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The initial effects of afforestation on the ground-dwelling spider fauna of Irish peatlands and grasslands

Anne G. Oxbrough *, Tom Gittings, John O'Halloran, Paul S. Giller, Tom C. Kelly

Department of Zoology, Ecology and Plant Science, Cooperage Building, University College Cork, Distillery Fields, North Mall, Cork, Ireland

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Abstract

Across Europe, the majority of afforestation is carried out on former agricultural land. Given this current planting trend it is important to assess the impact that afforestation will have on the flora and fauna of habitats typically used for afforestation. The study aim was to investigate the initial effects of afforestation (5 years after planting) on the ground-dwelling spider fauna within three habitats (peatlands, improved grasslands and wet grasslands) in Ireland. A paired sampling approach was used where 24 pairs of unplanted and planted sites (eight within each habitat type) were matched for habitat, vegetation type, soil properties, and geographical location. The planted sites were comprised of 5-year-old stands of Sitka spruce (*Picea sitchensis*). Within each habitat pitfall traps were established in areas of vegetation cover representative of the site as a whole, as well as in supplementary features which may also contribute to the biodiversity of a site, for instance in hedgerows, wet flushes, and the edges of ditches or streams.

During the study 33,157 spiders were collected in 189 species and 18 families. Forty species sampled were associated with open habitats whereas 15 species were associated with forested habitats, 54 species were associated with wet habitats whereas two species were associated with dry habitats. Across the habitats fewer wet-associated species and fewer rare species were supported after afforestation. In particular areas of wet flush in the peatlands supported a unique and diverse spider fauna which was lost after afforestation. In contrast, the planted improved grasslands were more species rich, and supported a greater number of spider species associated with low vegetation than comparable unplanted sites. The hedgerow spider fauna did not differ notably in assemblage composition between the unplanted and planted sites. This study suggests that even in the early stages of the forest cycle (first 5 years) there is a change in the spider fauna, with the rare or specialist species being replaced by habitat generalists or species associated with forested habitats. It is also suggested that peatlands are particularly sensitive to afforestation, indicating that in terms of biodiversity loss, this habitat is the least suitable for afforestation.

Keywords: Spiders; Afforestation; Sitka spruce; Peatland; Grassland; Habitat specialists

1. Introduction

Afforestation causes major changes in both the abiotic and biotic aspects of an ecosystem. During the forest plantation cycle, as the habitat changes from an open to a forested environment, the greatest changes in the flora and fauna occur when the canopy closes (Wallace and Good, 1995; Humphrey et al., 1999; Jukes et al., 2001; Oxbrough et al., 2005). However, during the early stages of afforestation the silvicultural processes which take place (i.e. land preparation, chemical application, soil drainage) as well as the inevitable change in land-use that occurs (i.e. grazed to non-grazed land) are also likely to influence the organisms present.

Previous research examining the initial affects of afforestation on habitats has documented changes in soil properties (Bellot et al., 2004; Farley and Kelly, 2004), vegetation composition (Wulf, 2004), and bird diversity (Allan et al., 1997). There has however been less investigation of these effects on invertebrates, despite their prevalence in terrestrial ecosystems and importance in food webs. Spiders are a large group of terrestrial predators which are primarily affected by changes in habitat structure (Uetz, 1991). They can disperse aerially (Richter, 1970) as well as over land, giving them the ability to colonise habitats relatively quickly compared to other groups of invertebrates with a more sessile nature. This suggests that environmental changes, which occur over a relatively short period of time, for instance the first few years

* Corresponding author. Tel.: +353 214904677; fax: +353 214904664.
E-mail address: aoxbrough@hotmail.com (A.G. Oxbrough).

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after afforestation, may be reflected by changes in the spider fauna.

Across Europe the majority of afforestation is carried out on former agricultural land (UNECE, 2003). Indeed, 90% of current Irish afforestation is carried out by agricultural land owners (Teagasc, 2005). Given these current planting trends it is important to assess the impact that afforestation has on the organisms which are found in pre-planting habitats, particularly less disturbed habitats of more limited extent. With this in mind the present study aimed to investigate the initial effects of afforestation on the ground-dwelling spider fauna within three habitat types: peatlands, improved grasslands and wet grasslands, which are typically used for afforestation in Ireland.

2. Methodology

2.1. Study areas and sampling design

A paired sampling approach was used in the present study. Ideally, researchers should be able to survey a location both before and after the event being investigated (Before–After–Control–Impact design: Green, 1979). However for investigations involving land-use changes such as afforestation, which take place over many years, a sampling design which tracks sites over time is difficult to implement. Paired-site sampling designs have been successfully utilised in previous research (Kladivko et al., 1997; Berger et al., 2002; Barnett et al., 2004). This approach was adopted in the present study to allow the influence of afforestation on ground-dwelling spider assemblages to be investigated over the course of one field season rather than over several years.

