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RESEARCH PAPER

A comparison of species lists of vascular plants points to recent habitat change on the North Frisian Island, Amrum

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Current and historical floral checklists of the North Frisian island Amrum were compared to determine how the environment of the island has changed over the past half century. Ellenberg indicator values and habitat preferences of colonising and extinct vascular plant species were used to show that the island has not escaped the ruderalization of habitats that has occurred in many places across Northern Europe. The most significant changes appear to be a result of planting conifer woodland on the island during the early 20th century.

Flora, colonisation, extinction, ruderalization, afforestation

INTRODUCTION

Since the 19th century it has been popular to create floral checklists. These checklists were made with little concern for their future scientific use, yet they are a unique resource for comparing our current environment with that of the recent past. These lists can be analysed qualitatively by comparing the habitats species grow in and quantitatively by using Ellenberg's indicator values (Ellenberg et al. 1992). Through such an analysis, one can determine changes in the local environment that have not only influenced vegetation but also will have affected the local fauna.

Botanists have documented Amrum's flora regularly for many years. Being such a small island (±20 km²), it is relatively easy to survey and has well-defined limits. Christiansen (1961) published a comprehensive checklist of the flora of Amrum covering the years 1930 to 1960. He also summarized earlier accounts. A survey was conducted for the Atlas of the Flora of Schleswig-Holstein some time between 1958 and 1985 (Raabe 1987), then, another checklist was published covering the period 1987-1992 (Türk 1994). After over half a century of such checklists, now is a good time to make updates and evaluate what these

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Table 1 A selection of notable additions to the flora of Amrum. A full annotated checklist can be found at www.reticule.co.uk/flora/amrum.

Species name	Notes
Alliaria petiolata	Recorded from Sylt in the last 50 years and common elsewhere in Schleswig-Holstein.
Anisantha sterilis	Currently, localised to one small area. Previously recorded on the neighbouring islands of Sylt and Föhr. Common in towns elsewhere in Schleswig-Holstein.
Circaea lutetiana	Common in eastern Schleswig-Holstein, but here confined to one small area within a plantation.
Epilobium ciliatum	First collected in North America in 1891 and introduced to Europe at the beginning of the 20th century. Its European range is still expanding.
Epilobium parviflorum	Common across mainland Schleswig-Holstein.
Epipactis helleborine	Represented by only one plant.
Geranium dissectum	Recorded on Föhr previously and common on mainland Schleswig-Holstein.
Geum urbanum	Rare on Amrum, but it has been recorded on Föhr and is common elsewhere Schleswig-Holstein.
Glaucium flavum	Very rare in Schleswig-Holstein. The Atlas der Flora Schleswig-Holsteins und Hamburgs (Raabe 1987) shows only two sites, one on the neighbouring island of Sylt. The seeds were probably introduced in flotsam from the sea.
Glechoma hederacea	A common species in mainland Germany and present on the neighbouring islands of Sylt and Föhr.
Impatiens parviflora	Localised to one plantation, but likely to increase. It was first recorded in Schleswig-Holstein in 1865 and is still spreading.
Malva moschata	A common species in mainland Germany and present on the neighbouring islands of Sylt and Föhr.
Mycelis muralis	An actively colonising species of dry woodland and walls.
Ononis repens	Represented by just one plant and possibly introduced in grass seed. It has been recorded on Sylt and Föhr previously.
Oxalis corniculata	Increasing its range across northern Europe, rarely found away from human habitation.
Papaver somniferum	Introduced into Northern Europe as long ago as the Bronze age. Its seeds can remain in the seed bank for a considerable time. It may have been ignored in previous surveys as a casual garden escape.
Scrophularia nodosa	Common in eastern Schleswig-Holstein.
Symphoricarpos albus	Probably originally planted, but it suckers and has formed large stands in pine plantations.
Verbascum nigrum	Represented by only one specimen, but the seed of Verbasum species are long lived. Common elsewhere in Schleswig-Holstein.
Vulpia myuros	An archaeophyte in northern Europe, but still expanding its range.

can tell us about the recent changes in the flora of this island.

Compared to many areas of Northern Europe, recent environmental changes on Amrum have been quite modest. There has been a continued intensification of agriculture and abandonment of traditional farming practices. Yet, there has also been a greater awareness of nature conservation and the consequent establishment of nature reserves. An increase in tourism has led to increased water use, house building and traffic. Also, there has been a rapid afforestation of some of the island with conifers.

