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The spider community of a northern German heathland: faunistic results

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Summary

The spider community of a northern German heathland nature reserve was investigated from 22 April 1992 to 6 October 1993 using pitfall traps. 8695 adult individuals belonging to 137 species were collected. The comparison of the spider communities of various interlocking patches of different forms of heath habitats showed significant differences in species composition. The importance of certain aspects of the vegetational characteristics of certain forms of heathland for the conservation of the typical spider community is discussed.

Introduction

Vegetation modifies microclimatic factors of the habitat such as wind, moisture, and solar radiation. It also determines the spatial structure of the habitat (Wise, 1993). Several investigations have demonstrated a close relationship between the communities of plants and spiders (e.g. Duffey, 1966; Uetz, 1975; Robinson, 1981; Abraham, 1983; Greenstone, 1984).

The objective of this investigation was to determine if and how the species composition of the spider community differs in various patches of heath habitat with respect to phases of life cycle (e.g. age, height, and cover of *Calluna vulgaris*), soil moisture, grass cover, and growth of trees.

The typical heathland of the north-west German lowland grows on dry and acid soils and is dominated by *Calluna vulgaris*. It was man-made by following a particular agricultural regime: about 6000 years ago people started to drive back the forest by grazing and clearing. In the open areas thus created, *Calluna vulgaris* could spread. These *Calluna* areas were used as pasture for sheep, the plants were cut and sods of the surface humus were removed for use as burning material, fertilizer, or bedding for animals (Gimingham, 1972; Ellenberg, 1986).

During its life span, *Calluna vulgaris* undergoes four stages of development: the pioneer phase with low plants and percentage cover below 20%; the growth and maturity phase, with almost complete cover and maximum height; the degenerate phase after about 25–40 years; and, finally, the entire area of *Calluna* dies. A cyclical generation of the heathland can only take place if the layer of accumulated surface humus is not too thick. Otherwise, the heathland will eventually be replaced by forest (Gimingham, 1972; Ellenberg, 1986).

Through regular cutting and grazing of *Calluna* as described, the development of the heathland was frequently taken back to the pioneer phase. As a result, large areas of *Calluna* could remain for several centuries. During the last two centuries it became unprofitable to cultivate heathland and this marginal type of agriculture was gradually given up. Without management, the heathland will eventually be replaced by forest.

Today, heathland in the north-west German lowland persists only in nature reserves and has to be managed regularly. The management regime basically imitates the former agricultural use of the land. The goal is to create a mosaic of different phases of the heathland life cycle.

Calluna vulgaris dominates heathlands to various degrees. It may be mixed with other plant species depending on environmental conditions and management. *Erica tetralix* may come in under slightly moister conditions (Ellenberg, 1992). Over-intensive grazing will cause the heathland vegetation to become increasingly

Group	Abbreviation
predominantly *Calluna vulgaris*	
pioneer stands	**P**
open heather, building phase	**oH**
old heather, degenerate phase	**dH**
moist heather with *Erica tetralix*, building phase	**mH**
heather with grass	
stands with mostly *Calamagrostis epigeios*	**C**
heather with grasses (*Agrostis, Deschampsia, Festuca*)	**G**
stands with mostly *Nardus stricta*	**N**
forest edge	
border forest /heather	**F**

Table 1: Groups of stands based on the result of the ordination (PCoA).

grassy (Bakker *et al*., 1983). The input of nitrogen through the air seems to weaken the competitive strength of *Calluna vulgaris,* thereby allowing grasses to become more abundant (Steubing & Buchwald, 1989).

Area of investigation

The area of investigation is the Fischbeker Heide, a nature reserve belonging to the city of Hamburg, Germany. It has been a reserve since 1958. Its total area is 773 ha, with about 180 ha covered with heathland, most of which is dominated by *Calluna vulgaris*.

Each year since 1985, single plots ranging in size from 0.5 to 6 ha have been mown. Thereby a mosaic of plots with differing age of heath vegetation has been created.

For the last 10 years the area has been grazed by sheep. The herd comprises about 200 animals. The entire area is intensively used for recreation; part of the heathland is used as a gliding site.

