

VASCULAR PLANTS OF THE MAŁY BOREK NATURE RESERVE
IN THE AUGUSTÓW FOREST (NE POLAND)PAWEŁ PAWLIKOWSKI, DAN WOŁKOWYCKI, PIOTR ZANIEWSKI, IWONA DEMBICZ,
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ABSTRACT. During the survey of the Mały Borek nature reserve (Augustów Forest, NE Poland) 236 species of vascular plants were recorded, including 10 plant species red-listed in Poland and 19 species protected under the Polish law. The most valuable species were sedges typical of the boreal coniferous forests: *Carex vaginata*, *C. globularis* and *C. loliacea*. The presence of neophytes was very limited (1.3% of the flora) in the area studied. The principal aim of the establishment of the reserve was the conservation of old-growth coniferous forests with long ecological continuity. Since the reserve studied consists mainly of old-growth coniferous forests, the number of species regarded as ancient forest indicators is lower (54 species) than in the well-preserved reserves with deciduous stands in north-east Poland, but still rather high. The most valuable, threatened species are bound to wetland forests that are presently disturbed due to drainage. Restoration of the former hydrological conditions is essential for the preservation of the vascular plants in the reserve.

KEY WORDS: vascular plants, nature reserve, red list species, coniferous forest, ecological continuity, indicator species, ancient forest species

INTRODUCTION

Due to deforestation of large areas of Europe and conversion of most of the remaining forest ecosystems into commercial woodlands, old and well-preserved forests are now very rare and require protection (SCHMIDER 1990, ZERBE 2002). The Augustów Forest is a large forest area located in the north-eastern Poland, dominated by coniferous (pine-spruce) forests. Ten nature reserves (and a national park), protecting species-rich forest ecosystems (SOKOŁOWSKI 2010) have been established within its borders so far. A recent study by

PAWLIKOWSKI et AL. (2011) proved that one of the nature reserves ("Kozi Rynek") was insufficiently surveyed and was characterised by the presence of a relatively large number of ancient indicator species of vascular plants. The concept of ancient forest plant species has been developed to distinguish best preserved patches of forest ecosystems with maintained ecological continuity (PETERKEN 1974, HERMY et AL. 1999). A list of ancient forest plant indicator species for Poland was presented by DZWONKO and LOSTER (2001).

The aim of the study was to complete the list of vascular plants of the Mały Borek nature reserve in the

Augustów Forest and to reveal how many ancient forest indicator species are present in a nature reserve dominated by old-growth coniferous forests. In addition, we wanted to compare the number of ancient forest plant species in the reserve studied with other protected forests in the north-eastern Poland.

MATERIALS AND METHODS

The Mały Borek nature reserve was created in 1959 to preserve forest vegetation typical of the Augustów Forest. The reserve covers an area of 90.53 hectares and it is located in the centre of the forest complex, in the Forest District and commune of Plaska, within sandy outwash plains of the Augustów Plain mesoregion within the Lithuanian Lake District (KONDRACKI 2002).

The nature reserve is situated in the north-western quarter of the square GB31 in the grid cartogram of the "Atlas of distribution of vascular plants in Poland" (ATPOL – ZAJĄC 1978). The relief of the reserve is not very diverse. Dominating soils are podzolic soils, developed from outwash sands (covering 55% of the reserve area). The central and southern parts of the reserve (around 30% of its area) are covered with organic soils, developed mainly from *Sphagnum*-peat, which are now subjected to oxidation processes. Brunic arenosols occupy a smaller area (13%; SOKOŁOWSKI 2010). The reserve is dominated by fresh and moist pine forests with a significant share of spruce. Smaller areas are covered by bog woodlands, alder forests and very small patches

of mixed forests (with spruce and deciduous trees) on moorsh soils (SOKOŁOWSKI 2010). Old-growth tree stands of an age exceeding (at places) 150 years dominate (mean age ca. 115 years) and the forests of that area are known to have long lasting ecological continuity (SOKOŁOWSKI 2010). Peatlands occupying the southern part of the area were drained in the 1960s as a result of digging ditches (first of all the so-called Rów Małoborkowski) in the meadows adjacent to the reserve (Fig. 1). This led to the decrease of *Sphagnum*-dominated bog vegetation and deep hydrological disturbances in the swamp forest communities (SOKOŁOWSKI 1970). Vascular plants of the Mały Borek nature reserve have not been the subject of a separate publication yet. According to SOKOŁOWSKI (2010) the reserve hosts 125 species of vascular plants, from which only 24 were listed in the cited work (including seven protected species).

