THE COLONISATION OF AN AREA OF RESTORED CHALK DOWNLAND BY SPIDERS (ARANEAE)

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Abstract

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Changes in both the plant and spider communities have been recorded on a 1.5 hectare area of restored downland that was previously arable. The restoration involved the relocation of turf of both high and lower species diversity from the route of the new road using a newly developed technique, and three different seed mixes. Both pitfall trapping and D-Vac sampling have been used, but only the pitfall trap data is used here. The spider data used is from 14 109 individuals representing 65 species. Sampling and botanical survey were carried out in 1993-1996 and 1998, and will be repeated in 2000 and 2002. As the downland sward has developed and the amount of bare ground has decreased there has been a rapid decrease in the number of highly mobile, early colonising species which is mirrored by rapid increase in cursorial species. The latter have already reached a peak and are now declining to numbers more typical of mature downland. The spider communities on the different treatments in each year have been analysed using CANOCO. This shows how the five communities have changed and converged over the six year period.

Introduction

Habitat restoration and creation is a subject that is of growing importance throughout the world but particularly in Europe (ENGLISH NATURE, 1992; GREEN, 1995; JARMAN 1995; SCOTT, LUSCOMBE, 1995; SHEAIL et al., 1997; URBANSKA, GRODZIŃSKA, 1995; WELLS, 1981). Proposals for dramatic changes in funding for agriculture may offer opportunities to return considerable areas of “marginal” farmland to semi-natural habitats. It is therefore vital that the mechanisms of colonisation, both botanical and invertebrate, are understood so that appropriate methods can be formulated should these opportunities arise.

Since 1990, the Institute of Terrestrial Ecology at Furzebrook Research Station in Dorset, UK has been involved with a controversial, high profile project to build the last linking part of the M3 motorway through Twyford Down near Winchester. Our remit was to act as ecological advisers on a day to day basis and also to organise the restoration to chalk downland of some seven hectares of land, half of which had been arable and the rest re-landscaped land on a now disused road. This followed the findings of the 1987 Public Inquiry into the scheme. We were also to monitor the restoration for a period of ten years from the initial restoration both to assess the success of the methods and to feed back information to the site management. The land was released to us for restoration in three parts over three years, two of these are on the arable land and the third is the re-landscaped route of a road superseded by the motorway. Botanical monitoring is being carried out on all three areas. Invertebrates are being monitored on the two ex-arable sites and a Standard Butterfly Transect (as used by the National Butterfly Monitoring Scheme) covering all three restoration areas plus the adjacent SSSI, is walked every week throughout the annual study period. The monitoring takes place on years one, two, three, four, six, eight and ten following the restoration.

This paper presents an initial analysis of six years of colonisation by spiders of the first site to be restored. Although the spiders form only a relatively small part of the fauna they are interesting in that being mostly generalist predators they are not linked to the downland flora as are many groups that are species specific herbivores. Even so an initial analysis shows that the development of the spider fauna closely tracks certain physical aspects of the developing downland sward. These results are given along with those for certain species groups and "guilds" or functional groups.

Study area

The study described here is being carried out on part of a 3.5 ha area of land (Fig. 1) on top of Twyford Down near Winchester in Hampshire, southern England. The land had been arable for many years and was adjacent to the St Catherine's Hill reserve managed by the Hampshire Wildlife Trust. The reserve was also designated as a Site of Special Scientific Interest (SSSI) by English Nature. In the winter of 1992, the first 1.5 ha of this was released by the main motorway constructor for restoration. This area, referred to as Arethusa A, is roughly triangular (Fig. 2) in shape with ancient hawthorn, *Crataegus monogyna*, scrub along the western edge and the deep cutting of the new road along the south-eastern edge. The northern edge connects with the arable site which was released for restoration in the following winter (1993). It also contains a clump of mixed deciduous trees. The aspect varies from north-west to south of south-west. The slope is not steep.

As the site had been arable for many years and had been heavily fertilised, it was necessary to drastically lower the fertility of the soil, downland being necessarily a very low nutrient habitat. To this end all the topsoil was stripped and removed to form a seed bed from the subsoil. A small area of downland turf of varying botanical diversity which was part of the SSSI lay in the path of the construction. This was moved from its original site and laid on the study site, using a technique known as "Macroturfing". This technique accurately cuts and lifts turves that are 2.4 m x 1.2 m and up to 30 cm thick. It has