Ground-dwelling spider assemblages were surveyed in the following habitats: peatlands, improved grasslands, wet grasslands. Twenty-four matched pairs of unplanted and planted sites (eight within each habitat) were selected on the basis of habitat, soil type, and geographical location. The site-pairs within each habitat type were widely distributed across Ireland, although improved grassland sites were grouped in the south-east (Fig. 1). Where possible the paired sites were adjacent to each other, although three of the pairs were separated by 1–5 km. The habitat type of the planted sites prior to afforestation was determined by consultation with land owners, foresters' records

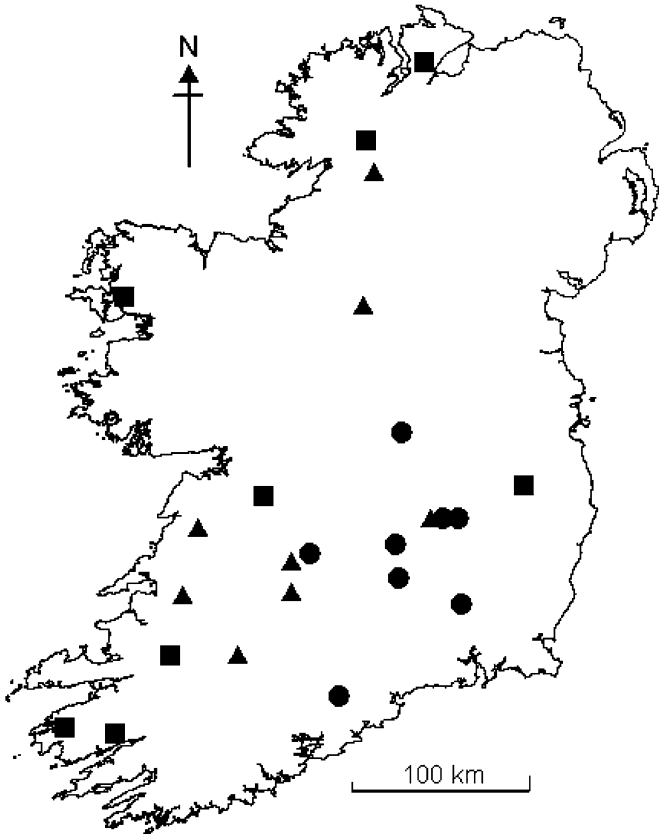

Fig. 1. Distribution of paired study sites across Ireland within the following habitats: (●) improved grassland; (▲) wet grassland; (■) peatland.

and the vegetation present at the site. The planted sites were comprised of 5-year-old stands of Sitka spruce (*Picea sitchensis*), which is currently the most widely planted tree species in Ireland, accounting for 65% of annual afforestation (Teagasc, 2005).

General environmental and habitat characteristics of the habitats surveyed are shown in Table 1. The management regime varied among the habitat types: the unplanted improved grasslands were subject to heavy grazing and were usually fertilised at least once per year. The peatlands and wet grasslands were generally under low to heavy grazing pressure, however approximately half of the wet grasslands were also

Table 1
Environmental and habitat characteristics among the habitats and planting types (U, unplanted; P, planted); mean ± S.D. and range of altitude is shown

Fossitt (2000) habitat type	Soil type	Altitude (m)	Drainage	Common plant species
Peatland (U)	Peat	143 ± 78, 20–250	Poor	*Molinia caerulea*, *Calluna vulgaris*, *Eriophorum angustifolium*, *Eriophorum vaginatum*, Sphagnum mosses
Peatland (P)	Peat	136 ± 73, 15–225	Moderate	*Molinia caerulea*, *C. vulgaris*
Wet grassland (U)	Gley	100 ± 42, 45–175	Moderate	*Juncus acutiflorus*, *Juncus effuses*, *Agrostis stolonifera*, *Molinea caerulea*
Wet grassland (P)	Gley	101 ± 53, 45–190	Moderate	*A. stolonifera*, *J. acutiflorus*, *J. effusus*, *Holcus lanatus*, *Molinea caerulea*
Improved grassland (U)	Brown earth/brown podzolic	164 ± 79, 45–300	Good	*Lolium perenne*, *A. stolonifera*, *H. lanatus*, *Cynosurus cristatus*
Improved grassland (P)	Brown earth/brown podzolic	166 ± 78, 45–290	Good	*A. stolonifera*, *H. lanatus*, *Elytrigia repens*, *Festuca rubra*