A survey of vascular plants of the Mały Borek nature reserve was carried out mainly in July 2011, with supplementing inventories in September 2011 and in May 2012. The study was conducted using the topographic method (FALIŃSKI 1990). The names of vascular plant species and their status as anthropophytes follow MIREK et AL. (2002). The list of species contains the following additional information: the category of threat according to the "Polish plant red data book" (POLSKA CZERWONA KSIĘGA... 2001): CR – critically endangered species, EN – endangered species; VU – vulnerable species), the category of threat according to the "Red list of the vascular plants in Poland" (ZARZYCKI and SZELAĞ 2006): E – critically endangered species, V – endangered species,

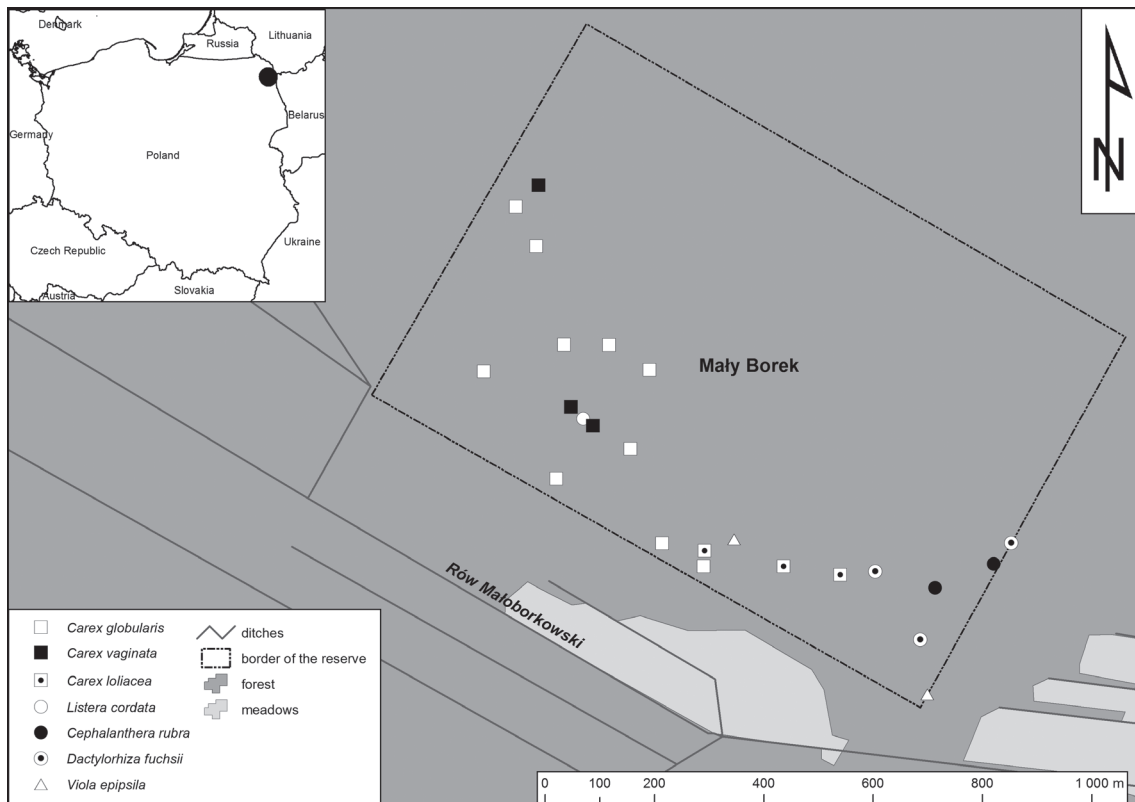


FIG. 1. Distribution of endangered plant species in the Mały Borek nature reserve in Augustów Forest (NE Poland)

(E) – species critically endangered in isolated localities outside the main area of its distribution; (V) – species endangered in isolated localities outside the main area of its distribution), information on protection status in Poland (S – strictly protected species, P – partially protected species) and information on inclusion in the list of the ancient forests plant species (AF; DZWONKO and LOSTER 2001). The symbol * is used to denote the most valuable species; their distribution and population size are further discussed in the results section.

