

Zeitschrift: Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübél, in Zürich

Herausgeber: Geobotanisches Institut, Stiftung Rübél (Zürich)

Band: 107 (1992)

Artikel: Changes of bryophyte floras of the Leżna-Włodawa Lake District (E. Poland) from Middle Pleistocene to the present time

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DOI: <https://doi.org/10.5169/seals-308961>

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**Changes of bryophyte floras of the
Łęczna-Włodawa Lake District (E. Poland)
from Middle Pleistocene to the present time**

Kazimierz KARCZMARZ

1. INTRODUCTION

The fossil as well as subfossil and contemporary bryophytes of the Leczna-Włodawa Lake District have been studied in the last 30 years. The aim of this paper is to compare the composition of bryophyte floras in three periods, Middle and Later Pleistocene, Holocene and present times (last 20-30 years), with conclusions about the trends of changes of this sensible group of plants. It is only a short abstract of the extensive work (KARCZMARZ unpubl.).

2. MATERIAL AND METHODS

The Leczna-Włodawa Lake District is situated in the depression of eastern Poland (Figs. 1, 2). The area investigated is characterized by some shallow and large lakes of glacial origin and by deep lakes of karst origin. The vegetation of this region is well preserved (FIJALKOWSKI 1960, KARCZMARZ 1963a,b, KARCZMARZ and SOKOLOWSKI 1990). The Pleistocene bryophytes were studied in five profiles by palynologists (BREM 1953, STACHURSKA 1957, 1961, KARCZMARZ 1968, JANCZYK-KOPIKOWA 1979) and Holocene mosses from 16 profiles have been studied mainly by JASNOWSKI (1957a,b, 1959), KARCZMARZ (1963a,b, 1968, 1989) and MAREK (1965).

The list of the present bryoflora was elaborated by POMARANSKA (1990, see also KARCZMARZ (unpubl.), and references quoted there). Nomenclature follows FRAHM and FREY (1983).

