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A *Juncus subnodulosus* SCHRANK fossil site in Holocene biogenic biogenic deposits of Lake Kojle

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Abstract: Subfossil seeds of *Juncus subnodulosus* Schrank have been found in the sediments of the mire developed at the southern shore of Lake Kojle (Suwałki Landscape Park). It is the first palaeoecological site of this species in North-Eastern Poland. At present the range of Blunt-flowered Rush is limited to North-Western Poland. Location of this site far from modern area of occurrence reveals different range of *Juncus subnodulosus* in the past. It seems to be very important especially regarding eastern border of this plant, which is classified as an oceanic species.

Key words: *Juncus subnodulosus* Schrank, paleoecology, mire, plant macrofossils, Suwałki Landscape Park

Introduction

Paleoecological studies on former distribution of plants, in particular those having clear environmental requirements, allow determining climate and trophic conditions occurring in the past in a given area. North-Eastern Poland is an interesting region of Europe in terms of paleoclimate research, as this area includes borders of localities of various groups of plants. The most significant are those belonging to Atlantic and boreal elements. A very idiosyncratic situation occurs here – organisms on borders of their natural localities compete with each other for living space. The Suwałki Region is, therefore, a very good area to carry out research on changes in localities of plants in the past. Paleoecological research carried out in this area is the key to understanding the mechanisms of migrations of plants in the direction North-East, and the factors that cause the migrations. Knowledge on former plant communities in the context of their habitat preferences shows present ecosystems in another light. It is a significant issue, in particular in the context of protection of habitats of rare plants. This paper presents the discovery of a new fossil location of one of such species - *Juncus subnodulosus*.

The *Juncus subnodulosus* (Blunt-flowered Rush) belongs to the Juncaceae family, which comprises 23 species of rushes in Poland (Mirek et al. 2002), which grow in different habitats (Zarzycki et al. 2002). At present the Blunt-flowered Rush is classified as a species growing in wetlands, fre-

quently fens, spring mires (Rothmaler 1976, Matuszkiewicz 2007), as well as in wet meadows (Kloss 1965, Markowski & Stasiak 1988). Regarding trophy and acidity, the species belongs to the elements growing on the alkaline habitat, rich in calcium. *Juncus subnodulosus* is assumed to be an indicator of calcareous habitat (Ellenberg et al. 1991, Zarzycki et al. 2002, Matuszkiewicz 2007). It forms its own plant community *Juncetum subnodulosi* (Markowski, Stasiak 1988, Matuszkiewicz 2007) and grows in areas with oceanic climate (Ellenberg et al. 1991). In Europe it occurs in high density on the British Isles (without Scotland), eastern Spain, France, Germany, Austria, Italy and the northern part of the Balkan Peninsula (Meusel et al. 1965). The eastern limit of its distribution runs across Poland. It is a rare species, growing mainly in North-Western Poland.

Methods

Deposits were extracted using an Instorf peat sampler. Samples were sieved under running water (mesh size 0.25 mm and 0.5 mm). The fossil remains were identified under the stereoscopic microscope at a magnification of 10-100× and under the microscope at 200-400×. The seeds of the rush were identified on the basis of the key for the identification of rush and grass seeds, developed by Körber-Grohne (1964), and the photographs provided by Jacquat (1988) and Tobolski (2000).

Study site description

The study site is located in North-Eastern Poland, in the territory of the Suwałki Landscape Park N 55°16'23,1'', E 22°53'24.3'' (Fig. 1). Sediment core for paleobotanical analysis was taken from a mire located at the southern shore of Lake Kojle. Lake Kojle and Lake Perty located next to it, constituted one lake in the past. This fact is confirmed by presence of limnic sediments underlying layer of peat in the mire area between these two lakes. The lakes together with the surrounding mires fill hollows in a moraine upland where the elevation differences reach a dozen or so meters.

Cladium mariscus currently grows in the area surrounding coring place. It is the only site of this plant in the Suwałki Landscape Park, and one of few in this part of Poland (Kłosowski, 1986/87). Apart from *Cladium mariscus*, *Carex paniculata*, *Phragmites australis*, and *Thelypteris palustris* also occur there.