METHODS

To update the checklists of the flora of Amrum surveys were conducted between the 2nd and 14th July 2005, 1st and 14th July 2006 and 17th and 31st August 2007. All parts of the island were visited systematically. Each 1 km^2 was visited and an effort was made to visit uncommon habitats. The resulting checklist is available on the Internet (www.botanical-keys.co.uk/flora/amrum). The analysis was conducted on a subset of data excluding hybrids, entirely planted and casual species. Critical genera such as *Rubus* and *Taraxacum* were treated as single aggregate species. Where more than one subspecies of a taxon was present they were kept separate, as long as Ellenberg indicator values were available for both subspecies. Otherwise, they were considered at the species level.

No specific set of Ellenberg indicator values is available for Schleswig-Holstein, though there are comprehensive lists available for Central Europe (Ellenberg et al. 1992) and the United Kingdom (Hill et al. 2004). The analysis was done using both datasets and the same results were reached even though the absolute values were slightly different. Only the results using the Central Europe data are presented here. The values for Central Europe were used from the database maintained at the University of Vienna (www.boku.ac.at/statedv/edvbotanik/). Species were separated into two groups; those that had been recorded between 1930

Table 2 A summary of the total number of taxa in each group used for the analysis. The degree of endangerment follows Mierwald and Beller (1990).

	Number of taxa	Species endangered in Schleswig-Holstein (%)
Total 1930-1985	516	26.0%
Total 1987-2006	529	18.7%
Extinct taxa	79	55.7%
Colonising taxa	92	6.5%

and 1985 combining the checklists of Christiansen (1961) and Raabe (1987) and those that had been recorded between 1987 and 2007 combining the current survey with the checklist of Türk (1994) and miscellaneous records from Petersen (2000). Species not recorded since 1985 were assumed extinct, whereas species only recorded after 1987 are assumed colonists. It was considered a better approach to combine checklists to reduce the effects of recorder bias and misidentification.

RESULTS

The survey of the flora revealed many new species previously unrecorded on Amrum (Tab. 1) and several that had not been recorded for more than 50 years. Most of these species are common elsewhere in Schleswig-Holstein and many have been recorded from the neighbouring islands of Sylt and Föhr. Some of these recently colonising and rediscovered species are native to the mainland, for example *Glyceria fluitans* and *Silene dioica*, while others are introductions to Europe that have been expanding their range, for example *Epilobium ciliatum, Impatiens parviflora* and *Oxalis corniculata*. None of these recent additions to the flora are common on the island and some such as *Lobularia maritima* are probably just casual introductions. A few are well established in small areas and could spread, for example *Vulpia myuros* and *Impatiens parviflora*. A small number of species were originally planted on the island but are now spreading independently. A spectacular example of this is *Prunus serotina*, which is now abundant. Planted trees were ignored by previous authors, so it is difficult to judge when exactly these species naturalised. Extinctions and colonisations are difficult to prove absolutely. Yet, although some errors are likely, the number is likely to be small.

In general, extinctions have been of species that are endangered in Schleswig-Holstein (Tab. 2). Those few extinct species that are common on the mainland were probably never common on Amrum (e.g., *Atriplex glabriuscula*, *Rhynchospora fusca*). Overall, there has been a slight increase in the total number of species growing on Amrum. Nevertheless, because the majority of extinctions have been of rare taxa and the colonisations have been of regionally common taxa, the biodiversity of Schleswig-Holstein as a whole has been impoverished.

When the Ellenberg indicator values of extinct and colonising species are compared, no significant difference is found in the indicator values for reaction (R) or for temperature (Fig. 1). This analysis of the Ellenberg indicator values for extinct and colonised species exposes a drying ($P < 0.05$) and shading ($P < 0.001$) of the island's habitats (Fig. 1). Colonisers have an average nitrogen index that is higher than that of extinct species ($P < 0.001$, Fig. 1).

Extinctions and colonisations are not uniform across habitats (Fig. 2). Colonisation of the woodlands and plantations by shade-loving plants has been dramatic.