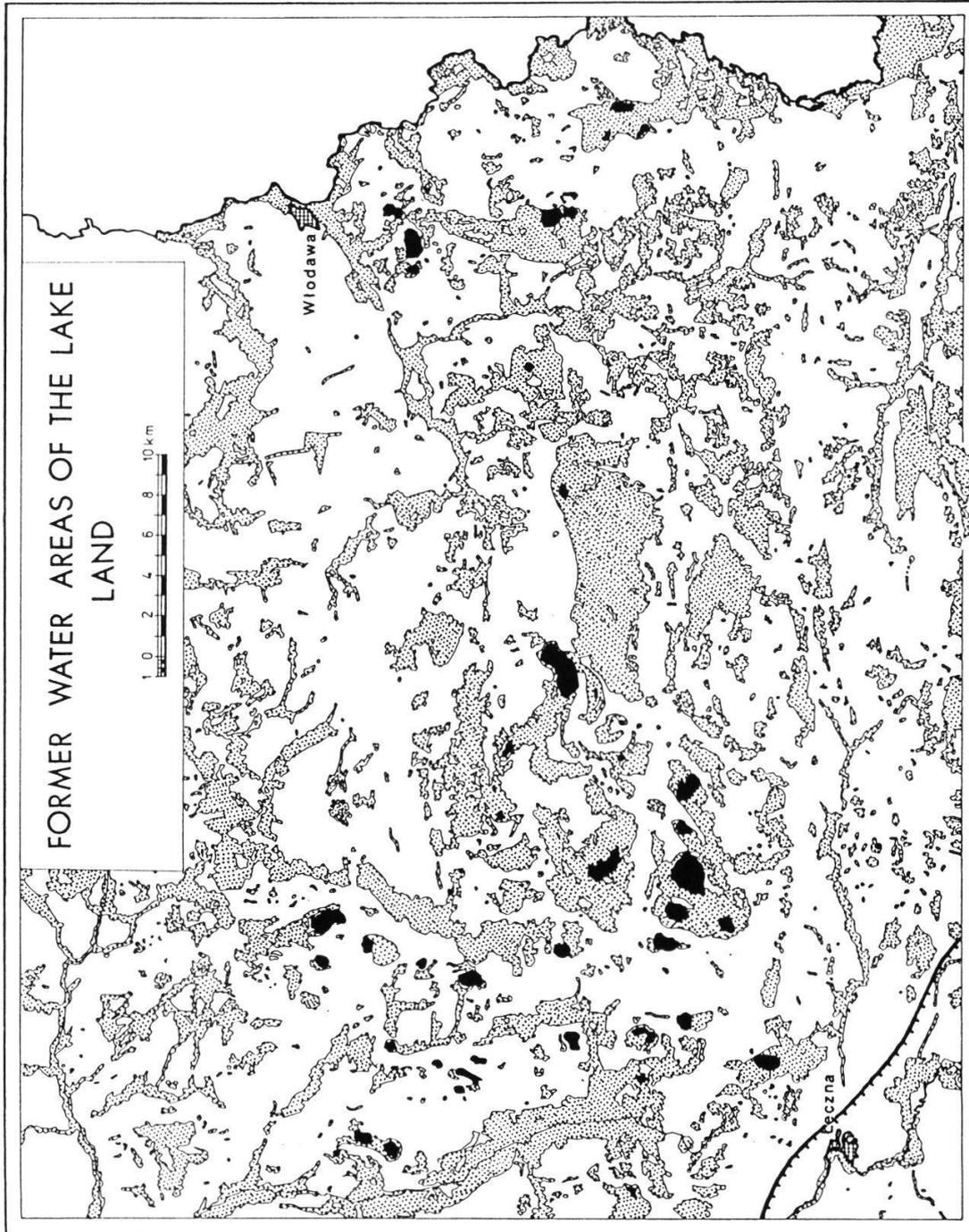


Fig. 1. Boundary of the glaciation in Poland (GALON and ROSZKOWNA 1967) and localization of investigated region.

