Does the inner Baltic Sea coast provide a habitat for invasive neophytes?

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Summary

Invasive plants usually prefer habitats which are characterized by changed natural dynamics or experienced pronounced human impact. Along the inner Baltic Sea coast of Mecklenburg-Vorpommern (Northeast Germany) both factors are relevant. Using a comprehensive floristic investigation of vascular plants from terrestrial habitats in 645 sampling areas along a 315 km stretch of the coast line we want to find out whether the inner Baltic Sea coast provides a particularly receptive habitat for neophytes in this part of central Europe. We want also to know whether a threat to native coastal flora by invasive neophytes is detectable.

Among the 654 recorded vascular plant taxa, 58 are considered to be neophytes. None of them reach a frequency of more than 6 % among the 645 sampling areas, and only seven species occur more often than nine (up to 37) times. Most neophytic vascular plants are very rare. In comparison with inland data the share and frequency of neophytic species are not markedly different at the inner coast. Only five neophytic species showed a distinct coastal preference compared with their inland occurrence, including the two most frequent neophytic species in the study area, *Lactuca tatarica* and *Calystegia silvatica*.

Ninety-one taxa are recorded as 'dominant' in their plant communities, which is interpreted as an indicator for invasive behaviour, though *Lactuca tatarica* and *Acorus calamus* are the only two neophytes among them. All other neophytes occurred on a scattered basis or as single individuals. According to these data, the inner Baltic Sea coast does not facilitate establishment of invasive neophytes, despite apparently suitable preconditions.

Key words: Baltic Sea coast, coastal habitats, invasive plant species, neophytes, Mecklenburg-Vorpommern

1. Introduction

Invasive plants usually prefer habitats which are characterized by changed natural dynamics or which have experienced pronounced human impact (Lohmeyer & Sukopp 1992, Burke & Grime 1996, Sobrino et al. 2002, Kowarik 2003). The terrestrial habitats of the inner Baltic Sea coast of Mecklenburg-Vorpommern (Northeast Germany) are a good example showing where both factors are relevant (Fukarek 1989). Furthermore, shipping traffic and water as a vector generally support plant dispersal in coastal areas (Grosholz 2002). By a comprehensive floristic investigation of a comparatively large area we want to address the following questions:

1. Does the inner Baltic Sea coast provide a particularly suitable habitat for neophytes in this part of central Europe?
2. Can we find indications for a threat of the native coastal flora by invasive neophytes?

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2. Material and Methods

During four vegetation periods between 1998 and 2001 the 315 km inner coastline between Ribnitz-Damgarten (N 54°15'08"; E 12°27'25") and Altwarp (N 53°41'52"; E 14°16'12") in NE Germany was investigated by the Geobotany working group of Mecklenburg-Vorpommern (see Fig. 3). The inner coastline differs from the outer coast by a lower level of surge and sediment relocation. Therefore dunes are almost absent here and flooding by brackish water is a main characteristic of the natural coastal reed vegetation zone (Fukarek 1969). This nutrient-rich vegetation has been widely replaced by grassland and settlements and remained mostly situated off-side a flood control dike. Most vegetation types show a typical level of disturbance due to the high natural dynamics and some anthropogenic impacts (Polte 2004, Isermann 2004).

The brackish water causes oligohalinic conditions after a flooding event, which alternates with periods of non-saline conditions after rain or higher salinity after long evapotranspiration periods in summer. The salinity of the flooding water varies from about 1 to 10 ‰ NaCl.

The coastline was divided into 192 cross sections with similar geomorphology and level of human impact. The longitudinal borders are indicated by the 'geolitoral', the terrestrial area from water level up to the latest influence of flooding by brackish water, in this region up to 90 cm over mean water level (Krisch 1990). Each section was split according to the vegetation physiognomy and land use character into overall 645 sampling areas. The shape and size of the sampling areas were not standardized and adapted to the habitat type. In each sampling area all plant species were recorded together with semi-quantitative details of their abundance ('rare', 'scattered', 'frequent', 'dominant', Rehbein & Berg 1999). 'Dominant' was selected for species covering more than 50 % of the sampling area. In case of herbaceous plants we used dominance as an indicator for high competitivity and so for an invasive behaviour within plant communities (Trepl 1994, Huston 2004).

