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EFFECT OF FIRE ON SPIDER FAUNA IN SUBARCTIC BIRCH FOREST, NORTHERN FINLAND

In July 1985, an area of about 30 ha of subarctic birch woodland in Finnish Lapland was destroeyd by forest fire. The burned area is situated in a river canyon in the Kevo Strict Nature Reserve (69°36'N, 26°52'E). On the plateau along the banks of the river, at an altitude of 120 m, the open dry mountain birch (Betula pubescens spp. tortuosa) forest had consisted of low, 2-3 m tall, trees and bushes. On the steep valley slope the birches had grown more scatteredly on small terraces. The burned slope area extended up to an altitude of 220-240 m a.s.l. The ground and field layers had been characterized by mosses, e.g. Pleurozium schreberi and Hylocomium splendens, and some lichens; the most abundant vascular plants had been Empetrum hermaphroditum, Vaccinium myrtillus, V. vitis-idaea, Cornus suecica, Deschampsia flexuosa, Calamagrostis lapponica and Lycopodium annotinum.

The fire destroyed most of the area totally. The only exception was trapping site no. 1, where about 10 % of the vegetation survived. A year after the fire there was a layer of charcoal and ash, 0.5 - 1.0 cm thick, on the ground; only very few seedlings grew in the burned area, coverage being less than 1 %. The pioneer plant species included Vaccinium myrtillus, V. vitis-idaea, Calamagrotis lapponica, Trientalis europaea, Epilobium angustifolium, Ledum palustre and Linnaea borealis.

The density of spider populations was studied by means of 25 x 25 cm soil samples in the plateau area. The samples were extracted for one week in Tullgren funnels. The spider communities were also studied using pitfall traps. On riverside plateau there were four trapping sites in the totally burned

area (nos. 2-4), one in the partly burned area (1) and two in the undisturbed control area (6-7). On the valley slope there were two trapping sites on the burned terraces (9-10) and one on a control site (8). At each trapping site there were six traps. The trapping period was June 17 - August 17, 1986.

RESULTS

The density of spiders was clearly lower in the burned area than in the control area (Table 1). Very low densities were found in the samples taken early in the season, June 17 and June 25. The difference between the burned and control samples was also highest at that time, and statistically significant. Later this difference was reduced, probably due to spiders invading to the burned areas. The average density in burned and control areas was 20.6 and 162.1 ind./sq. m, respectively.

Table 1. Density of spiders (ind./sq. m) at burned and control sites (Student's t-test).

Date	Burned mean (S.E.)	N	Control mean (S.E.)	N	p
June 17	6.4 (3.9)	5	378.7 (124.1)	3	<0.007
June 25	4.0 (4.0)	4	106.7 (29.7)	3	<0.010
July 17	16.0 (10.1)	5	85.3 (21.3)	3	(<0.015)
August 4	44.8 (9.3)	5	85.3 (21.3)	3	N.S.
August 17	32.0 (11.3)	5	154.7 (50.9)	3	(<0.022)

The diversity of the trapped spider material is shown in Table 2. The figures for the control sites on the riverside plateau (6, 7) were lower than those for the burned sites. This was mainly caused by the high abundance of the dominant species, Hybauchenidium prodigiale. The diversity and evenness values varied less among the three sites on the valley slope.

The similarity of the sites was determined using the percentage of similarity and the Sørensen's similarity index (Table 3). The highest similarity index was found between the control sites on the riverside plateau. All the burned sites on the plateau had great similarities, while on the other hand the three slope sites also formed a group.

Table 2. Diversity of spider material from different trapping sites; PB: partly burned, B: totally burned, C: control site.

Site	ind. no.	species no.	% of the dominant species	H'	Evenness
1 (PB)	105	17	45.7	1.67	0.59
2 (B)	62	13	25.8	1.99	0.78
3 (B)	61	12	26.2	2.06	0.83
4 (B)	70	20	35.7	2.29	0.76
5 (B)	78	14	42.3	1.92	0.73
6 (C)	284	19	58.1	1.54	0.52
7 (C)	257	22	70.4	1.24	0.40
8 (C)	81	17	21.0	2.44	0.86
9 (B)	39	17	17.9	2.54	0.90
10 (B)	67	15	35.8	2.14	0.79

Table 3. Similarity between trapping sites; QS: Sørensen's similarity index, PS: percentage of similarity.

		QS									
		1	2	3	4	5	6	7	8	9	10
	1		47	41	38	52	33	36	29	47	44
	2	52		40	55	37	25	23	20	27	29
	3	50	54		44	54	32	35	41	48	44
	4	49	48	47		59	62	43	43	43	46
PS	5	54	46	47	71		67	54	52	39	41
	6	20	17	22	29	38		68	50	33	47
	7	13	10	15	17	26	89		46	31	32
	8	40	39	42	37	35	23	14		53	56
	9	39	51	52	34	31	22	14	52		56
	10	56	46	54	40	35	22	15	48	52	

The abundance of the spiders was statistically lower in the traps at the burned sites than at the undisturbed control sites, 47.8 ind. and 146.3 ind./trap site respectively.