In the area of the gliding site 45 traps were placed into plots which were in different phases of heath life cycle and dominated by *Calluna vulgaris* to varying degrees. These plots are naturally arranged almost like an experimental design: all have the same exposure to the sun (no slope) and are small, adjacent, and interlocked like a mosaic. The youngest heather area was mown at the beginning of 1992, which was also the year of the beginning of this study. This area was in the early pioneer stage. The oldest plot has been untouched since 1945: here the heathland is in its degenerate phase. Most of the area was mown in 1989 and is in the growing phase of heathland. In some parts of the investigation area, grasses were growing mixed with *Calluna vulgaris*; these were mostly *Deschampsia flexuosa, Nardus stricta, Festuca ovina* and *Agrostis tenuis* and, in a clearly delimited area, *Calamagrostis epigeios*. Five traps were positioned along the interface of open heathland and forest consisting of mainly *Pinus* trees. The investigated area was about 4 ha and grazed by sheep.

Methods

The epigeic spiders were collected with pitfall traps from 22 April 1992 to 6 October 1993. The traps consisted of plastic cups with an opening diameter of 7 cm. About one-third of each cup was filled with a mixture of ethanol and glycerol (2:1). The traps were emptied every 14 days, except during the winter when they were emptied every 4 weeks. In total, 45 traps were used.

Results and Discussion

8695 adult individuals belonging to 137 species were collected (Table 2). The spider species composition at each trap location (stand) was compared with that of the others via an ordination (Principal Coordinates Analysis (PCoA), Jongman *et al*., 1987). The comparisons were carried out on the basis of quantitative data. Before the ordination analysis the data were related to the number of sampling days for each trap, standardized, and logarithmically transformed.

Figure 1 shows the result of the PCoA for all stands. The stands located at the edge between open heather and forest (W1–W5) are clearly grouped into a separate cluster which means that they differ in their species composition from all the other stands.

In a second step, the stands at the forest edge were excluded from the analysis. The remaining stands fall into several groups (Fig. 2). Some of these groups correspond with distinct and delimited patches of certain heath habitats in the field—pioneer stands (P), moist heather (APII) and degenerate heather (AH). The other groups,

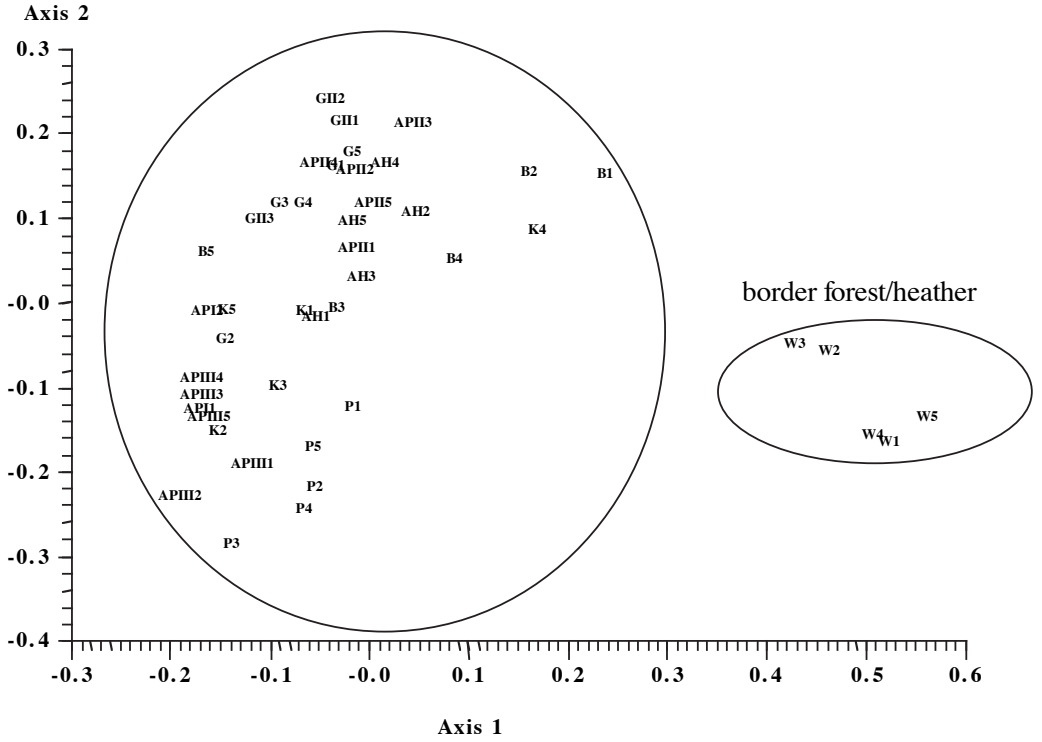

Fig. 1: Ordination diagram of all stands.

