

Effects of intensive fire on the ground-living spider (Araneae) fauna of a pine forest

Эффект интенсивного пожара на наземную фауну пауков (Araneae) в сосновом лесу

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ABSTRACT. Ground-living spiders were collected using pitfall traps in southern Finland, during autumn 1997, in a totally burned pine forest three months after the fire. The species found included both typical forest species, e.g., *Tapinocyba pallens* and *Tenuiphantes mengei*, and also some pioneer species, like *Agyneta rurestris*. During the following summer, the total number of specimens was higher at the burned (55 ind./trap/season) than at the control site (36 ind./trap/season). Also, the species richness was higher at the burned (38 species) than at the control (34) site. The total percentage values for Linyphiidae and Lycosidae were 59.4% and 32.5% at the burned site and 86.7% and 2.3% at the control site, respectively. *Xerolycosa nemoralis* (11.9%) was the most abundant species at the burned site, and *Centromerus arcanus* (16.1%) was most abundant at the control site. *Tapinocyba pallens* was the second most abundant species at both sites (11.1% and 15.8%). Abundant species found only at the burned site included *Xerolycosa nemoralis*, *Pardosa riparia*, *Euryopsis flavomaculata* and *Agyneta rurestris*.

РЕЗЮМЕ. Наземные пауки собирались почвенными ловушками в полностью выгоревшем сосновом лесу через 3 месяца после пожара осенью 1997 года в южной Финляндии. Собранный материал включал как типичные лесные виды, например, *Tapinocyba pallens* и *Tenuiphantes mengei*, так и некоторые пионерные виды, такие как *Agyneta rurestris*. В течении следующего лета общее количество пауков было выше в выгоревшем лесу (55 экз./ловушка/сезон), чем на контрольном участке (36 экз./ловушка/сезон). Также видовое разнообразие было выше на выгоревшем участке (38 видов), чем на контрольном участке (34). Процент Linyphiidae и Lycosidae был 59,4% и 32,5% на выгоревшем участке и 86,7% и 2,3% на контрольном участке соответственно. *Xerolycosa nemoralis* (11,9%) была наиболее массовым видом на выгоревшем, а *Centromerus arcanus* (16,1%) на контрольном участках. *Tapinocyba pallens* была вторым наиболее массовым видом на обоих участках (11,1% и 15,8%). Массовыми видами, обнаруженными только на выгоревшем участке, были *Xerolycosa nemoralis*, *Pardosa riparia*, *Euryopsis flavomaculata* и *Agyneta rurestris*.

KEY WORDS: Araneae, spider fauna, forest fire, ground-layer, Finland.

КЛЮЧЕВЫЕ СЛОВА: Araneae, фауна пауков, лесной пожар, наземный слой, Финляндия.

Introduction

Fires occur in the Holarctic taiga forest zone relatively infrequently and the fauna living there is probably not pre-adapted to such environ-

mental stress, as for example is the biota of Mediterranean-type ecosystems where fires are a frequent occurrence [e.g., Stamou, 1998]. Forest fires are rare and small in Finland, mainly due to active fire control. This is in contrast to

the situation in the boreal taiga, both in Russia and Canada where large areas of forest are destroyed by fire each year. Therefore for Finnish spiders, there is little information regarding the effects of forest fire and their post-fire succession. Huhta [1971] studied succession after prescribed burning, and Koponen [1988, 1989, 1995] the effects of natural fire in Finnish Lapland. A large forest fire in 1997 destroyed approximately 150 hectares of forest in Tammela, south-west Finland. In this paper, the effects of this fire on the ground-living spider fauna are presented.

Material and methods

The study area is situated in Tammela, Riihivalkama, east of the Torrnsuo National Park (Finnish Grid 27°E: 6740:323); c. 60°44'N, 23°45'E (Fig. 1). The study site is a dry gentle slope with young pine trees (diameter 20 cm or less).

The forest was burned in early June (9–10th). It was totally burned: all mosses, lichens and vascular plants were destroyed, and dead pines were still standing in autumn 1997, but these were cut down and removed in May 1998. Under the 2–5 mm thick layer of ash and charcoal there was a humus layer, but locally only mineral soil. During autumn 1997 and early summer 1998 the study site was an open, black and hot environment. The distance from non-burned forests to the study site was at least 150 m.