For information about the floristic status, as well as the distribution and habitat preferences of the species we used Fukarek & Henker (2006). For comparison with inland data we further used the floristic database of Mecklenburg-Vorpommern with about 3000 taxa and 1,5 million records (AG Geobotanik MV 2005). The botanical nomenclature was taken from Fukarek & Henker (2006).

3. Results

3.1 Floristic results

Among the 654 recorded vascular plant taxa, 58 are considered to be neophytes (Tab. 1). Many of the observed neophytes are ruderal plants widely distributed in Central Europe, e.g. *Conyza canadensis, Impatiens parviflora* and *Rumex thyrsiflorus*. Neophytic woody plants were often planted for coastal protection or escaped from neighbouring cultivated stands. The most frequent was *Alnus incana* with six records. Another small group comprises neophytic freshwater species. These species predominantly occur in the eastern part of the area which is characterized by a decreased level of salinity. *Acorus calamus* with 25 records can be counted among them as a consolidated component of the siltation vegetation in freshwater and weakly brackish situations. *Elodea canadensis* is considered invasive in Germany, but plays only a minor role in the investigated area with only six stands of a few individuals.

The overall abundance and frequency of neophytes in the study area was rather low and the most frequent species *Calystegia silvatica* and *Lactuca tatarica* occurred only in 5 % and 6 % of the plots, respectively.

Table 1: The 58 neophytic vascular plants in the study area.

Plant group	Species
Frequent ruderal species in Central Europe	*Amaranthus retroflexus, Armoracia rusticana, Aster novi-belgii agg., Bromus inermis, Conyza canadensis, Diplotaxis muralis, Diplotaxis tenuifolia, Epilobium adenocaulon, Epilobium lamyi, Epilobium tetragonum, Euphorbia cyparissias, Galinsoga parviflora, Impatiens parviflora, Lepidium densiflorum, Lepidium ruderale, Matricaria discoidea, Oenothera biennis, Rumex thyrsiflorus, Salsola kali ssp. ruthenica, Senecio vernalis, Sisymbrium altissimum*
Rare Neophytes in Central Europe	*Anthoxanthum aristatum, Coronopus didymus, Datura stramonium var. tatula, Mentha longifolia, Oenothera canovirens, Silene conica,Vulpia bromoides*
Woody plants	*Acer negundo, Alnus incana, Clematis vitalba, Elaeagnus angustifolia, Elaeagnus commutata, Ligustrum vulgare, Populus alba, Populus* x *canadensis, Salix elaeagnos, Sambucus racemosa, Symphoricarpos albus, Syringa vulgaris*
Tall perennials	*Bromus carinatus, Helianthus tuberosus, Reynoutria japonica, Solidago canaden*sis, *Solidago gigantea*
Feral economic plants	*Brassica napus, Helianthus annuus, Lolium multiflorum, Lycopersicon esculentum*
Freshwater plants	*Acorus calamus, Bidens frondosa, Elodea canadensis, Lemna turionifera*
Neophytes with coastal preference	*Calystegia pulchra, Calystegia silvatica, Cotula coronopifolia, Lactuca tatarica, Rosa rugosa*

None of the 58 neophytic taxa reached a frequency of more than 6 % among the 645 sampling areas, and only seven species occur more often than nine times (occurrence given in brackets): *Helianthus tuberosus* (10), *Solidago gigantea* (10), *Impatiens parviflora* (11), *Conyza canadensis* (16), *Acorus calamus* (25), *Calystegia silvatica* (32) and *Lactuca tatarica* (37). Most neophytic vascular plants are very rare (Fig. 1).

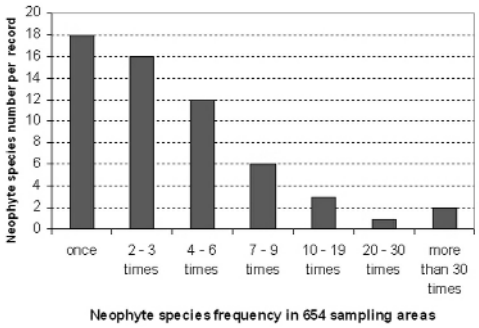

Fig. 1: Neophyte species frequency (in 654 sampling areas) and neophyte species number per record.