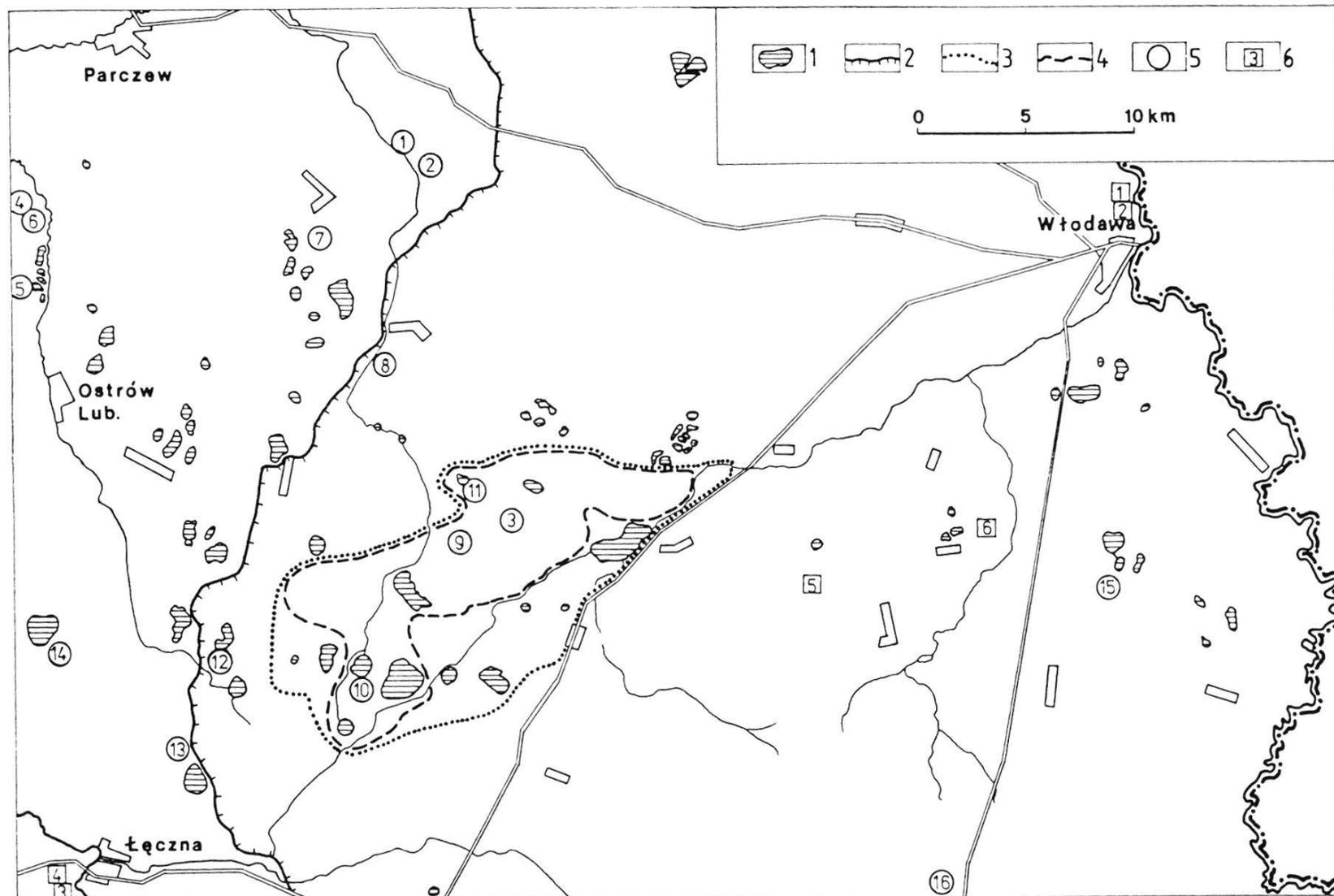


Fig. 2. Localization of the sites of subfossil moss peats on the Leczna-Włodawa Lake Land.
 1 - lakes and large ponds, 2 - Wieprz-Krzna River Canal, 3-4 - Polesie Park boundaries: 3 - optimal, 4 - minimal, 5 - subfossil moss peat sites, 6 - geological profiles with moss peat layers and calcareous gyttja. Numbers 1-16 in squares and circles see Table 1B.

3. RESULTS AND DISCUSSION

The bryophytes occurring in the regions in the Middle and Later Pleistocene, Holocene and at present are listed in Table 1. The list comprises 25 species of oldest age, 30 species of Holocene, and their relation to the present distribution and quantitative changes. The bryoflora of the Leczna-Włodawa Lake District is very rich, it comprises 179 species of *Bryales*, 40 species of *Hepaticae* and 23 species of *Sphagnales*. Bryophyte flora of peat-bog biocenoses and moist forests is rich.

The present changes of the peat-bog bryophyte flora of the Lake District due to by human activity were observed as early as the end of 19th century. They were caused by building regular canals on the Krowie Bagno Mire near Hansk, Kulczyn, Wytyczno and Dubeczno. By the end of the fifties the building of the big Wieprz-Krzna River Canal and several tributary canals was started to regulate small rivers and to dry marshes. The changes were very rapid and intensive: water level of the neighbouring lakes lowered and three small lakes disappeared (Masluchy, Pniowno, Turowolskie), this led to rapid and big changes of the peat bog vegetation (POPIOLEK 1988). The range and rate of changes in the composition of Pleistocene floras are reflected by the frequency of water mosses (*Calliergon*, *Drepanocladus*) which played an important role in the structure of communities and in spreading of the plant cover in shallow depressions and lakes. With regard to the composition, the floras of the Masovian (Mindel-Riss) and Lublinian Interglacials are similar to those of the Holocene.