Ground-living spiders were studied three to four months after the fire. Twenty-four pitfall traps with ethylene glycol and detergent (mouth diameter 70 mm, with covers) operated there from 12 September–7 October 1997. The following summer, ten similar traps were placed in the burned site and ten in a control site approx-

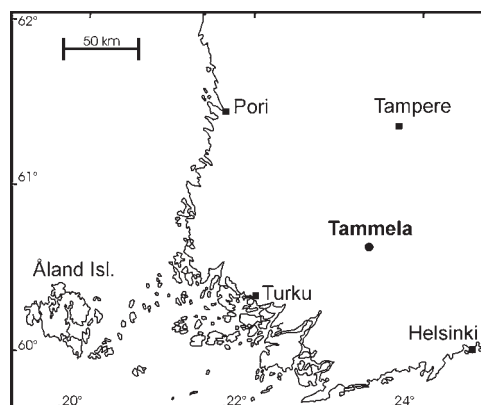


Fig. 1. Location of the study area (Tammela) in southwestern Finland.

Рис. 1. Расположение места исследований Таммела в юго-западной Финляндии.

imately 300 m from the burned site. The study period in 1998 was 9 May–27 September. Coverage of ground and field layer vegetation was estimated around traps (Table 1). The spiders collected, which are deposited in the Zoological Museum, University of Turku, consisted of about 960 specimens.

Results

Post-fire autumn

The spiders trapped three to four months after the fire, autumn 1997, are shown in Table 2. Altogether, 16 species were found. *Tapinocyba pallens* (O. Pickard-Cambridge, 1872) was clearly dominant, and *Tenuiphantes mengei* (Kulczyński, 1887) and *Agyneta rurestris* (C.L. Koch, 1836) were also abundant. The number of individuals caught (0.11 ind./trap/day) is relatively low; probably due to both the destructive effect of the fire and the late collecting period.

Ground and field layer vegetation at burned and control sites.

Table 1.

Наземная растительность выгоревшего и контрольного участков.

Таблица 1.

Sites	Coverage %	Species
Burned site, September 1997	< 1%	—
Burned site, 9 May 1998	< 1%	—
Burned site, 15 July 1998	10%	<i>Epilobium angustifolium</i> , <i>Ceratodon</i> moss
Burned site, 13 September 1998	20%	<i>E. angustifolium</i> , <i>Ceratodon</i> moss
Control site, 1998	100%	<i>Pleurozium</i> and <i>Dicranum</i> moss, <i>Linnaea borealis</i> , <i>Trientalis europea</i> , <i>Vaccinium vitis-idaea</i> , <i>V. myrtillus</i> , etc.

Table 2.
Spiders trapped at the burned site in autumn 1997.
Таблица 2.
Пауки, собранные на выгоревшем участке осенью 1997 года.

Species	Numbers
<i>Tapinocyba pallens</i> (O. Pickard-Cambridge, 1872)	11
<i>Tenuiphantes mengei</i> (Kulczyński, 1887)	6
<i>Agyneta rurestris</i> (C.L. Koch, 1836)	5
<i>Agroeca proxima</i> (O. Pickard-Cambridge, 1871)	3
<i>Pardosa lugubris</i> (Walckenaer, 1802)	3
<i>Trochosa terricola</i> Thorell, 1856	3
<i>Porrhomma pallidum</i> Jackson, 1913	2
<i>Gnaphosa bicolor</i> (Hahn, 1833)	2
<i>Haplodrassus signifer</i> (C.L. Koch, 1839)	2
<i>Zora spinimana</i> (Sundevall, 1833)	1
<i>Xerolycosa nemoralis</i> (Westring, 1861)	1
<i>Crustulina guttata</i> (Wider, 1834)	1
<i>Silometopus elegans</i> (O. Pickard-Cambridge, 1872)	1
<i>Walckenaeria cucullata</i> (C.L. Koch, 1836)	1
<i>Centromerus arcanus</i> (O. Pickard-Cambridge, 1873)	1
<i>Oryphantes angulatus</i> (O. Pickard-Cambridge, 1881)	1
Linyphiidae spp. (juv.)	21
Total:	16 species

Additional species collected only by hand-collecting from the burned forest floor during the post-fire autumn period were: *Alopecosa* sp., *Gnaphosa muscorum* (L. Koch, 1866), *Metellina segmentata* (Clerck, 1757), *Robertus scoticus* Jackson, 1914, *Steatoda phalerata* (Panzer, 1801), *Erigone atra* Blackwall, 1833 and *Agyneta gulosa* (L. Koch, 1869). For autumn 1997, the total number of species from the burned forest floor was 23.