3.2 Coastal preference of neophytic vascular plants

The vascular plant flora of Mecklenburg-Vorpommern includes 261 (11 %) naturalized and 692 (28 %) non-established neophytes (Fukarek & Henker 2006). According to the floristic database (AG Geobotanik 2005), the frequency of neophytic plants in the nine hundred 5.5 x 5.5 km plots differs from 0.1 to 82 %, with a mean value of 7 % and a mean proportion of 6 %. Figure 2 shows the highest level of neophytes around bigger towns and in the Elbe valley in the south west. The coastline does not display high proportions of neophytic plants.

Only five neophytic species show a coastal preference compared with their inland occurrence: *Calystegia pulchra, Calystegia silvatica, Cotula coronopifolia, Lactuca tatarica* and *Rosa rugosa* (Fig. 3), including the two most frequent neophytic species *Lactuca tatarica* and *Calystegia silvatica* (Fig. 4).

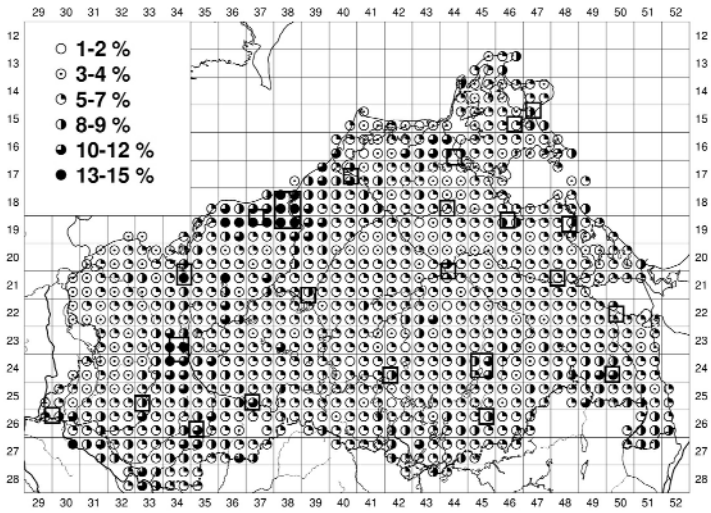

Fig. 2: Proportion of neophytic vascular plants in Mecklenburg-Vorpommern (NE-Germany) using data of 5.5 x 5.5 km grids from the floristic database (AG Geobotanik 2005). The bold rectangles indicate towns with more than 10,000 inhabitants.

3.3 Risk assessment

Analyzing the semiquantitative abundances, 91 taxa are recorded as 'dominant' in their plant communities, at least once. *Lactuca tatarica* and *Acorus calamus* are the only two neophytes among them. All other dominant species are native ones. The number of neophytes in general decreases in habitats where the influence of flooding brackish water is more conspicuous. Only *Cotula coronopifolia* can be considered a halophyte. Tall perennials like *Helianthus tuberosus*, *Reynoutria japonica* and *Solidago canadensis* are known as competitive invasives in central Europe (Kowarik 2003). Among them *Helianthus tuberosus* and *Solidago gigantea* have been recorded 10 times each. None of the tall perennials have formed dominant stands in the study area. *Helianthus tuberosus* prefers places of high anthropogenic disturbance, especially in the vicinity of human settlements.

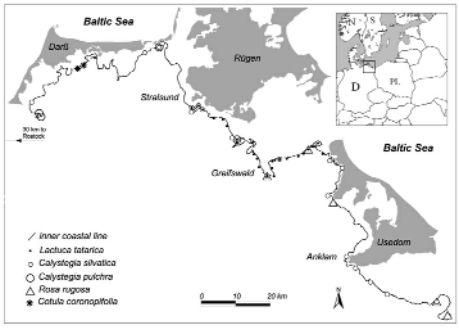

Fig. 3: The study area and distribution map of five neophytic species with a distinct coastal preference.