Three regularities result from the investigated profiles of Holocene mossy peats:

- 1) The number of peat mosses is small in the particular Pleistocene and Holocene periods (Table 1). Out of six relict moss species, four (locally five) can form in 60% six various fen moss-peat types with *Calliergon giganteum*, *C. trifarium*, *Drepanocladus sendtneri*, *Meesia* sp. (dominant *M. triquetra*), *Scorpidium scorpioides* and *Tomenthypnum nitens*. A distinct dependence on the occurrence of horizons of calcareous gyttja exists for most calciphilous species. For this reason peat with *Calliergon trifarium* and *Scorpidium scorpioides* is very frequent. In the Leczna-Włodawa Lake District (OKRUSZKO et al. 1971, BALAGA et al. 1983) as well as in the adjacent Volhynian Polesie it is a common geological phenomenon because chalk rocks are shallow under the surface of Quaternary deposits.
- 2) Mosses forming the basic structure of peat deposits are *Drepanocladus*

sp. div., *Aulacomnium palustre*, *Bryum pseudotriquetrum* and *Campylium stellatum*.

- 3) Mosses of peat deposits in high and intermediate peat bogs are *Sphagnum* sp. div., *Aulacomnium palustre*, *Calliergon stramineum*, *Drepanocladus fluitans*, *Polytrichum strictum*, sometimes *Helodium blandowii* and *Tomenthypnum nitens*. The two latter species are good indicators of changes of hydrological relations and oligotrophic processes of the peat bogs. Seven species are disappearing fastest at present: *Bryum neodamense*, *Calliergon trifarium*, *Cinclidium stygium*, *Drepanocladus lycopodioides*, *Meesia triquetra*, *Paludella squarrosa* and *Scorpidium scorpioides*. On high and intermediate peat bogs the occurrence of relict species is limited to *Tomenthypnum nitens*, *Helodium blandowii* and *Pohlia sphagnicola* (KARCZMARZ and SOKOLOWSKI 1990). Historically, the rarest mosses are *Paludella squarrosa* and *Cinclidium stygium*. The localities in the Hansk region of *Meesia uliginosa* described by KWIECINSKI (1892) have not been confirmed. The exceptionally rare *Timmia megapolitana* on fen in the Piwonia river valley near Bohutyn (JASNOWSKI 1956) disappeared after the Wieprz-Krzna River Canal was built. *Calliergon megalophyllum* grows only in the *Caricetum hudsonii* ass. in eutrophic lakes (west margin of Biale Lake near Sosnowica) or in ditches. *Pseudobryum cinclidioides* is noted in one locality in alder forest with spruce near Sobibor. Relict calciphilous mosses found in Holocene peats formed on gyttja layers the types of peats described earlier (JASNOWSKI 1957a, 1959). Their frequency in the described profiles is very high (7-12 species). However, the total number basiphilous and acidophilous (4-6) relict mosses appearing much later in upper horizons is lower. Thus, except the absence of *Meesia longiseta* in the present moss flora, the floristic relations of the flora of fossil

Table 1 (page 313). Occurrence of fossil bryophytes in geological and peat profiles on the Leczna-Włodawa Lake District.

Geological profiles:

A: Middle and Later Pleistocene: 1 - Masovian Interglacial (STACHURSKA 1961, KARCZMARZ 1968), 2-3 - Włodawa I, II - Masovian Interglacial (STACHURSKA 1957, JASNOWSKI 1957), 4 - Ciechanki Krzesimowskie-Lublinian Interglacial (BREM 1953), 5 - Lancuchow-Interstadial Brorup (KARCZMARZ 1968, JANCZYK-KOPIKOWA 1979)

B: Holocene: 1. Dzikie Bagno Mire, 2. Koden, 3. Wola Weresczynska, 4. Nadzieja, 5. Bagno Jezioro Mire, 6. Grodek, 7. Bohutyn, 8. Bagno Staw Mire (JASNOWSKI 1959), 9. Lake Krasne (JASNOWSKI 1959, MAREK 1965), 10. Lake Bikcze (JASNOWSKI 1959), 11. Lake Moszne (JASNOWSKI 1959, BALAGA et al. 1992), 12. Lake Lukcze (BALAGA 1982), 13. Ludwin (KARCZMARZ 1963), 14. Lake Mytycze, 15. Osowa, 16. Bachus (MAREK 1965).