Results

During the analysis of the botanical composition of the biogenic deposits comprising the roof layer of lake sediments and peat formed at the southern shore of Lake Kojle (Fig. 1B), subfossil seeds of *Juncus subnodulosus* Schrank were

found. The fossil presence of *Juncus subnodulosus* in the mire adjacent to the southern shore of Lake Kojle is confirmed by generative organs in the form of seeds (Fig. 2). Blunt-flowered Rush seeds are relatively easy to identify. The remains of cells on the walls of the seed enable identification. They adopt the shape similar to a rectangle with well visible openings (Fig. 3). The length and width of rectangular remains of the cells is variable. They form parallel rows running along the vertical axis of the seed. The dimensions of the identified seeds range within 0.5 x 0.25 mm.

The seeds of *Juncus subnodulosus* were found in sedge-herbaceous peat at the depth of 47.5- 57.5 cm. In total 7 seeds were found. Content of Cyperaceae radicelli, in the same layer, reached 60% in the bottom and 30% in the roof. There were also found generative organs of *Cladium mariscus*, *Carex paniculata*, *Lycopus europaeus*, *Juncus articulatus* and leaved stalks of Bryidae, including *Meesia triquetra*. This of peat overlies several metres thick layer of calcareous gyttja, with the content of calcium carbonate reaching 80%.

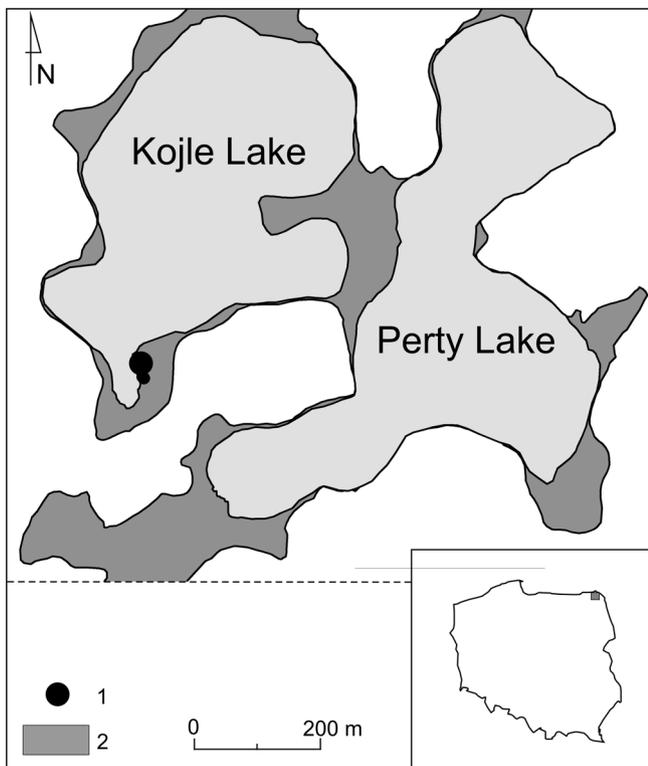


Fig. 1. The location of the investigated sites: 1 – the location of the new fossil site, 2 – mires.

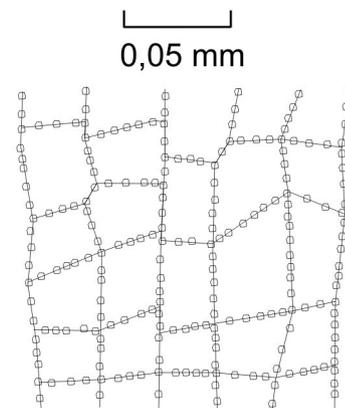
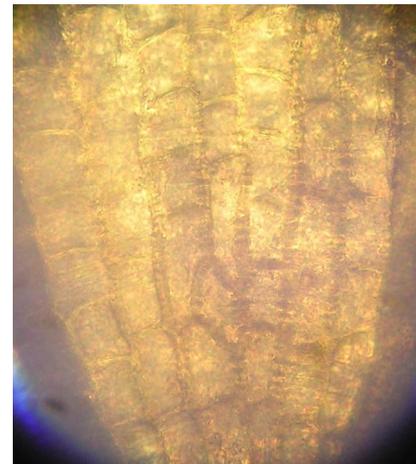


Fig. 3. *Juncus subnodulosus* Schrank cells of testa (Photo by M. Gałka).