4. Discussion

The inner Baltic Sea coastal habitats are characterized by an open vegetation structure and conditions of low competition due to the high natural dynamic, and some anthropogenic, impacts in the area (Polte 2004, Isermann 2004). Thus, a high frequency and dominance of neophytes was expected but our results give no evidence for such a pattern. Most of the recorded neophytic species are widely distributed in ruderal habitats of Central Europe. Abundance as well as frequency of neophytes in the study area is not gen-

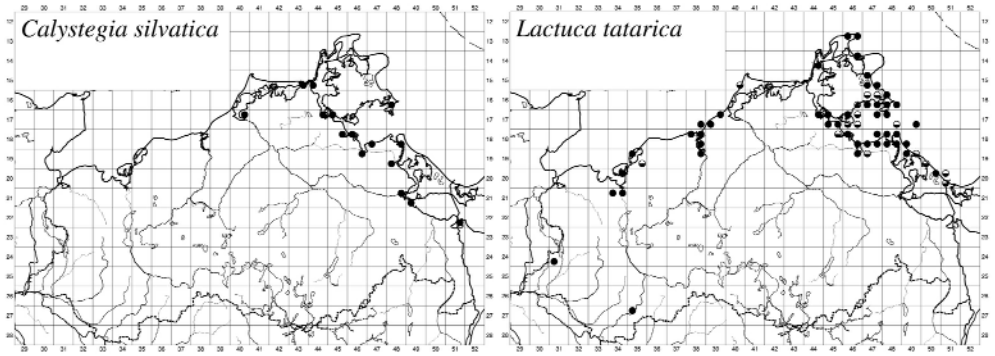

Fig. 4: Distribution of *Calystegia silvatica* and *Lactuca tatarica* in Mecklenburg-Vorpommern (NE-Germany) as examples of the coastal preference of neophytic vascular plants.

erally enhanced in comparison to the inner parts of north East Germany.

A special coastal preference could be found only for a small group of five species. Among them *Lactuca tatarica* and *Calystegia silvatica* are the most frequent neophytes in the area. So the coast does enhance the number of naturalized neophytes in Central Europe, but not by a substantial quantity. *Lactuca tatarica* grows in open dune vegetation with high vegetation dynamics and low competition pressure. Litterski & Berg (2000) found no evidence for a threat to the native dune vegetation by this species either. Both neophytic *Calystegia*-species grow in brackish reed vegetation similar to *Calystegia sepium*, but they prefer edges and disturbed places. *Rosa rugosa* is widely planted in coastal regions of Europe and occurs as an invasive species in other coastal regions especially in outer coastal dunes (Isermann 2003). Along the inner Baltic Sea coastal dunes are very rare and no evidence for a similar development was detected. *Cotula coronopifolia* was found for the first time in Mecklenburg-Vorpommern during our investigation (Mohr 1999). It is an annual species with a high potential for reproduction and migration and the most halophytic of all neophytic species found. It is not very competitive and fills the vegetation gaps in open and disturbed places.

One reason for the unexpectedly low impact of neophytes in the area seems to be the soil salinity. Many of the recorded neophytes, e. g. *Acorus calamus*, *Mentha longifolia* and the freshwater species avoid brackish habitats or occur predominantly in the eastern parts of the study area with surface water salinity below 3 ‰ NaCl. The woody plants only occur on higher ground levels.

An actual threat to the native coastal flora can only be deduced when neophytes show an 'invasive behavior', as indicated by the formation of species-poor dominant plots. Such plots are widely distributed in central Europe and often found in formerly species-rich plant communities as a result of the anthropogenic nutrient accumulation during the last century (Ellenberg 1988). In the sampling areas dominance is observed with only two neophytic plants. By contrast, 89 native species, e. g. *Phragmites australis, Phalaris arundinacea, Calamagrostis epigeios* and *Eupatorium cannabinum* create dominant species-poor plots. So an area-wide replacement effect of the native flora especially by neophytes is not apparent.

All tall perennials do certainly need further attention in long term studies with regard to their invasive potential. For example, *Bromus carinatus* entered Mecklenburg-Vorpommern some decades ago (Fukarek & Henker 2006). This species is creating dense plots similar to those of *Bromus inermis*, and could become more invasive in the future.

According to our data, we nevertheless conclude that the inner Baltic Sea coast does not provide a special habitat for invasive vascular plant species, despite the apparently suitable preconditions.

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