C - present localities, D - actual. c - common, + - destroyed, - absent.

Table 1. Occurrence of fossil bryophytes in geological and peat profiles on the Leczna-Wlodawa Lake District.

Bryophyte species	Age and number of profiles			
	A	B	C	D
	Middle and Later Pleistocene	Holocene	Present localities	Actual
	1-5	1-16	1960-90	1980-90
Number of localities				
<i>Meesia triquetra</i>	2	12	9	3
<i>Scorpidium scorpidioides</i>	3	11	532	37
<i>Drepanocladus sendtneri</i>	5	10	18	? 12
<i>Drepanocladus revolvens</i>	4	10	c	c
<i>Drepanocladus lycopodioides</i>	2	10	22	5
<i>Calliergon trifarium</i>	3	8	20	? 5
<i>Calliergon giganteum</i>	4	7	71	?
<i>Drepanocladus fluitans</i>	3	5	c	c
<i>Drepanocladus aduncus</i> var. <i>aduncus</i>	5	3	c	c
<i>Drepanocladus aduncus</i> var. <i>kneiffii</i>	1	6	c	c
<i>Drepanocladus exannulatus</i> var. <i>exannulatus</i>	2	5	5	?
<i>Drepanocladus exannulatus</i> var. <i>brachydictyus</i>	1	2	+	-
<i>Bryum pseudotriquetrum</i>	1	4	c	c
<i>Calliergon stramineum</i>	3	3	c	c
<i>Campylium stellatum</i>	2	1	c	c
<i>Sphagnum palustre</i>	1	1	c	c
<i>Sphagnum subsecundum</i>	1	1	c	c
<i>Sphagnum</i> sp.	2	-	c	c
<i>Amblystegium</i> sp.	1	-	c	c
<i>Calliergonella cuspidata</i>	1	-	c	c
<i>Cratoneuron commutatum</i>	1	-	2	?
<i>Dicranella cerviculata</i>	1	-	c	c
<i>Campylopus fragilis</i> var. <i>pyriformis</i>	1	-	+	-
<i>Cephalozia catenulata</i>	1	-	+	-
<i>Drepanocladus aduncus</i> f. <i>capillifolia</i>	1	-	4	?
<i>Drepanocladus aduncus</i> var. <i>polycarpos</i>	-	5	c	c
<i>Drepanocladus vernicosus</i>	-	6	c	c
<i>Aulacomnium palustre</i>	-	5	c	c
<i>Tomenthypnum nitens</i>	-	6	54	42
<i>Helodium blandowii</i>	-	4	32	13
<i>Paludella squarrosa</i>	-	4	4	1
<i>Meesia longiseta</i>	-	2	+	-
<i>Calliergon cordifolium</i>	-	1	c	c
<i>Pohlia nutans</i>	-	1	c	c
<i>Polytrichum strictum</i>	-	1	c	c
<i>Sphagnum fallax</i>	-	2	c	c
<i>Sphagnum flexuosum</i>	-	1	c	c
<i>Sphagnum teres</i>	-	1	19	? 13

peats are similar to the present ones. In the whole Lake land a decreasing role of relict mosses in the formation of peat layers of peat associations and a rapid disappearance of their localities have been found (KARCZMARZ 1963a,b). Due to the lowering water level of peat bogs, relict mosses are rapidly diminishing whereas on gyttja surface *Cladium mariscus* and calciphilous bryophytes (e.g. *Ctenidium molluscum*, *Leptobryum pyriforme* and *Preissia quadrata*) are growing. Particular note may also be taken of the phenomenon of the development of impoverished bryophyte communities. At present they are presented by four ecological groups: spring and aquatic (1), epiphytic (1), epixylic (1), and terrestrial (4). Very impoverished epiphytic flora with total disappearance of *Orthotrichum*, *Tortula* and *Leucodon sciuroides* was already observed in 1970.