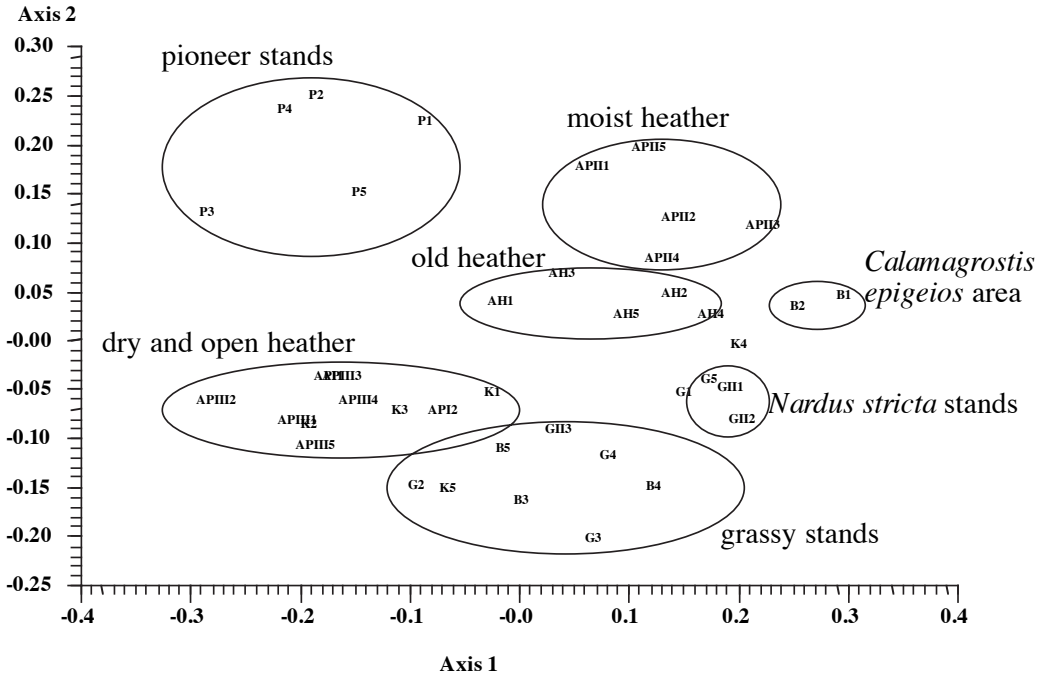

Fig. 2: Ordination diagram of the remaining stands after exclusion of the stands along the border of the forest.

Species name	**P**	**oH**	**dH**	**mH**	**C**	**G**	**N**	**F**	**G1**	**K4**
Aelurillus v-insignitus	1.06	0.84	0.21				0.34			
Agelena labyrinthica	0.41	0.77							1.17	
Agroeca proxima	0.21	0.46		1.23		0.47	1.55	1.12	1.17	
Agyneta decora		0.09			0.63	0.16				1.00
Agyneta subtilis								0.86		
Alopecosa accentuata	9.23	15.05	6.77	16.14	4.52	8.18	11.90	0.22	8.18	
Alopecosa cuneata		0.09	0.62	3.92		0.93	0.76	0.67		2.00
Alopecosa fabrilis	0.84	0.19		0.52		0.34		0.22		
Alopecosa pulverulenta				0.46	6.47	0.35	0.71	1.56	2.34	2.00
Alopecosa trabalis		0.09								
Araeoncus humilis	1.26	2.21	2.56	1.06	1.95	2.24	1.26	0.22	3.51	
Araneus diadematus	0.22					0.16				
Arctosa perita	0.83		0.21	0.27		0.17	0.37			
Asthenargus paganus								0.44		
Attulus saltator	0.64	0.74	0.21							
Bathyphantes gracilis		0.46	0.43		1.37	0.33		0.22		
Bolyphantes luteolus		0.65		0.25	1.89		0.34	0.45		6.00
Centromerita bicolor	0.21	2.29	1.47	1.93	5.89	1.97	3.95	0.67	2.34	6.00
Centromerita concinna	18.23	26.63	59.24	57.24	47.67	32.73	55.62	15.31	63.14	102.00
Centromerus incilium								0.44		
Centromerus prudens	0.42	0.48	0.21	0.53	2.58	0.67	1.92			2.00
Centromerus sylvaticus		0.19	0.21		1.26			0.88		
Ceratinella brevipes			0.21	0.25				0.22		
Cercidia prominens								0.22		
Cheiracanthium sp.	0.42					0.17				
Cheiracanthium virescens	0.63			0.24	0.63	0.15	0.34			
Clubiona diversa						0.34	1.01		1.17	
Clubiona terrestris								0.22		
Clubiona trivialis		0.09	0.43							
Coelotes terrestris		0.10	0.21							
Cryphoeca silvicola								0.43		
Dicymbium tibiale				0.24	1.32			1.08		
Diplocephalus cristatus	0.20									
Diplocephalus latifrons		0.09								
Diplostyla concolor				0.28						
Drassodes cupreus	0.22	0.18		1.01	0.63					1.00
Drassodes pubescens				0.21				0.22		
Enoplognatha thoracica	0.42	0.28	0.21	0.24	0.69	0.47	1.54	2.20		1.00
Episinus truncatus		0.09				0.16				
Erigone atra	17.35	13.60	17.39	14.19	3.95	10.94	6.16	1.08	9.35	1.00
Erigone dentipalpis	2.28	2.00	0.22	0.51		1.63	1.13	0.22		
Erigonella hiemalis	0.21		0.63		4.00	0.50		0.90		2.00
Euophrys frontalis	0.64	0.10		0.24				0.90		
Euophrys lanigera		0.09								
Euophrys petrensis	0.41	1.53	1.30	0.27		0.15		0.66		
Evarcha falcata		0.09						0.44		
Gonatium rubens	0.20							0.45		
Gongylidiellum latebricola								1.09		
Hahnia helveola		0.09								
Hahnia nava	2.33	0.09	0.43	6.44		0.17	0.75	1.57		
Haplodrassus signifer	6.63	5.59	5.94	8.48	9.68	6.71	8.44	18.83	14.03	18.00
Heliophanus flavipes							0.34			