Fig. 2. *Juncus subnodulosus* Schrank seeds (Photo by M. Gałka).

By means of palynological dating the age of occurrence of *Juncus subnodulosus* in the peat at the southern shore of Lake Kojle was estimated as the Middle Subatlantic period (unpublished data by K. Tobolski).

Discussion

It is the first fossil site in North-Eastern Poland and the third one listed in paleobotanical bibliography in Poland. The contemporary absence of the Blunt-flowered Rush in NE Poland flora emphasises value of this finding. Its nearest modern site is situated at the distance of more than 200 km west of Suwalski Landscape Park (Fig. 4). Previously, Tobolski found two fossil sites of this plant on the southern coast of the Baltic Sea – Gardno-Łeba Lowland and in the coastal peat, south of Lake Bukowo (Tobolski et al. 1997).

In the past *Juncus subnodulosus* was a peat-forming species, what was proved by Tobolski (op. cit.). The peat-forming abilities prove its different position in the past, both in the aspect of competition – the length of settling of the same site and in the development of the amount of root mass.

If we take into consideration its past range in Poland, which was much wider and stretched eastwards, it is possible to draw a conclusion that the range decreased as a result of climatic changes. Changes of the climate cause gradual shifting of vegetation zones. The north-eastern part of Poland is subjected to the process of borealisation, which is expressed

by the migration of stenothermic or oceanic plants to the south or west of Poland. The subfossil site of *Juncus subnodulosus*, which lies at a distance from its contemporary range, is an example of this process. In the past, during the period of warmer climate the plant, which is now classified as an oceanic species, found suitable settlement conditions in the zone contemporary classified as influenced by continental climate.

The presence of *Juncus subnodulosus* in the easternmost site may also be related to the presence of calcium cations in the substrate. In this case presence of a layer of calcareous gyttja, underlying the peat is important. By growing in a strongly calcareous environment the species may have compensate the deficit of climatic factors, especially thermal ones, with the presence of calcium carbonate in the substrate. This dependence was also brought up for *Cladium mariscus* (Gałka, Tobolski 2006).

Summary

1. The subfossil site of *Juncus subnodulosus* situated at a distance from its contemporary place of occurrence proves that it had a much wider range in the past. It stretched especially to the east, which is important due to the fact that currently the plant is classified as an oceanic species.
2. The presence of *Juncus subnodulosus* seeds in the peat which is about 10 cm thick proves its longer presence in the mire.
3. The age of the peat layer with subfossil *Juncus subnodulosus* seeds was dated at the Middle Subatlantic period.

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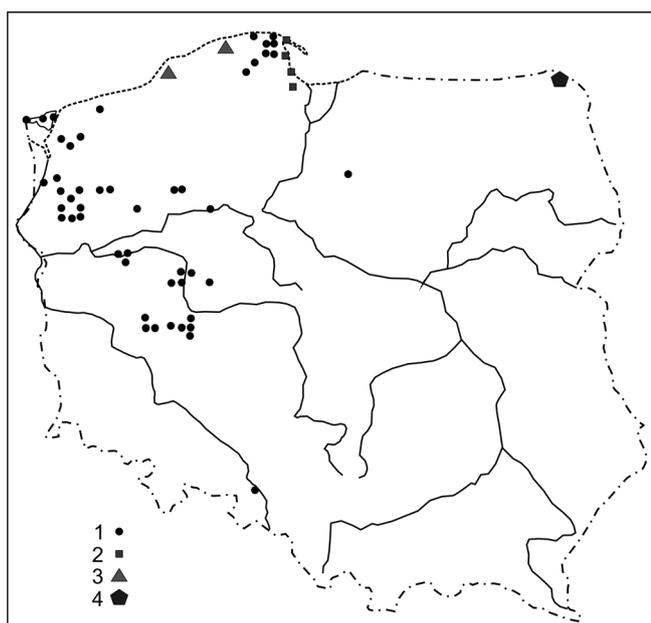


Fig. 4. The contemporary and fossil occurrence of *Juncus subnodulosus* Schrank in Poland: A) 1 – contemporary, 2 – vanished in the 20th century, 3 – fossil (Tobolski 1999 (after Markowski, Stasiak 1988, slightly altered), 4 – the location of the new fossil site.

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