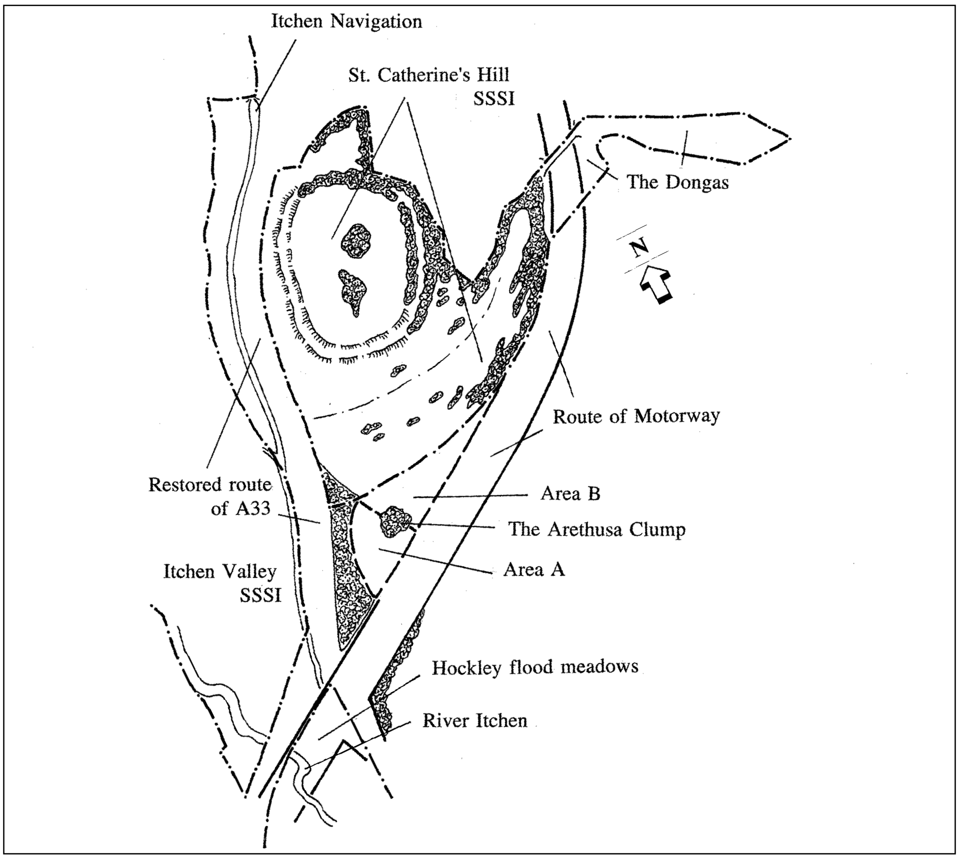

Fig. 1. Map showing restoration areas.

proved to be very successful in such ecological engineering projects due to the thickness of the turf which preserves deep rooted plants such as orchids, burrowing invertebrates and ants nests. The speed of translocation also minimises problems of desiccation and frost damage. The turf was divided into "high quality" species rich turf, HQ and "low quality" less species rich turf LQ. These were laid as two separate treatments, the former being laid in bands to optimise the influence of the turf. The area not turfed was seeded with three different seed mixes, S1- species rich for a short turf, S2- less species rich for a longer turf and HS a machine collected mix. Where possible the seed was of local provenance (Ward, Stevenson, 1992; Stevenson, Ward, 1993; Stevenson et al., 1994) Mowing was used for management of the site during the first summer but this has now been superseded by sheep grazing, particularly with Shetland and Jacobs Sheep. Detailed descriptions of the restoration are available in various contact reports (Ward, Stevenson, 1994; Snazell et al., 1995).