DISCUSSION

Increased human water use on the island has been mentioned previously as an important environmental change (Türk 1994). However, the lower light requirements of the colonisers points to the growth of woodlands and plantations as being of at least equal significance. Indeed, planting of trees will locally increase water use and lower the water tables (Cannell 1999). Pines were first planted on Amrum in the late nineteenth century and increased gradually (Türk 1994). After the Second World War, an increase in planting occurred to bring the total area to what it is today (185 hectares; about one tenth of the islands area). Fur-

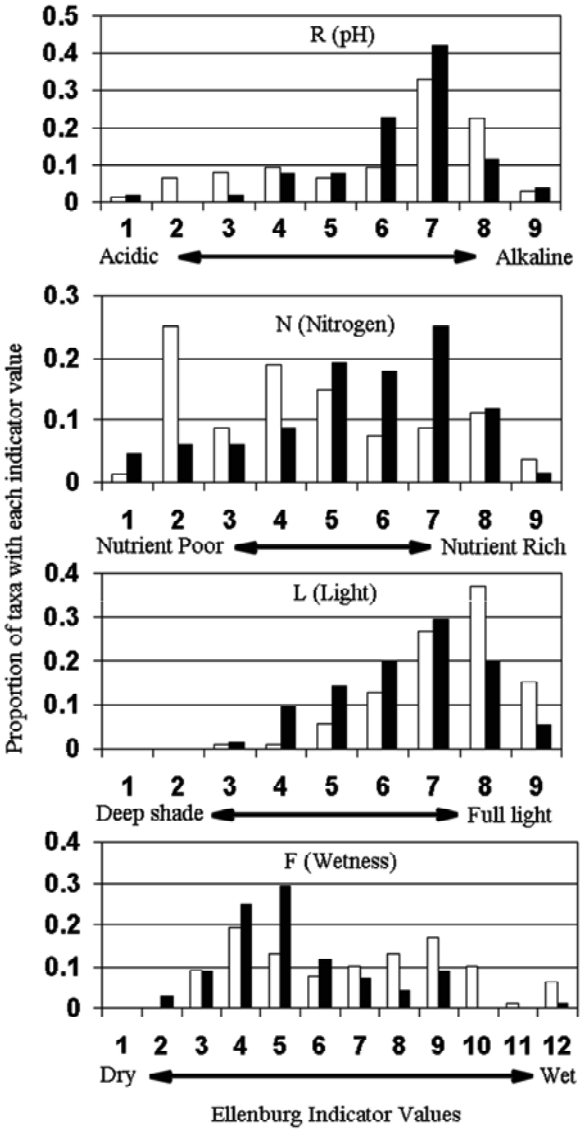

Figure 1 Proportion of colonizers (solid bars) and extinctions (open bars) with each Ellenberg indicator value. Mann-Whitney U Tests showed significant differences ($P < 0.001$) between the distributions of Ellenberg indicator values for L (Light), F (Wetness) and N (Nitrogen). No significant difference was found between the distributions of indicator values of R (pH) or T (temperature, not shown).

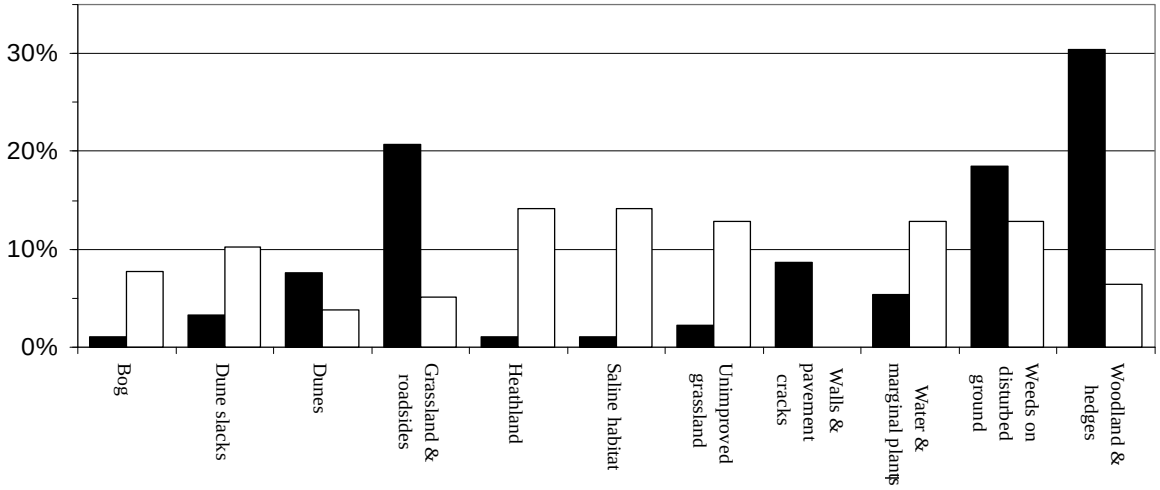

Figure 2 The percentage of colonising taxa in each habitat (solid bars) and the percentage of extinct taxa (open bars) in each habitat.

thermore, abandonment of grazing on some areas has led to the successional development of semi-natural woodland.