RESULTS

The flora of the reserve consisted of 236 species of vascular plants, including 150 dicots, 70 monocots, three gymnosperms and 13 species of pteridophytes. Among them were nine species threatened with extinction in Poland and 19 protected species. Five species were included in the “Polish plant red data book” (POLSKA CZERWONA KSIĘGA... 2001): *Carex globularis*, *C. loliacea*, *C. vaginata*, *Cephalanthera rubra* and *Viola epipsila*. Ten taxa were listed in the “Red list of the vascular plants in Poland” (ZARZYCKI and SZELĄG 2006); apart from those mentioned above there were: *Dactylorhiza fuchsii*, *Goodyera repens*, *Huperzia selago*, *Listera cordata* and *Ranunculus lingua*. Within the reserve, 54 species considered as indicative for ancient forests in Poland, and three alien species (*Erigeron annuus*, *Quercus rubra* and *Padus serotina*) were recorded.

List of species

Species are listed in alphabetical order within the classes. Additional information is given in brackets (for details see Materials and methods section).

Equisetopsida: *Equisetum fluviatile*, *E. pratense*, *E. sylvaticum* (AF).

Lycopodiopsida: *Huperzia selago* ((V), S, AF), *Lycopodium annotinum* (S, AF), *L. clavatum* (S).

Polypodiopsida: *Athyrium filix-femina* (AF), *Dryopteris carthusiana* (AF), *D. dilatata* (AF), *D. filix-mas* (AF), *Gymnocarpium dryopteris* (AF), *Pteridium aquilinum* (AF), *Thelypteris palustris*.

Pinopsida: *Juniperus communis*, *Picea abies*, *Pinus sylvestris*.

Magnoliopsida: *Acer platanoides*, *Achillea millefolium*, *Acinos arvensis*, *Aegopodium podagraria* (AF), *Alnus glutinosa*, *Andromeda polifolia*, *Anemone nemorosa* (AF), *Angelica sylvestris*, *Anthriscus sylvestris*, *Aquilegia vulgaris* (S), *Arenaria serpyllifolia*, *Astragalus arenarius*, *Betula pendula*, *B. pubescens*, *Calluna vulgaris*, *Caltha palustris*, *Cardamine amara*, *Cardaminopsis arenosa*, *Cerastium holosteoides*, *Chamaenerion angustifolium*, *Chrysosplenium alternifolium* (AF), *Cicuta virosa*, *Circaea alpina* (AF), *Cirsium oleraceum*, *C. palustre*, *Comarum palustre*, *Corylus avellana*, *Crepis paludosa*, *Daphne mezereum* (S, AF), *Echium vulgare*, *Epilobium montanum* (AF), *E. palustre*, *Erigeron acris*, *E. annuus*, *Euonymus europaeus*, *Eupatorium cannabinum*, *Filipendula ulmaria*, *Fragaria vesca*, *Frangula alnus* (P), *Fraxinus excelsior*, *Galeobdolon luteum* (AF), *Galeopsis bifida*, *Galium mollugo*, *G. palustre*, *G. uliginosum*, *Geranium robertianum*, *Geum*

