold (stadial) period may have lead to permafrost degradation and the formation of thermokarst lakes (so-called thaw lakes) (*vide* Bohncke et al., 2008). It is possible that older biogenic – Eemian – sediments are present under the mineral sediments of the basin bottom at Taboły (Fig. 3C). These deposits gradually filled the basins formed after the ground subsidence. Dead ice lumps melted in the basin during the final phase of the Warta glaciation or in the oldest part of the Eemian interglacial. Thawing Eemian biogenic sediments were compacted by covering sands. Then, new water basins were formed in the places where there had previously been Eemian lakes. Lacustrine sediments accumulated at the bottom of the new lakes in the Late Glacial. No Eemian sediments in Taboły were discovered, but it is still possible that the sediments were there, especially in the central part of the deposit. Because of technical difficulties, only one drilling in the peripheral southern part of the miren was made. This problem was discussed in detail by Kupryjanowicz (2008). The presence of Eemian sediments in the substratum of many contemporary mires in the northern part of the Podlasie region was described by Żurek (1992), Kupryjanowicz (1991, 2008), Kupryjanowicz, Drzymulska (2002).

The above idea acknowledges the possibility of thermokarst processes. Thermokarst as a process of permafrost degradation is caused by disturbances of the thermal equilibrium in the upper permafrost zone and results in surface subsidence and characteristic landforms (French, 2007). The mechanism of this process consists of the consolidation of the thawing ice-rich soils or soils that contain monomineralic ice deposits, under the pressure of the thawing layer, and the expulsion of the contained moisture to the surface or by an aquifer (Yershov, 1998). The non-uniform development of the process gives rise to a variety of landforms and microrelief types, i. e. collapse swallow holes, flat bottom depressions, alases, frost mounds and lakes. Many thermokarst lakes originate in poorly-drained low-centered ice-wedge polygons (French, 2007). At present, thermokarst is observed in Northeast Siberia, Northern Canada and Alaska (Klimaszewski, 1994; French, 2007; Ulrich et al., 2010). In the past, this phenomemon was related to the areas located south of the border of the Weichselian ice sheet (Stasiak, 1971). The former thermokarst lakes were described, e. g., in Germany (Bohncke et al., 2008) and Šafárka in Slovakia (Jankovská et al., 2002) The possibility of traces of thermokarst lakes was considered by de Gans (1981) in deposits of the Drentsche Aa valley in the Netherlands. Thermokarst genesis was noted also in the Polish Lake Maliszewskie (Wizna basin) (Żurek, 1978), the former lake of the Stare Biele mire (Żurek, 2000), and in many contemporary lakes of the Łęczna-Włodawa Lakeland (Bałaga et al., 1996). The thermokarst noted in the latter region, referred to as "shallow thermokarst", caused the appearance of shallow and large lake basins and small hollows without flow. As a generalization, most thaw lakes are shallow and the majority possess smooth curving margins (French, 2007). Such thermokarst may be linked to the kind of thermokarst noted in Taboły.

Water body development in Taboły

The southern basin of the water body was developed in a mild climate. Carpological remains found in the bottom samples of lacustrine sediment, such as, endocarps of *Potamogeton friessi* (*P. mucronatus*), *Potamogeton panormitanus* and *Myriophyllum alternifolium* (*M. alterniflorum*) (Table 3), confirm the belief that the southern basin of the water body was developing when the climate was mild. *Myriophyllum alternifolium* is associated with a mild maritime climate nowadays (Podbielkowski, Tomaszewicz, 1982) and is treated as an uncommon boreal-atlantic species (Dąmbska, 1965). According to Mikulski (1974), *Potamogeton friessi* is an indicator of the oceanic climate, and *Myriophyllum alternifolium* is very temperature-sensitive. Negative temperatures are uncomfortable for the growth of vegetative forms of *Myriophyllum alternifolium*.

The northern part of the water body has developed differently. The first phase of the development took place when the climate was cool, probably during the Gerzensee oscillation. This cool phase of the Alleröd interstadial was noted 13200–12800 cal. yrs BP (Litt et al., 2001), what corresponds quite precisely to the dating of TVII core (13016–12776 cal. yrs BP). Carpological remains of *Potamogeton filiformis* found in the sediment (Table 2) confirm the development under cool climate conditions (Tobolski, 1998).

Both basins were divided by the shallow waters (TVIII, Fig. 3A) containing aquatic vegetation. Sedge-peat formed the bottom layer of the sediment. The remains of *Potamogeton filiformis* and *Myriophyllum spicatum* were found in the sediment. Both species are frost-resistant. The subfossil plant community was identified as *Caricetum vesicariae*. This association is often found in shallow waters (20–30 cm deep) (Podbielkowski, Tomaszewicz, 1982). The transformation of the lake into mire was related to a decrease of water level of the lakes and rivers in the territory of Northern Poland (Ralska-Jasiewiczowa, Starkel, 1988).

CONCLUSIONS

Different factors influenced the development of the Taboły mire during the Late Glacial. The development of the deposit was related to the progressive warming that began in the Meiendorf phase or the Bølling interstadial. It is likely that the ground ice blocks melted and filled the depressions, and the mires were initiated in quite a shallow depression. The thermokarst phenomenon most probably took place at this time. Probably, until the Allerød interstadial, the shape of the mire basin had been different. Thermokarst seems to be possible and is also suggested in other nearby mires. In the history of the mire, the lake phase is also distinguished. The water body was characterized to have a heterogeneous form, and both of the basins had a different development history and were of different age. All these aspects formed the present shape of the mire.

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PALEOEKOLOGINIAI TABOŁY PELKĖS KILMĖS IR ANKSTYVOJO VYSTYMOSI ASPEKTAI ŠIAURĖS RYTŲ LENKIJOJE

Santrauka

Iš Taboły pelkės Šiaurės rytų Lenkijoje tyrimams buvo paimti 17-os gręžinių pavyzdžiai siekiant išsiaiškinti, kaip kaupėsi nuosėdos. Pelkės vystymasis vėlyvuoju ledynmečiu buvo nustatytas remiantis makroskopinėmis augalų liekanomis, jų degradacijos lygiu, radiokarboniniu datavimu. Pradinę asociaciją reprezentuoja *Scorpidium scorpioides*, kuri formavosi prieš 11941–11537 metų TIV gręžinio rajone. Ankstyvesnėje ežero stadijoje, kuri buvo nustatyta Taboły pelkės raidoje, išskirti du baseinai (TVII ir TIX gręžinių rajonai), besiskiriantys amžiumi ir vandens augmenija. Ežero formavimasis siejamas su termokarstiniais procesais.
Raktažodžiai: Šiaurės rytų Lenkija, Puszcza Knyszyńska miškas, vėlyvasis ledynmetis, pelkė, termokarstas