Table 2: Number of individuals per trap in the habitat groups based on the result of the PCoA for the entire sampling period. See Table 1 for abbreviations. Species names, in alphabetical order, follow Roberts (1987).

Species name	P	oH	dH	mH	C	G	N	F	G1	K4
Hypsosinga albovittata				0.27						
Hypsosinga sanguinea				0.25						
Lepthyphantes cristatus								0.21		
Lepthyphantes decolor		0.28				0.48		1.08		
Lepthyphantes ericaeus			0.21			0.15		0.67		
Lepthyphantes flavipes			0.21					0.22		2.00
Lepthyphantes mengei			0.84		0.63			1.79		2.00
Lepthyphantes minutus						0.16				
Lepthyphantes tenuis	0.20	0.27		0.21	1.32		1.01	0.22		1.00
Leptothrix hardyi	1.46	11.70	1.07			0.15				
Linyphia triangularis	0.21						0.37	1.11		2.00
Macrargus carpenteri		0.83	0.21	0.49	3.32	1.49	3.37	1.34		24.00
Macrargus rufus		0.74	0.42	0.25	1.95	0.81	0.71	5.05		9.00
Maso sundevalli						0.17				
Meioneta beata		0.39	0.21	1.23	2.69	0.15	0.37		5.85	3.00
Meioneta gulosa	0.20									
Meioneta rurestris	11.99	5.20	2.96	6.90	11.90	3.63	5.92	0.67	2.34	4.00
Micaria fulgens	0.22							3.14		1.00
Micaria pulicaria					1.37	0.50		4.01		
Micaria silesiaca	4.37	5.37	0.63	2.87		3.82	1.13	0.66	1.17	1.00
Micrargus herbigradus	0.83	0.09	1.29	0.21	1.26	0.33		1.12		
Micrargus subaequalis		0.20				0.17	0.37		1.17	1.00
Microlinyphia pusilla		0.10			0.69					
Minyriolus pusillus								0.44		
Neriene clathrata								0.21		
Neriene furtiva		0.09	0.21							
Oedothorax fuscus								0.22		
Oedothorax retusus	0.21									
Ostearius melanopygius										1.00
Oxyptila scabricula	0.42	3.42	1.27	3.78		1.29	0.37		3.51	6.00
Pachygnatha degeeri		0.19	0.21	1.99	0.69	0.84	3.82			
Pardosa lugubris		0.29	0.22	0.51	0.69	0.34		103.73		3.00
Pardosa monticola	0.83	1.70	0.22	1.47	2.58	7.40	11.33	0.22	1.17	
Pardosa nigriceps	0.21	0.19	0.64	2.13		0.50	1.35	11.30		1.00
Pardosa palustris	9.62	31.42	27.08	104.09	11.40	29.34	72.37	2.69	30.40	10.00
Pardosa pullata	0.64	0.66	5.13	4.95	48.29	3.35	16.66	1.12	9.35	2.00
Pelecopsis parallela	0.21									
Pellenes tripunctatus					0.69	0.86				
Peponocranium ludicrum			0.65					0.45		
Philodromus aureolus								0.67		
Philodromus collinus		0.09				0.17		0.21		
Philodromus histrio				0.27						
Phlegra fasciata						0.32				
Phrurolithus festivus		0.09		0.28	2.00	0.17	0.37			
Pisaura mirabilis				0.46				1.29		
Pocadicnemis pumila				0.25	4.52	0.34	1.05	5.98		
Robertus lividus	0.43	0.18	1.49	0.25		0.16		2.86		
Segestria senoculata								1.11		
Steatoda albomaculata	1.46	0.38		0.28						1.00
Steatoda grossa		0.10								
Steatoda phalerata	0.64	5.15	0.65	1.22	0.69	6.15	4.95	0.22	2.34	2.00
Stemonyphantes lineatus	0.63	1.10	1.25	2.20	4.69	1.15	0.34	4.58	1.17	2.00
Tallusia experta		0.09			0.63					
Tapinocyba praecox	0.82	0.96	2.94		1.32	2.56	2.48	0.22	2.34	2.00
Tapinopa longidens						0.16		0.66		2.00
Tegenaria agrestis	0.41	0.56				0.34				1.00