4. CONCLUSIONS

1. In the Leczna-Wlodawa Lake District, 30 species and varieties of bryophytes (24 *Bryales*, 5 *Sphagnales*, 1 *Hepaticae*) were found in the fossil flora of Pleistocene and Holocene. The list of the present bryoflora (except *Meesia uliginosa*) comprises 179 species of *Bryales*, 23 *Shagnales* and 40 *Hepaticae* (POMARANSKA 1990).
2. In spite of a small number of species, the fossil flora of Pleistocene mosses from Masovian (Mindel-Riss) Interglacial to Holocene, is similarly composed than the present one. The main features are the occurrence of aquatic and peat bog species, mainly from the families *Amblystegiaceae* and *Meesiaceae*.
3. The oldest Holocene fen peat layers at a depth of 4-5 overlying gyttja horizons (JASNOWSKA 1957b, 1959, BALAGA et al. 1983, 1990) are composed of macrofossils of calciphilous boreal mosses (*Calliergon giganteum*, *C. trifarium*, *Drepanocladus lycopodioides*, *D. revolvens*, *D. sendtneri*, *Meesia triquetra*, *Scorpidium scorpioides*).
4. The development of the intermediate peat layers localized in the upper horizons, i.e. above 3.5-4(5) m, occurred with the participation of *Aulacomnium palustre*, *Helodium blandowii*, *Tomenthypnum nitens* and *Sphagnum* sp. div.
5. In Holocene the main peat-forming role was played by six peat moss species, including four disappearing rapidly (*Calliergon trifarium*, *Meesia triquetra*, *Scorpidium scorpioides* and *Tomnthyppnum nitens*). Their present distribution and development of tufts occur in twelve associations

