**INTRODUCTION**

Carex disperma Dewey (= *C. tenella* Schkuhr, non Thuill.) and Carex loliacea L., are circumboreal species bound to the taiga zone. Both species reach their south-western range limit in Poland and in other countries of the Baltic Sea basin (Norway, Sweden, Kaliningrad region of Russia, Lithuania, Belarus) (Hultén, Fries 1986).* In Poland, they occur only in the north-eastern part of the country. Their localities were recorded almost exclusively in forest complexes that retained primeval features (Zając and Zając 2001). *C. disperma* and *C. loliacea* are considered threatened in Poland and both are given the ‘vulnerable’ species status (Pawlikowski 2001a, b; Zarzycki and Szelag 2006). The species are also listed as threatened in the neighbouring Kaliningrad region of Russia (Ingelöö et al. 1993).

In Poland, the data on the distribution of *Carex disperma* are often out of date. The majority of localities have not been confirmed for at least 30 years (e.g. Sokolowski 1988a), or since the beginning of the 20th century (Abromeit et al. 1931-1940). In the “Distribution Atlas of Vascular Plants in Poland” (Zając and Zając 2001), the majority of localities were assigned the ‘not confirmed’ status. Thus, very little is known about the species distribution dynamics in Poland or contradictory information is supplied. According to Schweitzer and Polakowski (1994), in the Romincka Forest, *Carex disperma* still occurs in two localities only (and *C. loliacea* is extinct), which is contrary to the information provided by Sokolowski (1988a) and Pawlikowski (2001a, b). Sokolowski (1988a) listed a total of 11 localities of *C. disperma* in Poland, whereas in the “Flora von Ost- und Westpreussen” (Abromeit et al. 1931-1940), solely from two forest complexes (Romincka Forest and Borki Forest) about 16 occurrences of the species are given.

*Carex disperma* and *C. loliacea* are likely to be confused with each other (e.g. Reznicek and Ball 1981) and some of the existing data on the species distribution can be invalid. Additionally, in the 19th century the names *Carex tenella* Schkuhr...
(the former name for *C. disperma*) and *C. loliacea* L. were treated as synonyms by many authors (e.g. Ledebour 1853). Consequently, apart from few data from the former East Prussia (Abromeit et al. 1931-1940), there are no reports of *C. disperma* in the 19th century from the territory of contemporary Poland. Only *Carex loliacea* was included in many contemporary Central-European botanical monographs (e.g. Kluk 1805; Rostafinski 1872; Potonie 1889).

The aim of this study is to verify the distribution and dynamics of *Carex disperma* in Poland, in relation to *C. loliacea*. In order to assess the conservation status of the species, current and up to date information on the resources are needed.

**MATERIAL AND METHODS**

**Taxonomical remarks**

*Carex disperma* Dewey (≡ *C. tenella* Schkuhr) and *Carex loliacea* L. are tiny, slender sedges that form small mats or loose tussocks. They have inflorescences with few spikes, each with few flowers only. According to the approach accepted by the majority of authors, *C. disperma* (as well as *C. loliacea*) belong to the subgenus *Vignea* (Egorova 1999), which groups species of bisexual spikes and distigmatic flowers. Their inclusion to the particular section is a matter of disagreement. Traditionally, after Kükenthal (1909), both species used to be included in the section *Tenuiflorae* (e.g. Hegi 1967-1980), but Ohwi (1936) had excluded *C. disperma* from the above section and proposed creating a new, monotypic section *Dispermae*. The classification of both species into separate sections within the *Vignea* subgenus (e.g. Toivonen and Timonen 1976; Egorova 1999) was confirmed later by the DNA sequence analyses (Ford et al. 2006).

*Carex disperma* and *C. loliacea* are likely to be confused with each other. Characteristics useful in distinguishing both species are presented in Table 1.