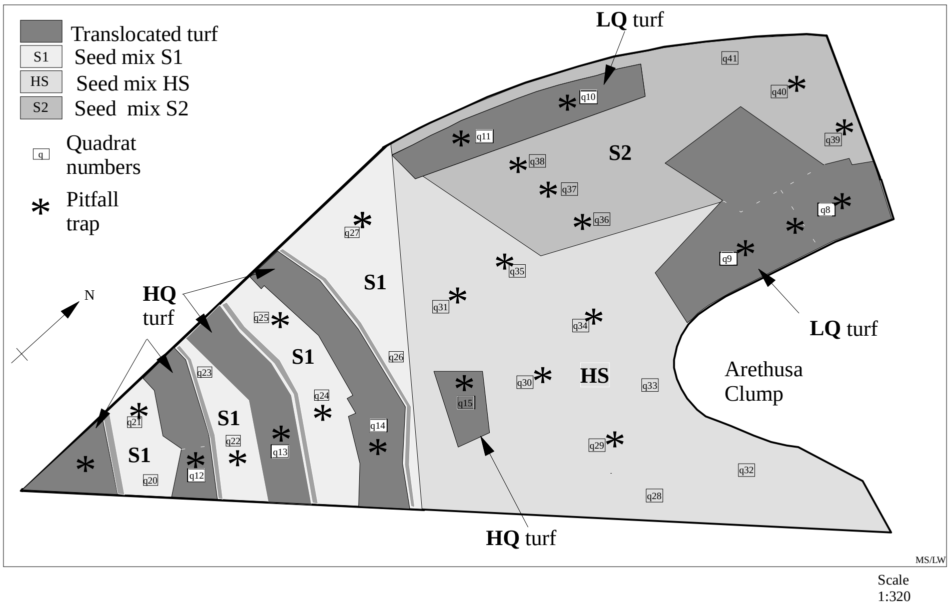

Fig. 2. Layout of Arethusa A restoration area.

Methods

A single pitfall trap, comprising a plastic beaker with a 73 mm diameter mouth containing ethylene glycol to a depth of some 30 mm, was placed at the NE corner of four 1m square fixed botanical quadrats in each of the turfed areas and five in each of the seeded treatments. The traps are deployed from early June to early October and are serviced at monthly intervals. Although only the Araneae are dealt with in this paper, the Coleoptera, Hemiptera, Mollusca and ants also form part of the main study. The problems that can occur when interpreting statistical data from pitfall traps have been discussed many times (Bell et al., 1997; Framenau, 1998; Snazell, 1982; Topping, Sunderland, 1992; Uetz, Unzicker, 1976). However, the method remains the only practical option for studies such as this and within certain limits can give meaningful results. D-Vac sampling is also part of the study, although that data will not be used in this paper.

Results

Two main functional groups or "guilds" dominate the changes in the spider communities on the site. These may be defined as the early colonisers which appear in large numbers very early in the first year and then quite rapidly diminish. These species are all able and common aeronauts. The other group are the cursorial species which are best typified by the Wolf spiders of the genus *Pardosa*. The early colonisers are identified for this study as the three *Oedothorax* species, *O. fuscus* (Blackwall), *O. retusus* (Westring) and *O. apicatus* (Blackwall), *Milleriana inerrans* (O. P.-Cambridge), the two *Erigone* species, *E. dentipalpis*

(Wider) and *E. atra* (Blackwall), and *Meioneta rurestris* (C. L. Koch). The arrival of these common aeronauts in very large numbers shortly after major disturbances has been seen on many occasions in cases of heathland burning for management (Merrett, 1976), clear cutting of woodland (Snazell unpublished data) and many others. In many cases the great majority of these spiders are *Erigone* and *Oedothorax* species. Occasionally very large numbers of *Lepthyphantes tenuis* (Blackwall) and *Savignia frontata* (Blackwall) (Duffey, 1956) and also *Bathyphantes gracilis* (Blackwall) (Snazell, unpubl.) have been recorded but although appearing rapidly on disturbed sites do not then virtually disappear as do the species previously mentioned. The mechanism that allows this remarkably rapid response to changes in an area of habitat is unclear.

In the study area distinct differences were seen between the turf and seeded areas (Fig. 3). Numbers taken on the seeded areas in the first year, 1993, were far higher (124.9 individuals per trap) than on the turf (33.9). However, by 1996, when the bare ground on the seeded areas had decreased to from its high of 51.3% in 1993 to 6.5% both the seeded and turf numbers had dropped to below two per trap. During the same period the aeronaut numbers on a nearby control had consistently run at below three per trap. We consider that the numbers of aeronauts found in the turf traps are probably due to "over-spill" from the seeded areas on to the relatively small area of turf.

A more detailed examination of the *Oedothorax* species reveals an interesting picture (Fig. 4). It is usually considered that the arrival of spiders on a particular area is probably serendipitous. However, in this case, the catch in 1993 was dominated by 183 specimens of *O. apicatus*. By 1994 this species had declined to a very low level, 15 and by 1995 had all but disappeared. Conversely *O. retusus* appeared in 1993 in reasonable numbers – 45 but peaked in 1994 at 158 and has declined since. By 1996 a total of 3 *Oedothorax* were taken on the whole site and by 1998 they had gone. We considered this to be a matter of chance until the same succession of species was shown on the second Twyford Down site, Arethusa B, which is running a year behind Arethusa A. Do these finding suggest a successional colonisation within the genus *Oedothorax*?