As there were seven burned and three control sites, equality of occurrence is obtained when 70 % of the individuals of a species are from burned sites; a higher percentage means a preference for burned sites and a lower percentage one for control sites (Table 4). Species found more commonly at burned sites included Pardosa palustris, Diplocentria bidentata and Pardosa eiseni. Of the less abundant species, Meioneta gulosa and Tiso aestivus also seemed to prefer burned sites. Hahnia ononidum occurred equally at burned and control sites, and Tapinocyba pallens nearly equally. Of the families, Linyphiidae (especially Erigoninae) was clearly more abundant at the control sites and the occurence of Lycosidae was equal at both type of site.

Table 4. Preference of certain abundant species (70 % of ind. at burned sites means equal occurrence at burned and control sites).

	% at burned sites	preference for
Pardosa palustris (40 ind.)	100.0	burned (total pref.)
Diplocentria bidentata (41)	92.1	burned (strong pref.)
Pardosa eiseni (119)	84.0	burned (slight pref.)
Hahnia ononidum (212)	70.8	equal
Tapinocyba pallens (15)	60.0	nearly equal
Ozyptila arctica (12)	50.0	control (slight pref.)
Gnaphosa muscorum (15)	46.7	control
Trichopterna mengei (17)	35.3	control
Walckenaeria karpinskii(15)	33.3	control
Gnaphosa microps (41)	31.7	control
Pardosa hyperborea (88)	22.7	control (strong pref.)
Lepthyphantes antroniensis (11)	18.2	control (strong pref.)
Hybauchenidium prodigiale (349)	0.9	control (strong pref.)
Zornella cultrigera (12)	0.0	control (total pref.)

In particular, Hybauchenidium prodigiale and Zornella cultrigera occurred in undisturbed areas, and Lepthyphantes antroniensis and Pardosa hyperborea were also clearly more common at the control than at the burned sites. Of the less often trapped species, many were found only at the control sites: e.g. Agyneta subtilis, Centromerus arcanus, Hilaira herniosa, Micrargus herbigradus and Walckenaeria cuspidata. Robertus scoticus, caught only by Tullgren funnels, also preferred control sites.

DISCUSSION

The effect of forest fire on the spider fauna and the postfire succession has been studied both after natural fires (e.g. Schaefer 1980, Hauge & Kvamme 1983) and after prescribed burning (e.g. Huhta 1971, Brabetz 1978). No earlier data for northern subarctic woodlands is available.

Of the present species commonly found at burned sites, Pardosa palustris has been reported as a pioneer species on heathlands by Merrett (1976) and in forests by Brabetz (1978) and Schaefer (1980), as has Meioneta gulosa in forests by Huhta (1971). Both Huhta (1971) and Hauge & Kvamme (1983) have found Tapinocyba pallens to occur commonly starting from the first postfire year, but interestingly enough Diplocentria bidentata is regarded as a later invader in the both papers. The two northern species, Pardosa eiseni and Tiso aestivus,

found in the present study at burned sites, were rare or absent in the materials of Huhta (1971) and Hauge & Kvamme (1983). Hahnia ononidum occurred equally at burned and control sites in the present study; Huhta (1971) and Schaefer (1980) caught only a few individuals of the species, and these were all from unburned sites. It is worth mentioning that the well-known pioneer species of the genus Erigone (e.g. Huhta 1971, Merrett 1976, Schaefer 1980) were absent in the present material.

Both Zornella cultrigera and Lepthyphantes antroniensis were also found only in unburned areas by Huhta (1971). The preference for unburned areas by Gnaphosa muscorum has also recorded by Hauge & Kvamme (1983) and that by Robertus scoticus and Centromerus arcanus by Huhta (1971).

In contrast to some earlier studies (e.g. Schaefer 1980), the diversity of the spider communities at burned sites in the present data was not lower than that at control sites. The spider density was diminished at the burned sites as much as or even more than reported by Huhta (1971).

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Barth: An important question seems to be: What are the reasons for the enormous differences in abundance of different spider species in the burnt area? Is this mainly due to prey abundance, availability of attachment structures for the webs, or -may be - differences in the duration of the life cycles?
Koponen: The fire destroyed the vegetation completely. There are no places to build nets. Also the microclimate has been changed: The burned area is very dry and warm. Thus the species preferring humid moss and litter layer cannot live there.

Jocqué: Did you find a shift from webbing to wandering spiders, as was found by Huhta after prescribed burning?
Koponen: This aspect was not studied in detail, but it does not seem to occur a marked shift after burning, possibly because of the little difference in tree cover of burned and control sites.

J. Łuczak: Is there any information in the ecological literature concerning the restauration of the spider fauna to conditions before the fire and the time needed?
Koponen: This is not very well known. I think such study would take some 20 years.