Species name	P	oH	dH	mH	C	G	N	F	G1	K4
Theridion bimaculatum		0.09	0.43					0.22		
Theridion simile			0.22							
Tiso vagans	0.21	0.29	0.84	0.24	11.84	2.41	9.56	0.22	15.20	1.00
Trochosa terricola	7.70	4.38	6.37	18.47	42.16	5.30	15.76	30.03	17.54	11.00
Troxochrus scabriculus	0.21									
Typhochrestus digitatus	10.60	20.78	3.19	6.95	2.58	29.22	4.40	0.44	2.34	5.00
Walckenaeria acuminata		0.10			1.26	0.16				
Walckenaeria atrotibialis	0.21	0.09	2.36	0.49	1.32	0.16	0.37	5.36		
Walckenaeria capito		0.09								
Walckenaeria cucullata	0.21							2.23		
Walckenaeria dysderoides	0.62	0.09		0.70	2.69	0.17		1.12		
Walckenaeria furcillata			0.22	0.28				1.78		
Walckenaeria monoceros	0.21	2.92	1.27	0.21		3.88	2.26			2.00
Walckenaeria nodosa		0.09								
Xerolycosa miniata	1.49	1.63	0.43	0.43	0.69	3.70	1.89			
Xerolycosa nemoralis	3.96	0.56	0.22		0.69	0.51		0.66	1.17	1.00
Xysticus audax	0.21			0.80			0.76	0.21		
Xysticus cristatus	0.41	1.91	1.93	9.98	3.32	10.11	10.95	0.22	2.34	3.00
Xysticus kochi	1.46	0.38		0.25		1.85	4.05	0.22		
Xysticus sabulosus	2.53	0.48		1.81						1.00
Zelotes clivicola								0.88		
Zelotes electus	0.42	1.13	0.43		0.63	0.32		0.22		1.00
Zelotes latreillei	0.42	0.18	0.21	2.29	2.06	0.17		2.23		2.00
Zelotes petrensis		0.18		0.28		0.16		0.22		
Zelotes pusillus	0.41	2.44	1.92	3.08	1.89	2.91	2.58	0.22	14.03	5.00
Zelotes serotinus	1.67	2.97		1.00	1.26	5.71	2.99		4.68	1.00
Zelotes subterraneus			0.22					0.67		
Zora silvestris					0.63					1.00
Zora spinimana					1.95			3.33		

Table 2 (continued)

however, are accumulations of stands that are similar in their vegetation type but spread over the entire area. The group "open and dry heather" comprises all stands belonging to the growing phase with predominantly *Calluna vulgaris* (API, APIII, K). The grassy stands fall into 3 groups characterized by the kind of grasses growing there. One group consists of the traps that were placed in the *Calamagrostis epigeios* area (B1 and B2). The second group consists of the traps that were placed in a *Nardus stricta* area (GII1, GII2 and G5). A third group consists of all traps that were located in grassy areas but cannot be separated any further (parts of B, G, GII and K). These stands were characterized by the occurrence of several grass species like *Deschampsia flexuosa* and *Festuca ovina*. Table 1 gives an overview of the different groups of stands based on the result of the PCoA.

