

# The invasibility of deciduous forest communities after disturbance: A case study of *Carex brizoides* and *Impatiens parviflora* invasion

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Received 11 October 2005; received in revised form 20 December 2006; accepted 21 January 2007

## Abstract

Phytosociological records from three different woodlands, each with oak–hornbeam stands (*Tilio–Carpinetum*), were analyzed in terms of the presence/absence of two harmful species, alien *Impatiens parviflora* and native *Carex brizoides*. Records from the Białowieża Primeval Forest (northeastern Poland) represented old-growth forest, and others from the Silesian Upland (southeastern Poland) represented managed forest and invaded forest. The three sets of records were compared in terms of stand structure, Ellenberg indicator scores, and the shares of various plant functional types. Vegetation analyses also included species richness scores, Shannon–Wiener indices, and DCA and CCA ordination with the cover of the two species as variables. There were fewer differences between managed and old-growth forest than between managed and invaded forest. Invaded forest was characterized by low species richness, higher frequency of hemerophilous species, lower frequency of myrmecochores, and higher light availability and temperature. It was concluded that, of the two invasive species, *C. brizoides* is a better indicator of human-induced disturbance. Both cover and binary data explained changes in floristic composition in the presence of this species. Invasion by both species was favored by forest management practices. Their presence led to further species impoverishment, and harmed the quality of the forest floor habitat. © 2007 Elsevier B.V. All rights reserved.

**Keywords:** Invasions; Old-growth forest; Managed forest; Plant functional types; Phytosociological studies; Poland

## 1. Introduction

The impact of human activity is a major factor affecting vegetation throughout the world today. Poland lies in the zone where the natural vegetation should be broadleaved deciduous forest. Since Neolithic times, changes in vegetation cover have been accelerating. In Poland the area covered by forests has decreased to an estimated 28% of the country's territory. The majority of old-growth forests have been cleared and converted to agriculture, or altered in other ways by human activity.

The anthropogenic factors affecting forest communities vary widely. They can be divided into three groups of impacts: at the landscape level (processes connected with forest fragmentation); at the community level (effects on community structure and species composition); and at the biotope level (processes affecting habitat quality, such as soil acidification, nitrogen input or eutrophication) (Faliński, 1966, 1998; Peterken and

Game, 1984; Łaska, 2001; Dzwonko and Gawronski, 2002). Alien plant invasion and the spread of expansive native species are two consequences of these changes. Nonindigenous species and indigenous plants are incorporated into plant communities, expand their range and increase their abundance, as a result of intentional (cultivation) or unintentional introduction, or inappropriate forest management practices including logging, thinning of tree stands, alteration of water regimes, removal of brushwood and litter, etc.

One of the most invasive alien species is the small balsam *Impatiens parviflora* DC, an Asiatic species very frequent in the forests of Central and Northern Europe (Pyšek et al., 1998). One of the most expansive native species is seagrass *Carex brizoides*, which is spreading due to disturbances and clearing in woodlands (Dzwonko and Gawroński, 1994; Medwecka-Kornaś, 1994; Olaczek, 1974). Both occur very abundantly in woodlands and are considered harmful. Behaviorally the two species differ completely. The former is a ballochorous annual and the latter is a perennial with a clonal growth type. Both, however, can affect the ground-layer vegetation or displace a resident community component having similar biology and

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habitat requirements. The permanent incorporation of an alien species into the structure of a previously existing or transforming community brings far-reaching changes to its dynamics and functioning (Faliński, 1998). Unmanaged old-growth forests are not usually invaded by these two species. In a comparison of forests in which the two most invasive woodland species are present and natural forests that are free of them, our study examined whether there any significant differences in the contributions of various functional plant groups, and in the community structure and habitat requirements of species in deciduous forests, and whether the differences are greater between old-growth and recent forests or between recent and invaded ones.