rivale, *Glechoma hederacea*, *Hepatica nobilis* (S, AF), *Hieracium lachenalii*, *H. pilosella*, *Hottonia palustris*, *Hypericum perforatum*, *Impatiens noli-tangere* (AF), *Knautia arvensis*, *Lapsana communis*, *Lathyrus vernus* (AF), *Leontodon autumnalis*, *Ledum palustre* (S), *Linaria vulgaris*, *Lychnis flos-cuculi*, *Lycopus europaeus*, *Lysimachia thyrsoiflora*, *L. vulgaris*, *Lythrum salicaria*, *Medicago lupulina*, *Melampyrum nemorosum* (AF), *M. pratense* (AF), *Melilotus albus*, *Menyanthes trifoliata* (P), *Mercurialis perennis* (AF), *Moehringia trinervia* (AF), *Monotropa hypopitys*, *Mycelis muralis* (AF), *Myosotis palustris*, *Myosoton aquaticum*, *Orthilia secunda* (AF), *Oxalis acetosella* (AF), *Oxycoccus palustris*, *Padus avium*, *Padus serotina*, *Peucedanum palustre*, *Plantago lanceolata*, *P. major*, *Polygonum hydropiper*, *P. minus*, *Populus tremula*, *Potentilla erecta*, *Prunella vulgaris*, *Pyrola minor*, *P. rotundifolia*, *Quercus robur*, *Q. rubra*, *Ranunculus acris*, *R. auricomus* (AF), *R. flammula*, *R. lanuginosus* (AF), *R. lingua* (V), *R. repens*, *Rhamnus catharticus*, *Ribes nigrum* (P, AF), *Rorippa amphibia*, *Rubus idaeus*, *R. saxatilis*, *Rumex acetosa*, *R. acetosella*, *R. obtusifolius*, *Salix aurita*, *S. caprea*, *S. cinerea*, *Scorzonera humilis*, *Scrophularia nodosa* (AF), *Scutellaria galericulata*, *Senecio sylvaticus*, *Silene vulgaris*, *Sium latifolium*, *Solanum dulcamara*, *Sorbus aucuparia*, *Stachys sylvatica* (AF), *Stellaria graminea*, *S. holostea* (AF), *S. longifolia*, *S. media*, *S. nemorum* (AF), *S. palustris*, *S. uliginosa*, *Taraxacum officinale* agg., *Thalictrum aquilegifolium*, *Thymus serpyllum*, *Tilia cordata*, *Trientalis europaea* (AF), *Trifolium alpestre*, *T. repens*, *Urtica dioica*, *Vaccinium myrtillus* (AF), *V. uliginosum*, *V. vitis-idaea* (AF), *Veronica arvensis*, *V. beccabunga*, *V. chamaedrys*, *V. officinalis*, *V. serpyllifolia*, *Viburnum opulus* (P), *Vicia cracca*, *Viola canina*, *V. epipsila* (CR, E, S)*, *V. palustris*, *V. reichenbachiana* (AF), *V. riviniana* (AF).

Liliopsida: *Agrostis canina*, *A. capillaris*, *A. stolonifera*, *Alisma plantago-aquatica*, *Alopecurus geniculatus*, *A. pratensis*, *Anthoxanthum odoratum*, *Calamagrostis arundinacea*, *C. canescens*, *Carex acutiformis*, *C. appropinquata*, *C. canescens*, *C. cespitosa*, *C. digitata* (AF), *C. echinata*, *C. elongata* (AF), *C. ericetorum*, *C. globularis* (EN, (E))* , *C. hirta*, *C. lasiocarpa*, *C. loliacea* (S, VU, V)*, *C. nigra*, *C. ovalis*, *C. pallascens*, *C. pseudocyperus*, *C. remota* (AF), *C. rostrata*, *C. vaginata* (VU, V)*, *C. vesicaria*, *Cephalanthera rubra* (EN, E, AF, S)*, *Convallaria majalis* (AF, P), *Dactylis glomerata*, *Dactylorhiza fuchsii* (V, S, AF), *Danthonia decumbens*, *Deschampsia caespitosa*, *D. flexuosa*, *Elymus caninus* (AF), *E. repens*, *Epipactis helleborine* (S, AF), *Eriophorum vaginatum*, *Festuca ovina* s. str., *F. pratensis*, *F. rubra*, *Glyceria fluitans*, *Goodyera repens* ((E), S), *Holcus lanatus*, *Iris pseudacorus*, *Juncus effusus*, *Lemna minor*, *Listera cordata* ((V), S)*, *Luzula campestris*, *L. multiflora*, *L. pilosa* (AF), *Maianthemum bifolium* (AF), *Melica nutans* (AF), *Milium effusum* (AF), *Molinia caerulea*, *Nardus stricta*, *Paris quadrifolia* (AF), *Phalaris arundinacea*, *Phragmites australis*, *Poa annua*, *P. compressa*, *P. nemoralis* (AF), *P. palustris*, *P. pratensis*, *P. trivialis*, *Polygonatum multiflorum* (AF), *P. odoratum* (AF), *Scirpus sylvaticus*.

Distribution and population size of the most interesting and threatened species

The localities of the threatened plant species were aggregated in the southern and south-western part of the reserve, mainly in the ecotone transitional zones between mineral soils and peat-covered depressions (Fig. 1). Among the vascular plants most threatened in the region of north-eastern Poland and throughout the entire country, were boreal sedges *Carex globularis*, *C. loliacea* and *C. vaginata*, orchids *Cephalanthera rubra* and *Listera cordata* as well as *Viola epipsila*.