The rapid appearance and equally rapid decline of the early colonisers mentioned above is mirrored by the much slower colonisation by the cursorial species (Fig. 5) which on this site are best exemplified by the *Pardosa* species. In fact, although six species of *Pardosa* are represented, *P. palustris* (Linnaeus) and *P. pullata* (Clerck) dominate the catch with 97%. Numbers rose slowly from the first year when they represented only 2.0% of the spider population, to reach very high levels in 1996, when they represented over 71%. However by 1998 their numbers had started to show a decline and it is expected that over the next few years they will start to occur in numbers more in line with those typical of mature downland.

The effects of the various treatments, seeding (S1, S2, S3) and turf translocation (LQ and HQ) on the successional trends in the spider communities were assessed using the multivariate ordination technique of Canonical Correspondence Analysis (CCA) using the CANOCO software package (Ter Braak, 1988). The ordination was based on the log abundances of each spider species for each individual trap in each study year. The key features of the vegetation in the quadrat adjacent to each pitfall trap, as perceived to

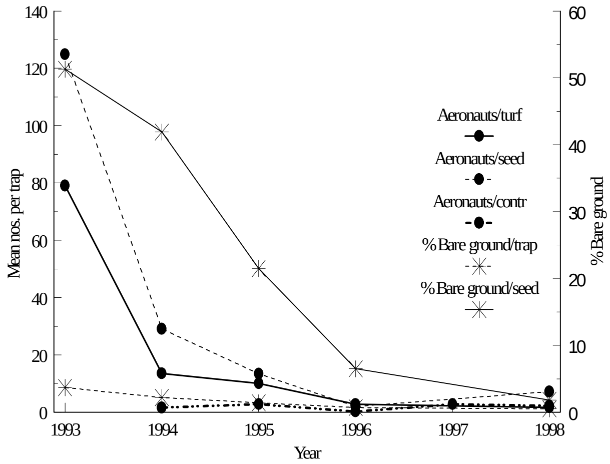

Fig. 3. Mean numbers per trap of aeronauting spiders taken in pitfall traps on the turf, seeded and control areas 1993–1998. Percentage bare ground is also shown.

influence spider species distribution, were represented by four variables: the percentage of bare ground, percentage cover of "moss", mean vegetation height and the number of plant species in the quadrat. The variables chosen were thought to be most relevant to spiders in a changing downland habitat. From a previous study (SNAZELL, 1982) it was clear that apart from soil moisture, structural elements of the habitat were the most important factors in determining spider habitat preference. We consider that the geology and topography of this site mean that soil moisture will be largely homogeneous throughout and will therefore have little differentiating effect on the spider fauna. CCA find ordination axes which account for as much as possible of the variation in spider compo-

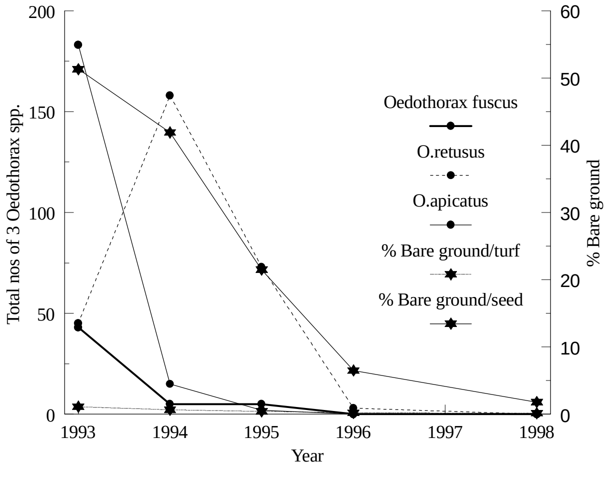

Fig. 4. Total numbers of 3 *Oedothorax* sp. taken in pitfall traps on the turf, seeded and control areas 1993–1998. Percentage bare ground is also shown.

sition between traps which can be “explained” by relationships with the vegetation characteristics of the adjacent plot. Traps are placed close together on the ordination axes if they have (relatively) similar spider communities. The direction arrows on the plot for each vegetation variable indicate its association with the axes (longer arrows indicate stronger correlations). The positions of the five traps for any particular treatment in any one year have been averaged for clarity.