Table 4.
The most abundant species at the burned site, 1998 (individual number and percentage of all identifiable specimens).

Таблица 4.
Самые массовые виды на выгоревшем участке, 1998 год (количество особей и процент всех определяемых особей).

Species	Individuals	Percentage
<i>Xerolycosa nemoralis</i> (Westring, 1861)	29	11.9
<i>Tapinocyba pallens</i> (O. Pickard-Cambridge, 1872)	27	11.1
<i>Alopecosa pulverulenta</i> (Clerck, 1757)	25	10.3
<i>Pardosa riparia</i> (C.L. Koch, 1833)	24	9.9
<i>Euryopsis flavomaculata</i> (C.L. Koch, 1836)	21	8.7
<i>Agyneta rurestris</i> (C.L. Koch, 1836)	21	8.7
<i>Pardosa lugubris</i> (Walckenaer, 1802)	15	6.2
<i>Centromerus arcanus</i> (O. Pickard-Cambridge, 1873)	9	3.7
<i>Diplostyla concolor</i> (Wider, 1834)	8	3.3
<i>Tenuiphantes mengei</i> (Kulczyński, 1887)	7	2.9
<i>Zora nemoralis</i> (Blackwall, 1861)	5	2.1
<i>Haplodrassus soerenseni</i> (Strand, 1900)	4	1.7
<i>Trochosa terricola</i> Thorell, 1856	4	1.7
<i>Porrhomma pallidum</i> Jackson, 1913	4	1.7
Total: (identifiable) individuals	243	

Table 3.
Composition of the spider fauna at the burned and control sites, 1998 (ten traps at each site).

Таблица 3.
Структура фауны пауков на выгоревшем и контрольном участках, 1998 год (10 ловушек на обоих участках).

	Burned	Control
Species number	38	34
Linyphiid species (and %) 20 (52.6%)	22 (64.7%)	
Lycosid species (and %) 7 (18.4%)	2 (5.9%)	
Individual number	539	354
Ind./trap/day	0.37	0.24
Linyphiidae % of all ind.	59.4%	86.7%
Lycosidae % of all ind.	32.5%	2.3%
Theridiidae % of all ind.	4.3%	1.4%
Gnaphosidae % of all ind.	2.2%	1.1%

The following summer

The general structure of spider communities found at the burned and the control sites during summer 1998 is shown in Table 3. The numbers of species and individuals in the pitfall traps were higher at the burned site. The number of linyphiid species was almost the same at the burned (20 species) and at the control (22) site, but markedly more lycosid species (seven) were trapped at the burned than at the control (two) site. In individual numbers, Lycosidae was clearly more abundant at the burned (32.5% of all specimens) than at the control (2.3%); the same trend was found for Theridiidae and Gnaphosidae. The most numerous trapped family

Table 5.

The most abundant species at the control site, 1998 (individual number and percentage of all identifiable specimens).

Таблица 5.

Самые массовые виды на контрольном участке, 1998 год (количество особей и процент всех определяемых особей).

Species	Individuals	Percentage
<i>Centromerus arcanus</i> (O. Pickard-Cambridge, 1873)	44	16.1
<i>Tapinocyba pallens</i> (O. Pickard-Cambridge, 1872)	43	15.8
<i>Agyneta cauta</i> (O. Pickard-Cambridge, 1902)	20	7.3
<i>A. conigera</i> (O. Pickard-Cambridge, 1873)	17	6.2
<i>Diplocentria bidentata</i> (Emerton, 1882)	13	4.7
<i>Walckenaeria antica</i> (Wider, 1834)	13	4.7
<i>Diplostyla concolor</i> (Wider, 1834)	11	4.0
<i>Zora nemoralis</i> (Blackwall, 1861)	11	4.0
<i>Bathypantes parvulus</i> (Westring, 1851)	9	3.3
<i>Tenuiphantes tenebricola</i> (Wider, 1834)	9	3.3
<i>Alopecosa aculeata</i> (Clerck, 1757)	8	2.9
<i>Walckenaeria cucullata</i> (C.L. Koch, 1836)	8	2.9
<i>Minyriolus pusillus</i> (Wider, 1834)	7	2.6
<i>Cryphoeca silvicola</i> (C.L. Koch, 1834)	5	1.8
<i>Neon reticulatus</i> (Blackwall, 1853)	5	1.8
<i>Robertus lividus</i> (Blackwall, 1836)	5	1.8
Total: (identifiable) individuals	274	

at both sites was Linyphiidae: 86.7% at the control and 59.4% at the burned site.