The two most valuable boreal sedges, *Carex globularis* and *C. vaginata*, were found in the southern and south-eastern part of the reserve. The former species was recorded in a ca. dozen of places in moist (or wet) pine-spruce forests; some of them are former spruce forests on peat that are drained at present. The population exceeded 1000 shoots, however, during the two seasons of the survey only several generative shoots were observed. Population of *Carex vaginata* covered a few dozens of square meters, mainly in the ecotone zones between alder forests or pine-spruce forests on peat and mesic coniferous forests on organic soils. Another boreal sedge, *C. loliacea*, as well as *Listera cordata* and *Viola epipsila*, were recorded in the southern part of the reserve. *C. loliacea* formed a few small sub-populations in drained spruce forests on peat and former swampy alder forests, with forest floor dominated by numerous eutrophic forest and meadow species. More than 30 shoots of *Listera cordata* (in drained spruce-pine-birch-alder forest) and two sub-populations of *Viola epipsila* were noted in swampy alder forests and a few generative shoots of *Cephalanthera rubra* were recorded in mixed (spruce-birch-aspen) forest among broadleaf forest floor species, in the transitional zone between mineral and organic soils in the eastern part of the reserve.

DISCUSSION AND CONCLUSIONS

The most valuable species of the Mały Borek nature reserve were sedges typical of the coniferous forests of the boreal zone: *Carex globularis*, *C. vaginata* and *C. loliacea*. In Poland their range covers mainly large forest areas (with ecological continuity) in north-eastern part of the country (ATLAS... 2001). Another precious species, *Cephalanthera rubra*, until now has been known in the Augustów Forest from a single, recently discovered locality (SZCZYGIELSKI and ROJEK 2008).

The number of vascular plant species in the studied reserve was not very high due to the lack of non-forest vegetation and paucity of more fertile soils, along with extensive dominance of coniferous, acidic forests. Noteworthy, the flora of the reserve is hardly enriched with alien species, which constitute only 1.3% of the total species number.

Within the reserve borders 54 species of ancient forests indicators were present, which seems not very high considering the long-lasting ecological continuity and dominance of old-growth forest stands. However, the number of ancient forest indicator species was lower than in other forest nature reserves of north-eastern Poland, such as the Kozi Rynek nature reserve in the

Augustów Forest (65 ancient forests indicator species - PAWLIKOWSKI et AL. 2011) and the "256 forest division" in the Białowieża National Park (89 species - FALIŃSKI and MUŁENKO 1997). The main reason of that phenomenon seems to be a limited diversity of forest communities in the Mały Borek reserve and, which seems especially important, extremely low area covered by broadleaf forests on mineral soils (for which the list of ancient forest indicator species was developed). Moreover, it seems that (apart from minor exceptions) a majority of species typical of coniferous forests display very limited association with the so called "ancient forests" (PITKIN et AL. 1995).

In the case of coniferous and wetland forests, such as in the Mały Borek nature reserve, the usage of the national list of ancient forest indicator species in order to evaluate ecological continuity seems to have limited value. This is mainly because the list covers species bound mainly to broadleaf forests, not taking into consideration species typical of primaeval coniferous and wetland forests (PITKIN et AL. 1995, OHLSON et AL. 1997, TRASS et AL. 1999), such as e.g. *Carex globularis*, *C. loliacea*, *C. vaginata* and *Listera cordata*. We think that the list of ancient forest plant indicator species could be expanded (see DZWONKO 2007) in order to be applicable not only to broadleaf forests, but coniferous and wetland forests as well.

Despite the natural character of the flora, the nature values of the Mały Borek nature reserve are endangered due to habitat transformations that have occurred for more than half a century as a result of the drainage of adjacent peatlands. This concerned especially rare boreal species of sedges occurring presently in drained wetland forests. Reduced viability, manifested by poor flowering and fruiting, related to long-term drying of bog forests in the reserve, was observed in the population of *Carex globularis*. In order to maintain the high nature values of the reserve, it is necessary to increase the groundwater level in the reserve area and in the meadows adjacent to the reserve on the south.

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