**Methods**

Specimens of *Carex disperma*, *C. loliacea* and their hybrids were searched for in Polish herbarium collections. This was supplemented by literature survey and field exploration of suitable habitats in the years 1998-2009. A list of all the localities of *C. disperma* in Poland is provided, as well as the map of distribution of *C. disperma* and *C. loliacea* using 10×10 km ATPOL grid square system (Zając 1978). Specimens collected during the field survey were deposited at the Faculty of Biology Herbarium (WA) at University of Warsaw.

**RESULTS**

So far, about 47 localities of *Carex disperma* have been reported from Poland (and about 150 localities of *C. loliacea*). The localities of *C. disperma* were recorded almost exclusively in large forests with primeval features (Fig. 1). These were: Borki (about 21 localities), Rominka (9), Białowieża (10), Knyszyn (3) and Augustów Forests (2). Fourteen of the localities are presently confirmed. The majority of the localities confirmed after the year 2000 were situated in Rominka Forest (6 localities), whereas in the remaining forest complexes: Białowieża, Borki, Knyszyn and Augustów Forests, a total of eight localities (respectively: 4, 2, 1, 1) were confirmed or discovered. The most abundant populations (each covering more than 20 m²) were recorded in a peatland south-east of Czarnowo Średnie settlement in Rominka Forest, in “Boczkí” reserve in Borki Forest, and in “Kozi Rynek” reserve in Augustów Forest. In eight localities the species resources were very small and *C. disperma* covered areas of less than 5 m². Particularly small were populations in the Białowieża Forest. Among the localities that should be considered extinct is the locality in Dylewo Hills (the westernmost locality in Poland, which indicated the western limit of *C. disperma* distribution in Europe), as well as some localities in Borki and Rominka Forests.

*Carex loliacea* was recorded quite often in almost all the forest complexes listed (Fig. 2), particularly in Augustów Forest, where *C. disperma* was hardly present. Moreover, the species was noted in several other places. Due to the presence of these scattered, isolated localities (e.g. in Napiwoda-Ramuki Forest and Pisz Forest in Warmia and Masuria Province, Suwałki Scenic Park in Podlasie Province, Sobibór Forest and near Konstantynów in Lublin Province), the total range of distribution of *C. loliacea* in Poland is significantly broader than that of *C. disperma*. Considering the 10×10 km squares in the “Distribution Atlas of Vascular Plants in Poland” (Zając and Zając 2001), *C. disperma* was recorded in 17 squares only, while the localities of *C. loliacea* were situated in 41 squares.

**TABLE 1. Characteristics differentiating *Carex disperma* and *Carex loliacea*.

<table>
<thead>
<tr>
<th><em>Carex disperma</em></th>
<th><em>Carex loliacea</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>perigynia beaked with a short beak, glabrous, faintly nerveshless, glossy</td>
<td>perigynia beakless or hardly beaked, distinctly nervesh and therefore appearing ribbed, dull</td>
</tr>
<tr>
<td>(0)-1-2(4)perigynia in single spike</td>
<td>(1)-2-7(12) perigynia in single spike</td>
</tr>
<tr>
<td>inflorescence 2-4 cm long</td>
<td>inflorescence 1-3 cm long</td>
</tr>
<tr>
<td>stems filiform, arch-like decumbent</td>
<td>stem rather rigid, usually erect when flowering and during early fruit development</td>
</tr>
<tr>
<td>intervals between lower spikes in inflorescence usually very unequal</td>
<td>intervals between lower spikes in inflorescence usually more-less similar</td>
</tr>
<tr>
<td>staminate flower(s) present at the apex of one spike at least</td>
<td>all spikes with pistillate flowers at the apex</td>
</tr>
</tbody>
</table>
Carex disperma, Carex loliacea and their hybrids in Polish herbarium collections

Apart from the two exsiccate issues (leg. J. Mądalski 1936 and leg. W. Gugnacka-Fiedor 1975), Carex disperma specimens were encountered in three herbarium collections only (29 sheets in BIL, OLS and TRN), and Carex loliacea in 13 collections (167 sheets in BIL, BSG, KRA, KRAM, KTU, LOD, LUB, OLS, POZ, TRN, WA, WRS and WSRP; abbreviations of the names of herbaria follow Mirek et. al. 1997). All the encountered errors were C. loliacea determined as C. disperma (but never vice versa).
Moreover, all the specimens determined as hybrids between *C. disperma* and *C. loliacea*, belonged to either *C. disperma* or *C. loliacea*.