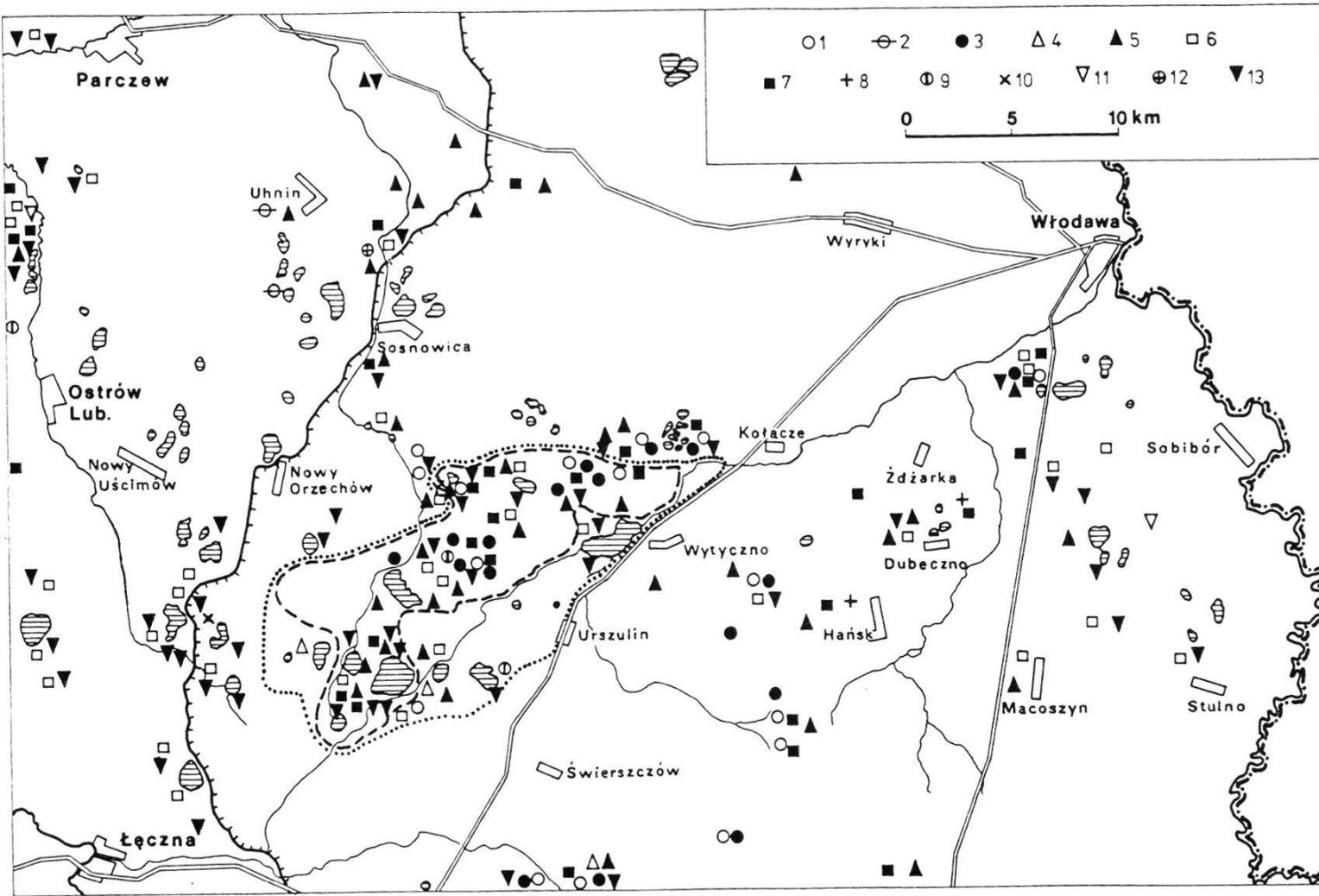


Fig. 3. Distribution of present and oldest localities of boreal relict mosses.

1 - *Bryum neodamense*, 2 - *Calliargon megalophyllum*, 3 - *Calliargon trifarium*, 4 - *Cinclidium stygium*, 5 - *Drepanocladus lycopodioides*, 6 - *Helodium blandowii*, 7 - *Meesia triquetra*, 8 - *Meesia uliginosa* (1982), 9 - *Paludella squarrosa*, 10 - *Pohlia sphagnicola*, 11 - *Pseudobryum cinclidioides*, 12 - *Timmia megapolitana* (1956), 13 - *Tomenthypnum nitens*

of sedge peat bogs and fens, intermediate and high peat bogs, exclusively in boggy forests (Fig. 3).
6. From 1960 to 1990, nine moss species belonging to the preserved glacial relicts show their maximal decrease in the investigated region (KAR-

CZMARZ 1963a,b, 1989): *Bryum neodamense*, *Calliergon trifarium*, *Drepanocladus lycopodioides*, *Messia triquetra*, *Paludella squarrosa* and *Scorpidium scorpioides* (Figs. 3, 4). The locality of *Messia uliginosa*