The position of the stands K4 and G1 in the second ordination step (Fig. 2) is not interpretable. Their species composition does not resemble the species compositon at the *Nardus* sites. The stand K4 was located under a single *Pinus* tree within an open heather area. Its species composition shows most similarity with the composition at the forest edge (Fig. 1). Both stands were excluded from further analysis.

It was shown that the species composition of epigeic spiders in heathland differs clearly between the different forms of heath habitat. The next question addressed was: in what respect do the species compositions differ?

The number of species found in the area dominated by *Calluna vulgaris* was only slightly higher than in the grassy areas. The highest number of species was found along the border of heather and forest. Here, forest species were found in addition to heather species (Fig. 3).

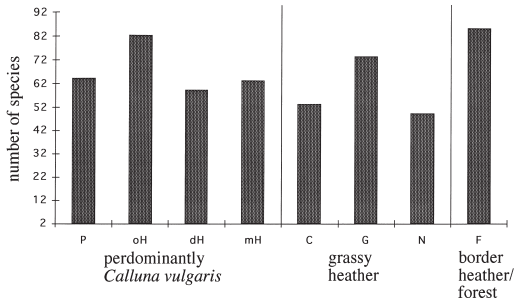

Fig. 3: Number of species found in the various habitat groups based on the result of the PCoA. See Table 1 for abbreviations.

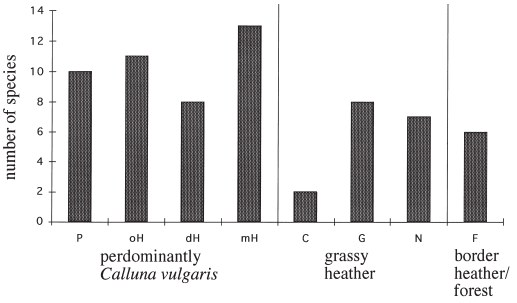

Fig. 4: Number of threatened species found in the various habitat groups based on the result of the PCoA. See Table 1 for abbreviations.

A t-test between the group of stands dominated by *Calluna vulgaris* (P, oH, dH, mH) and the grassy stands (C, G, N) showed that the number of threatened species following the red data list of Germany (Platen *et al*., 1996) is significantly higher in the areas dominated by *Calluna vulgaris* than in the grassy heather (P = 0.059, Fig. 4). Species are often threatened due to the loss and destruction of their habitats. In Germany this is very much true for species preferring dry and open situations such as typical heather species.

Comparing the stands dominated by *Calluna vulgaris* with each other it can be seen that the degenerate phase harbours the least number of species in total and the least number of threatened species.

As an example of the differences in species composition, Figure 5 shows how typical heather species in open situations are replaced by species preferring grassland at the *Nardus* sites.

For more details see the complete species list in Table 2.

Conclusions

It has been shown that even small and adjacent patches of different heath habitats harbour distinctly different spider communities. This result confirms how sensitively spiders react to differences in their environment. The occurrence of trees and grasses causes the typical heather species to diminish in favour of species that prefer forest or grassland. The spider community also becomes imporverished when *Calluna vulgaris* reaches its degenerate phase. These results emphasize the importance of the maintenance of heath habitats with little or no invasion of grass species and continuous rejuvenation for the conservation of the typical spider community of heathland.

Acknowledgements

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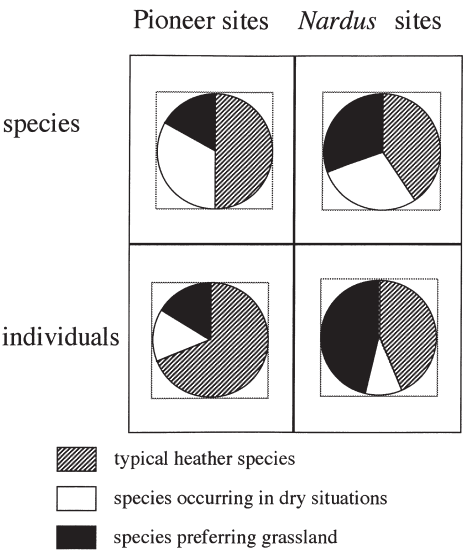

Fig. 5: Differences in species composition between pioneer and *Nardus* sites.

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