**List of reliable localities in Poland**

All the data sources relating to *Carex disperma* occurrences presented on the map (Fig. 1) are listed below. In the case of *C. loliacea*, a detailed list of localities is not presented as the number of localities and literature sources pertaining to them is too high. The map (Fig. 2) is based on herbarium specimens, literature data (e.g. Abromeit et al. 1931-1940; Koppe and Koppe 1937; Czerwiński 1986; Magiera 1986; Sokołowski 1988b and literature cited; Schweitzer, Polakowski 1994; Pawlikowski 2001a and literature cited, 2008a, b; Jutrzenka-Trzebiatowski et al. 2002) and my own unpublished information from the years 1999-2009.

Every locality described below was assigned an appropriate ATPOL grid square (Zając and Zając 2001). Abbreviations used: [B] – Białowieża; [CzŚ] – the village of Czarnowo Średnie; div. – number of the forest division [G] – Goldap; [H] – Hajnowka; [K] – Kruskalni; [KO] – Kowale Olecko – NP; National Park; res. – nature reserve, NC – not confirmed; s. – settlement; v. – village; ! – Paweł Pawlikowski.

**DYLEWO HILLS**

**DB79**: 1 km SE of Owczarnia s. next to the v. of Pietrzwałd (TRN: leg. J. Hutorowicz 1957), most probably extinct due to a habitat desiccation (! 2001).

**ROMINCKA FOREST**

**FA85**: ca. 3 km west of [CzŚ] and ca. 3 km north-east of the v. of Jurkisze, [G] comm. (Grütter 1897; Abromeit et al. 1931-1940 – div. 35), NC (! 1999-2000) – this locality is probably identical with the “Jurkisze” site (Polakowski 1963); 1 km north-west of [CzŚ], [G] comm. (Grütter 1897; Abromeit et al. 1931-1940 – div. 49, WA: leg. ! 2000, ! 1999-2003 – ca. 5 m²; since then not confirmed due to damaging forestry practices – clearcutting and drainage); 0.5 km north-west of [CzŚ], [G] comm. (Grütter 1897; Abromeit et al. 1931-1940 – div. 49, WA: leg. ! 2000 – ca. 4 m²); 1 km west of [CzŚ], [G] comm. (Grütter 1897; Abromeit et al. 1931-1940 – div. 33); northern part of “Mechacz Wielki” res., south of [CzŚ], [G] comm. (Koppe and Koppe 1931; WA: leg. ! 2000 – ca. 20 m²); south-western part of “Mechacz Wielki” res., north of the v. of Galwiecie, [G] comm. (WA: leg. ! 2000 – ca. 3 m²); 1.5 km south-east of [CzŚ], [G] comm. (WA: leg. ! 2002 – ca. 25 m²); this locality is probably identical with the “ca. 2 km östlich von Gross Jodupp” site (Schweitzer, Polakowski 1994); 2 km north of Czarne Lake, north-east of the v. of Budwiecie and north of the v. of Pluszkiewjny, [G] comm. (Grütter 1897; Abromeit et al. 1931-1940 – div. 4, Sokołowski 1963, BIL: leg. A. Kawecka 1969, Sokołowski 1988a, WA: leg. ! 2000 – less than 0.5 m²); southern part of “Boćki” res., Dubeninki comm. (WA: leg. ! 2001 – ca. 2 m²).