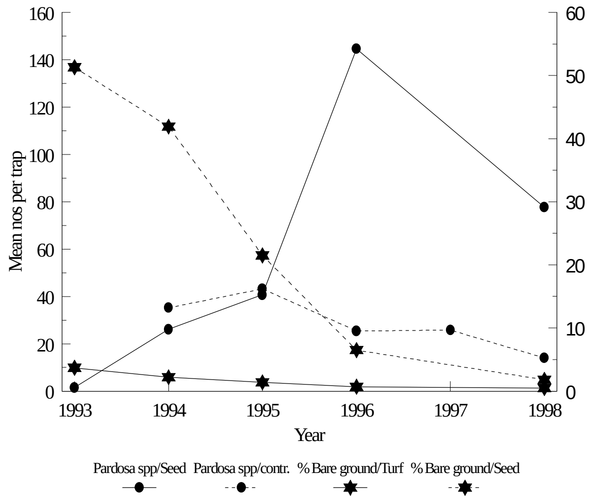

Fig. 5. Mean numbers per trap of *Pardosa* spiders taken in pitfall traps on the turf, seeded and control areas 1993–1998. Percentage bare ground is also shown.

Discussion

In Fig. 6, the successional trends in the spider communities can be followed over the period of the study so far (1=1993, 2=1994, 3=1995, 4=1996 and 6=1998). Very clear temporal patterns can be seen, with distinct differences between all the sites initially. As would be expected the turfed areas plot closer to each other than to the seeded in the first year, the seeded areas and their spider fauna scoring very strongly on the Bare Ground axis. The turfed areas have a much higher score on the Moss axis. The use of % cover of moss is a first attempt to find a character which can be used to typify the complexity of a “mature” sward. In later years the quantities of bare ground and the spider species associated with it decrease as the numbers of plant species and their cover increases. By 1996 (4) all the treatments plot relatively closely together as the they and their spider communities converge and by 1998 form a very tight group with an increase on the Moss axis. It is expected that, over the last four years of the study, the plots of the treatments will become ever more closely grouped as the whole site becomes more homogeneous, but that they will move further along the Moss axis as they mature and build up a more

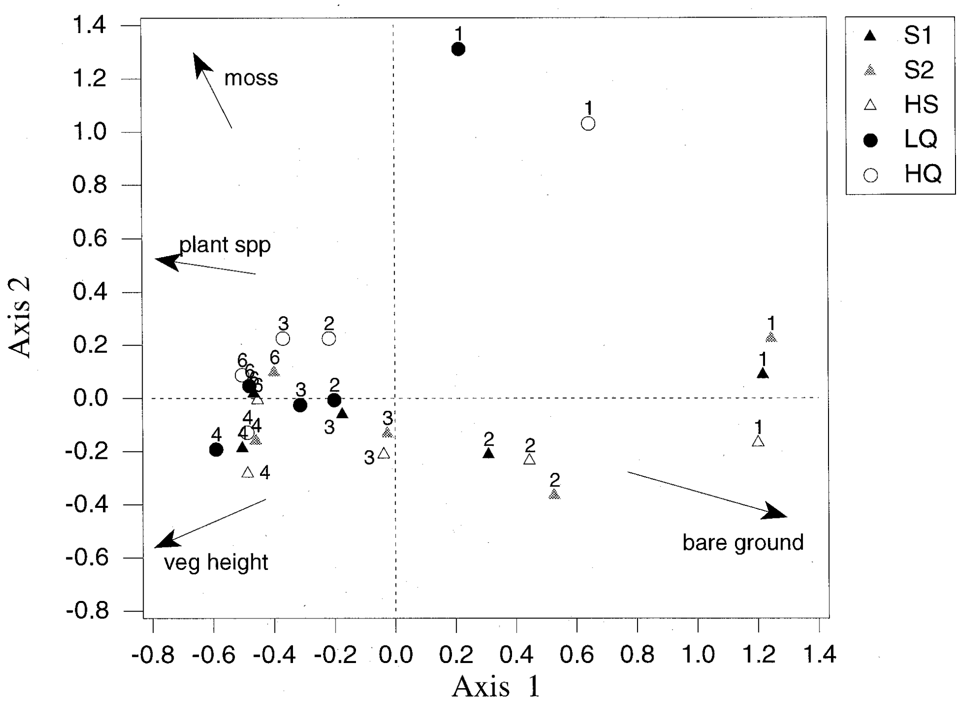

Fig. 6. CANOCO ordination showing successional trends in spider communities on each treatment. 1993–1998.

complex structure. However it is unlikely that they will become identical to the original translocated turves as there are necessarily differences in both aspect and hydrology. Obviously the "natural" development of the site is greatly affected by the management that is applied. In fact, chalk downland is a plagio-climax and therefore much of the nature of the sward and the fauna it carries is determined by the management. In 1996 the effect of a reduction in grazing and the resulting increase in the average vegetation height can be readily seen. Finally it will be possible to survey adjacent areas of mature, ancient downland using the same methods in order to place the newly created grassland in its true context.

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