The most abundant species at both sites are shown in Tables 4–5. *Xerolycosa nemoralis* (Westring, 1861) (11.9%), *Tapinocyba pallens*, *Alopecosa pulverulenta* (Clerck, 1757), *Pardosa riparia* (C.L. Koch, 1833), *Euryopsis flavomaculata* (C.L. Koch, 1836), *Agyneta rures-tris* and *Pardosa lugubris* (Walckenaer, 1802) were the dominant species at the burned site (Table 4). In unburned forest at the control site, *Centromerus arcanus* (O. Pickard-Cambridge, 1873) (16.1%), *Tapinocyba pallens*, *Agyneta cauta* (O. Pickard-Cambridge, 1902), *A. conigera* (O. Pickard-Cambridge, 1863), *Diplocentria bidentata* (Emerton, 1882), *Walckenaeria antica* (Wider, 1834), *Diplostyla concolor* (Wider, 1834) and *Zora nemoralis* (Blackwall, 1861) were the dominants (Table 5). Interestingly, *Tapinocyba pallens* was the second most abundant species both at the burned and the control site, and it was the most abundant species at both sites during the spring – early summer (9 May–9 June) trapping period. Abundant species found only at the burned site included *Xerolycosa nemoralis*, *Pardosa riparia*, *Euryopsis flavomaculata* and *Agyneta rures-tris*.

The number of individuals caught (0.37 and 0.24 ind./trap/day at the burned and control sites, respectively) is markedly higher than found during the first post-fire autumn at the burned site (0.11).

Discussion

The number of spider species found at the burned site three to four months after the fire was rather high: 16 in the traps and seven additional by hand-collecting. Whether some of these spider species had survived the fire is uncertain. Some relatively stationary invertebrates were caught in the traps during autumn 1997; these included an earthworm, some gastropods, millipedes, and also female coccids. At least some of these seem to have survived the fire, e.g., under large stones or deep in the soil [see also McKay, 1979; Koponen, 1989; Punttila *et al.*, 1994]; the same may also be true for some spiders. On the other hand, a great number of silk lines were seen on the burned ground, indicating that spiders may have ballooned into the site. Of the species found, especially *Agyneta rures-tris* and *Erigone atra* are known to be pioneer species [e.g., Merrett, 1976; Winter *et al.*, 1983; Koponen & Niemelä, 1994].

In a study in a Finnish Lapland mountain birch forest, significantly more spider specimens were caught using pitfall traps at the control site than at the burned site during the first, and three subsequent post-fire summers [Koponen, 1995]. This is in contrast to the data presented here. Similar trends to those in the present study were found for both species richness and individual numbers, in subarctic coniferous forests of northern Canada [Koponen, 1993]. The high (activity) abundance of spiders at the present burned site is mainly due the large numbers of Lycosidae caught in the open, warm habitats [cf. Koponen *et al.*, 1975; Schaefer, 1980; Koponen, 1993].

The most abundant species at the burned site, *Xerolycosa nemoralis*, has been found in Finland, for example, in heavily polluted barren lands [Koponen & Niemelä, 1994] and dried peat bogs [Koponen, 1979]. Thus it seems to be a colonizer of open, dry and warm areas. Interestingly, *X. nemoralis* was not abundant in a burned pine forest in northern Germany, but was more common in young pine plantations [Schaefer, 1980]. The dominant lycosid at that burned site was *Pardosa lugubris* [Schaefer, 1980], which was also among the most abundant species in the present study.

The abundant species at the control site are typical forest-floor dwellers [cf. Huhta, 1971], although some of them have previously also been found at burned sites. This is particularly true for *Tapinocyba pallens*, which has often been found soon after the fire, as was the case here [e.g., Huhta, 1971; Hauge & Kvamme, 1983; Koponen, 1988].

The spider community in the burned forest clearly differed from that in the natural forest during the first post-fire summer. It consisted of a combination of pioneer species, eurytopic and/or thermophilous species, and some typical pine forest species.

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