**FA86**: west part of “Żytkiejska Struga” res., Dubeninki comm. (Lettau 1902; Abromeit et al. 1931-1940: div. 53/54), NC (! 2005-2008); this locality is probably identical with the “ca. 3 km nordöstlich des Forsthauses” (Schweitzer, Polakowski 1994).

**BORKI FOREST**

**FB03**: 1 km south-east of a small lake near Budziska Leśne s., [K] comm. (Koppe and Koppe 1937 – div. 43); 1 km east of a small lake near Budziska Leśne s., [K] comm. (Koppe and Koppe 1937 – div. 59); 1.5 km south of Olszówka s., [K] comm. (Koppe and Koppe 1937 – div. 9); east of Góra Czarica hill and north of “Borki” res., three localities in neighbouring depressions, [K] comm. (Koppe and Koppe 1937 – div. 136, 146, 157); eastern part of the “Borki” res. and areas adjacent to the north-east and east, several (ca. 4) localities in separate depressions (they are treated together as the historical locations are imprecise), [K] comm. (Abromeit 1910; Abromeit 1928, Abromeit et al. 1931-1940 – div. 120, 205, 206; OLS: leg. B. Polakowski 1956, 1974, 1986, Polakowski 1961, KTM, KRA, KRAM, LOD, LUB, POZ, TRN, WA, WRSL: leg. W. Gugnacka-Fiedor 1975, ! 1999-2001; WA: leg. ! 1999 – ca. 20 m² in two separate localities); western part of “Borki” res. and areas adjacent to the north-west and west, at least two localities, [K] comm. (Abromeit 1918; Abromeit 1928; Abromeit et al. 1931-1940 – div. 127 or 129; Polakowski 1961); between Rogonie s. and Pilwag Lake, north-west of Łaźno Lake, [KO] comm. (Abromeit 1910; Abromeit et al. 1931-1940 – div. 25); north of two small lakes north of Pilwag Lake, [KO] comm. (Koppe and Koppe 1937 – div. 60A);

**FB04**: 1 km north of Olszanka s., [KO] comm. (Koppe and Koppe 1937 – div. 76); 1 km north of Ślepak Lake, north-east of the v. of Szwalk, [KO] comm. (Abromeit 1910; Abromeit et al. 1931-1940 – div. 73); 1 km north of Ciche Lake, [KO] comm. (Abromeit 1910; Abromeit et al. 1931-1940, Koppe and Koppe 1937 – div. 69);

**FB12**: 1.5 km east of Knieja Lučzańska s., [K] comm. (Abromeit 1928; Abromeit et al. 1931-1940 – div. 203);


**AUGUSTÓW FOREST**

**GB09**: Wigry NP., Wiatrołuża (Kaletnik) river valley east of the v. of Lipniak and south of the v. of Dębowo (BIL, leg. A. Sokołowski 1976; Sokołowski 1988a, 1990b, Jutrzenka-Trzebiatowski et al. 2002), NC (! 2009);


**KNYSZYN FOREST**

**GB03**: Stare Biele res., Szudziałowcom (Sokołowski 1985, 1988a, 1995b, BIL: leg. A. Sokołowski 1979);


**BIAŁOWIEŻA FOREST**

**GC45**: 1 km east of Gruszki s., div. 81A, Narewka comm. (BIL: leg. J. Żurowski 1974, Sokołowski 1988a, 1995a);


Uncertain information on localities in Poland

In his work, Czerwiński (1967) reported only Carex disperma, which is more rarely encountered than C. loliacea. Considering the lack of herbarium specimens collected by this author, these and other imprecise localities mentioned by the author of the paper should be considered uncertain. These are: Goldap (FA94), Sobolewo (FB19), Jaśki (FB28), Czarna Wieś (nowadays Czarna Białostocka, GB91), Jas- trzębna (GB41) (Czerwiński 1967), and Szeskie Hills (FA94) – Czerwiński (1978) and Biebrza National Park (FB58) – Czerwiński (1991). Moreover, the species is listed in the phytosociological table of Polakowski (1962) from the locality near the village of Wągniki (Wangnik) (Górowo Iławieckie comm. - EA92), but due to the lack of herbarium specimens the above mentioned locality should be considered uncertain as well.