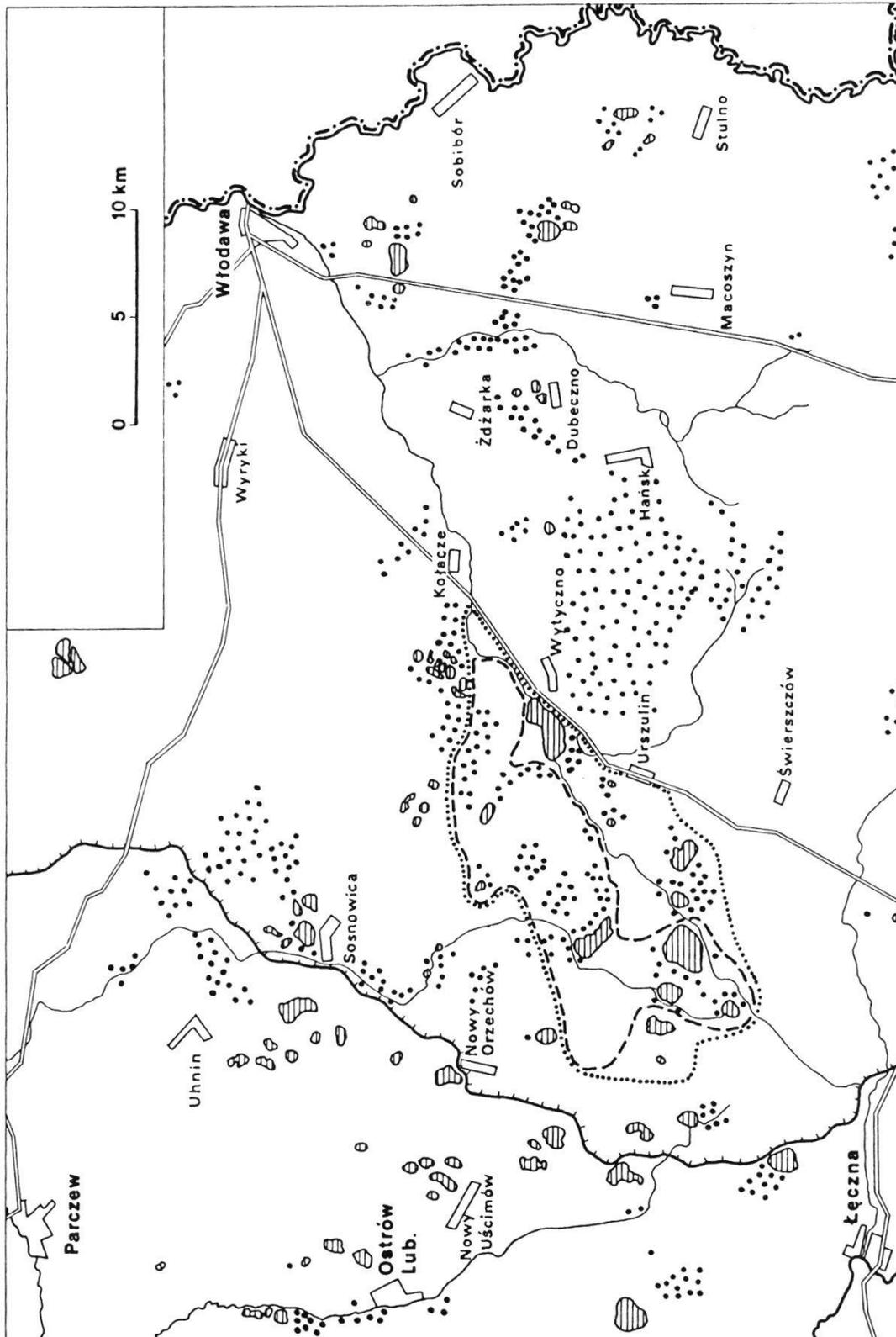


Fig. 4. Localities of *Scorpidium scorpioides* the Leczna-Włodawa Lake Land (cf. Fig. 2).

near Hansk (KWIECINSKI 1892) has not yet been confirmed, that of *Timmia megapolitana* near Bohutyn (JASNOWSKI 1956) has disappeared. At present a single locality of *Pseudobryum cinclidioides* near Sobibor as well as two localities of *Cinclidium stygium* are threatened.

7. Palaeobotanical data from Pleistocene and Holocene deposits of this region do not determine the time of the appearance of *Bryum neodamense*, *Cinclidium stygium*, *Meesia uliginosa* and *Timmia megapolitana*. Moreover, we have no data concerning the presence of *Calliergon turgescens* in deposits. This phenomenon is of a general character and has also been found in other regions of Poland (SZAFRAN 1952, JASNOWSKI 1957a, KAR-CZMARZ unpubl.).

SUMMARY

The paper deals with historical and present changes of bryophyte floras of the Leczna-Wlodawa Lake District (E. Poland). Bryological investigations were carried out on the basis of fossil remains of bryophytes in five Pleistocene and 15 Holocene profiles containing 30 species and varieties of bryophytes. Present data on 242 species result from field investigations from 1960 to 1990. Palaeobotanical and present data show the peat-forming role of mosses in peat deposits in intermediate and sedge peat bogs with special dominance of relict species. From 1960 to 1990, the protected boreal glacial relicts show the maximal decrease of the whole study area.

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