The higher nitrogen index of colonisers (Fig. 1) is consistent with other studies of recent vegetation change in Europe (Preston et al. 2000). Numerous extinctions have occurred in nutrient poor habitats such as bogs, heaths and unimproved grassland, yet, at least to some extent, nutrient poor soils still exist on Amrum, but now trees often cover them. Soil fertility has probably increased for a number of reasons, for example agricultural fertilisers, human waste and atmospheric nitrate deposition.

The limited physical area of Amrum makes its populations more susceptible to extinction. However, it is interesting that Amrum's apparent isolation, as an island, appears not to have restricted the colonisation of new species.

Apart from those habitats affected by afforestation, the only other group to have suffered more extinctions than colonisations are those of saline habitats. Some extinct species such as *Atriplex glabriuscula* and *Atriplex laciniata* are strand-line plants of which there are few species on Amrum. Other extinctions in saline habitats have been of plants requiring brackish conditions, for example *Ruppia maritima, Schoenoplectus triqueter* and *Apium graveolens*. There is no clear reason for the extinction of these species, but it does imply a loss of brackish habitat. Perhaps, more active land drainage and coastal defence work has eliminated small brackish ponds that these species require. They may have also suffered from an increase in wildfowl numbers. Geese and ducks graze, soil and muddy these ponds while roosting.

Evidence from extinctions and colonisations indicates that afforestation has been an important cause of habitat change on Amrum. Not only has the growth of woodland created

new habitat for colonisers, but it has also caused the loss of species-rich habitats such as heath and dune slacks. There has also been an increase in the average fertility of the habitats. Before the afforestation of Amrum, woodland plants such as *Circaea lutetiana, Glechoma hederacea* and *Dryopteris carthusiana* would not have found suitable habitats. In parallel, disproportionate extinctions have occurred in heath, bog and dune slacks, precisely the same habitats that are now often covered by trees.

Over fifteen years ago, Türk (1994) called for various improvements in the management of Amrum's flora. These improvements included removal of conifer plantations, reinstating grazing and turf cutting on heaths, and reducing the use of ground water. These management changes are still required or conservation-worthy habitat will continue to disappear. Although planting of new forests has ended, the remaining heaths and ungrazed grasslands are gradually being colonised by trees. If the rare plants of these habitats are valued, then some form of management change will be required to conserve them.

REFERENCES

Cannell, M. G. R. (1999): Environmental impacts of forest monocultures: water use, acidification, wildlife conservation, and carbon storage. New Forests 17, 239-262.

Christiansen, W. (1961): Flora der Nordfriesischen Inseln. Verlag Cram, de Gruyter & Co., Hamburg.

Ellenberg, H. Weber, H. E., Düll, R., Wirth, V., Werner, W., Paulißen, D. (1992): Zeigerwerte von Pflanzen in Mitteleuropa. Scripta Geobotanica 18, 1-248.

Hill, M. O., Preston, C. D., Roy, D. B. (2004): PLANTATT – Attributes of British and Irish plants: Status, size, life history, geography and habitats. Centre for Ecology & Hydrology, Huntingdon.

Mierwald, U., Beller, J. (1990): Rote Liste der Farn- und Blütenpflanzen Schleswig-Holsteins, 3. Fassung. Stand: September 1990. Landesamt für Naturschutz und Landschaftspflege Schleswig-Holstein, Flintbek.

Preston, C. D., Pearman, D. A., Dines, T. D. (2002): New Atlas of the British and Irish Flora. Oxford University Press, Oxford.

Raabe, E. W. (1987): Atlas der Flora Schleswig-Holsteins und Hamburgs. Wacholtz Verlag, Neumünster.

Türk, W. (1994): Flora und Vegetation der Insel Amrum – Bestand, Wandel, Gefährdung. Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein 64, 17-90.

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