DISCUSSION

Schweitzer and Polakowski (1994), who analysed the distribution dynamics of rare plant species in the present Warmia and Masuria Province, pointed out that although Carex loliacea was a more widely distributed species than C. disperma before the World War II, it decreased significantly and now C. disperma is a more common species. My results showed that C. disperma was much scarcer in Poland than C. loliacea. At the same time it should be pointed out that there are more reliable, historical records of C. disperma in Poland than it was previously thought (Sokolowski 1988a; Pawlikowski 2001b). Delin (1992) classified C. disperma (as well as C. loliacea) as a species occurring in ancient tree stands that have persisted for the last hundreds of years. He indicated that forest management activities in such forests, especially when accompanied by draining, led to the extinction of the species. This is in agreement with Trass et al. (1999), who listed C. disperma and C. loliacea among hemerophobic species, specific to primeval wet forests. Sokolowski (1988a) determined the reasons for Carex disperma and C. loliacea decline: lowering of the water table by draining as well as clear-cutting of the peatland forests.

Wet alder forests in the vicinity of several localities of C. disperma are still subject to clear-cutting, and disturbed hydrological conditions lead to eutrophication in some places. One of the populations of the species in Romnicka Forest (near the village of Czarnowo Średnie) disappeared within three years as a consequence of clear-cutting and draining of the wet alder forest in the year 2000. The conservation of both species requires the preservation of the natural conditions, first of all undisturbed hydrology with high groundwater level in wet forests they inhabit. As the main conservation measure, Sokolowski (1988a) indicated the establishment of sufficiently large nature reserves in order to preserve the hydrological conditions. This is particularly essential in the case of localities in Romnicka Forest that are still outside the nature reserves.

The majority of historical localities in Borki Forest were not confirmed after World War II, although the area was surveyed in order to confirm them. Their status is uncertain. The estimation of the species dynamics in Poland is difficult as the historical data from the present Podlascie Province are very scarce. Therefore only several localities can be considered extinct or most probably extinct. Applying the IUCN definitions of categories of threat (IUCN, 2008), Carex disperma should be given EN (endangered) category, as the number of individuals does not exceed 2500 and the number of individuals in the largest population does not exceed 250. At the same time, Carex loliacea, with the number of individuals exceeding 10 000, should not be considered threatened at all. It represents NT (near threatened) category because of the observed small decline in population size and number of localities.

Hybrid plants Carex disperma × C. loliacea were reported from Borki Forest at the end of the 19th century (Abromeit et al. 1931-1940). The above mentioned hybrid is listed in the monographs of the Polish flora (e.g. Raciborski and Szafer 1919; Szafer et al. 1953; Rutkowski 2004) as well. Nevertheless, I did not encounter such hybrid plants in Polish herbarium collections and during my field survey. Moreover, on the basis of leaf epidermis ultrastructure analyses, Toivonen (1981) denied the existence of such a hybrid and concluded that reports from the former East Prussia (at present Warmia and Masuria region) were invalid. Egorova (1999) also did not list the above mentioned hybrid combination. Thus, the inclusion of the C. disperma × C. loliacea hybrid in Polish flora monographs should be considered unfounded.

The existence of other hybrids between Carex disperma and species representing other sections, which were reported from the present Russian part of the Romnicka Forest (C. remota, C. curta – Abromeit et al. 1931-1940) seems to be doubtful. This is contrary with the entirely sterile within-section hybrid between C. loliacea and C. curta (Toivonen 1981) that was reported from north-eastern Poland by Abromeit et al. (1931-1940) since the plants showing intermediate features between the two species were encountered during my herbarium surveys as well (specimens in OLS, leg. Z. Endler 1981 in Skalskie Forest).

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LITERATURE CITED


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