## 2. Area descriptions and methods

### 2.1. Study area

#### 2.1.1. The Silesian Upland

The Silesian Upland (SU) (50°28N, 18°40E) is situated in southern Poland, covering an area of ca. 4000 km<sup>2</sup> (Fig. 1). It is characterized by differentiated relief and geological structure. Its central part consists of Carboniferous formations. The region is known for its deposits of important mineral resources: hard coal, zinc and lead ores, sand, gravel, dolomite, and iron ore. Mineral resource exploitation began in the early Middle Ages and intensified in the second half of the 18th century due to changes in the forms of economic activity, technical and scientific progress, and urbanization. Mean annual temperature is ca. 8 °C, and annual precipitation is 700–800 mm. The

prevailing winds are from the west (SW, W, NW). The many depressions and land deformations in woodland areas there are the result of previous coal mining activity, which led to wetting or desiccation of large areas. Waste heaps, mine pits and sedimentation ponds are characteristic features of the Silesian landscape (Kozyreva et al., 2004). Woodland and scrub communities are represented by secondary deciduous and pine forests, and less often by forests of fresh, damp or wet habitats—primary oak–hornbeam forests, riparian forests or alder carrs (Kozyreva et al., 2004). The majority of primary forests were cleared and converted to arable land, wasteland, and industrialized urban areas. Some of them were afforested, mainly with coniferous species and occasionally with deciduous species (Nyrek, 1975). Some remnants of old-growth forests persisted because the habitat quality was maintained, but they have been exploited by the forestry industry.

#### 2.1.2. Białowieża Primeval Forest

The Białowieża Primeval Forest (BPF) (52°43N, 23°50E) in northwestern Poland is the best-preserved lowland forest complex in Europe, comprising fragments of pristine nature (Fig. 1). It covers a total area of over 1500, 647 km<sup>2</sup> of which lies within the borders of Poland, with the remainder extending into Belarus. The climate of BPF is transitional between continental and Atlantic, making it somewhat variable (Jędrzejewska et al., 1994). Mean annual precipitation is 641 mm, while the mean annual temperature amounts to 6.8 °C. Its location on the continental watershed makes the system dependant on precipitation (Bobiec, 2002).

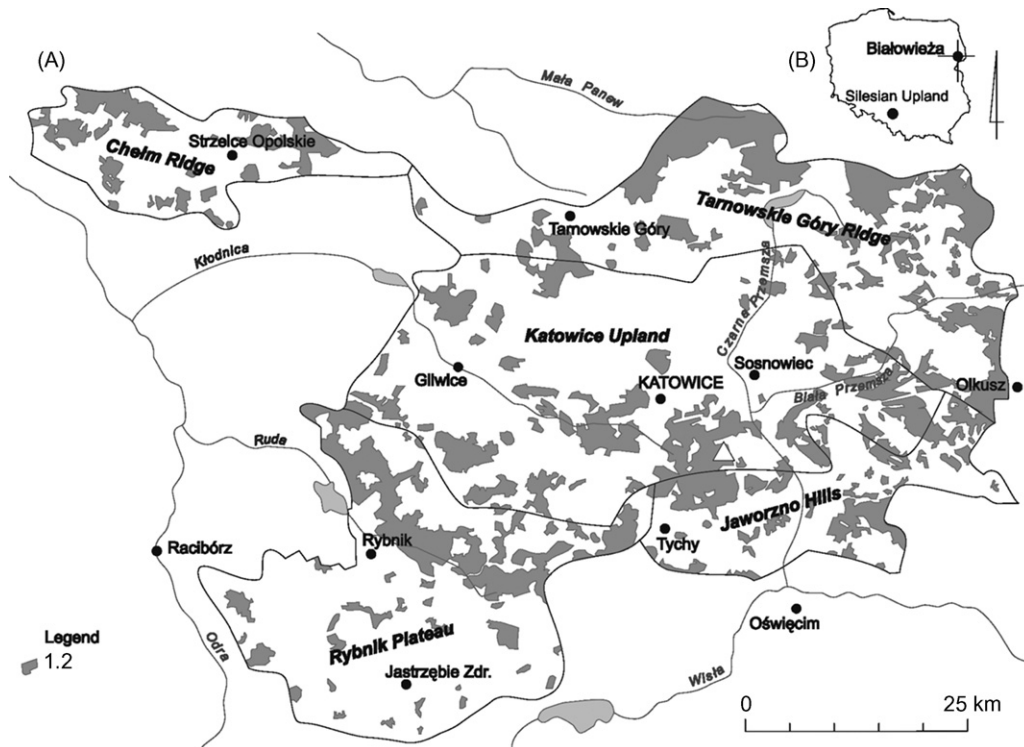


Fig. 1. Study area. Silesian Upland (A), and outline of Poland showing the locations of the Silesian Upland and Białowieża Primeval Forest (B). 1: forests and 2: towns.

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