

Spiders active on snow in northern Finland

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During the years 1968—1979 2113 spiders belonging to 102 species were collected on snow, mainly in two localities, Kiiminki and Kuusamo. A systematic set of samples was taken in Kiiminki in 1976—77. Linyphiidae *s. lat.* constituted 80 % of the total numbers (69 species). Numbers and species diversity were highest in November, decreased to practically zero in February, and increased again in late winter, the bulk of the catch then consisting of *Bolyphantes index*. Spiders were found almost exclusively in mild weather (down to -4°C).

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1. Introduction

During recent years, increasing attention has been paid to the winter activity, overwintering strategies and cold resistance of spiders, and to the physiological mechanisms involved in these (Wolska 1957, Buche 1966, Hågvar 1973, Kirchner 1973, Thaler & Steiner 1975, Schaefer 1976, 1977 a, b, Aitchison 1978). Most of these studies have been made in Central Europe, where the winters are relatively mild in comparison with northern Fennoscandia. In Finland winter records of spiders are very scanty. Huhta (1965) and Palmgren (1965) have analysed soil and litter samples taken in winter, but these afford no information on the activity of spiders. Frey (1913), in his study of insects found on snow, collected numerous spiders, but these were not identified.

Winter activity is a somewhat vague concept. It could be defined as activity during the climatic winter period (mean temperature below zero), but this cannot be instantaneously verified (only calculated afterwards from temperature records) and often includes periods without a snow cover. In the present study, the presence of snow has been used as an indicator of winter. Spiders active on the snow are immediately exposed to temperatures at or below zero, regardless of ambient air or soil temperature. The permanent snow cover comes somewhat later than the

climatic winter, in Oulu after mid-November, and in Kuusamo 2 weeks later. Correspondingly, the snow disappears ca. 2 weeks after the end of the climatic winter, in Oulu at the end of April, and in Kuusamo in mid-May.

This paper deals with the abundance, species composition and phenology of spiders collected on the snow in northern Finland, and their dependence on weather conditions. The material was collected mainly by the author Viramo and determined by the author Huhta.

2. Study sites, material and methods

The material was collected in 1968—1979. Sampling was at first irregular: spiders were collected whenever they were encountered on snow. After autumn 1976 sampling was performed more regularly on days when, on the basis of experience, invertebrates could be expected to be active. Sampling was stopped 2—3 weeks before the disappearance of the snow cover.

Samples were taken most systematically during winter 1976—77 in Kiiminki (722: 44'; 65° 7'N, 25° 48' E), in the vicinity of Oulu. Invertebrates were collected along two routes, each 4 km long, by carefully inspecting a strip 2 m in breadth, but also including animals observed outside the strip. Each sampling lasted 40—60 min depending on weather, number of animals and amount of litter on the snow. The routes passed through various types of forests, bogs and abandoned farmlands, but the material from different habitats was not kept separate. The samples can be regarded as semiquantitative, allowing comparison between dates of sampling.

The total material includes 2113 spiders, 708 of which

Table 1. Monthly totals of spiders combined from all samples, and total numbers collected at the main sampling localities. The column 'Horizon' indicates the vegetation layers where the species live, mainly according to Palmgren (1974, 1975, 1976). I = ground and litter, II = field vegetation, III = bushes, IV = trees.

	Horizon	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total	Kii- minki	Kuu- samo	Lumi- joki
Dictynidae												
<i>Dictyna arundinacea</i> (L.)	II-III	—	—	1j	—	—	—	—	1j	1	—	—
<i>D. pusilla</i> Thorell	II-IV	—	4♀ 1j	2♀	—	—	1♂ 1j	—	1♂ 6♀ 2j	6	2	—
<i>Dictyna</i> spp.	—	—	2j	4j	1j	—	—	1j	8j	4	1	1
Gnaphosidae												
<i>Drassodes</i> spp.	—	—	—	2j	—	—	—	—	2j	—	—	—
<i>Haplodrassus moderatus</i> (Kulcz.)	—	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Haplodrassus</i> spp.	—	—	4j	9j	11j	—	—	2j	26j	20	2	1
<i>Gnaphosa</i> spp.	—	—	2j	1j	—	—	—	42j	45j	3	42	—
Clubionidae												
<i>Clubiona subsultans</i> Thorell	IV	—	—	1♀	—	—	—	—	1♀	—	—	—
<i>C. stagnatilis</i> Kulcz.	—	—	1♀	—	1♀	—	—	—	2♀	—	1	1
<i>Clubiona</i> spp.	—	—	108j	5j	15j	—	—	—	1♀ 28j	4	2	17
<i>Agroeca brunnea</i> (Bl.)	I	—	1♂ 1♀ 1j	1j	—	—	—	—	1♂ 1♀ 2j	5	—	—
<i>Agroeca</i> spp.	—	—	—	—	1j	—	—	—	1j	—	—	—
Zoridae												
<i>Zora spinimana</i> (Sundev.)	I	—	1♂ 6♀ 5j	2♂ 4♀ 6j	2j	—	—	—	3♂ 10♀ 14j	26	1	—
<i>Zora</i> spp.	—	—	—	2j	—	—	—	—	2j	1	—	—
Thomisidae												
<i>Xysticus cristatus</i> (Cl.)	II-III	—	5j	1♀ 1j	—	—	—	—	1♀ 6j	5	1	—
<i>X. ulmi</i> (Hahn)	II-III	—	—	2j	—	—	—	—	2j	2	—	—
<i>Oxyptila brevipes</i> (Hahn)	I	—	1♂	—	—	—	—	—	1♂	—	—	—
<i>Philodromus aureolus</i> (Cl.)	II-IV	—	1j	11j	—	—	—	—	12j	12	—	—
<i>P. emarginatus</i> (Schrank)	IV	—	—	—	—	—	—	1j	1j	—	1	—
<i>P. fuscmarginatus</i> De Geer	IV	—	—	—	—	—	—	3j	3j	—	3	—
<i>Philodromus</i> spp.	—	5j	1j	1j	—	—	—	—	7j	2	5	—
<i>Tibellus oblongus</i> (Walck.)	—	—	—	1j	—	—	—	—	1j	1	—	—
Lycosidae												
<i>Pardosa</i> spp.	—	—	89j	70j	8j	—	1j	1j	169j	156	6	5
<i>Pirata uliginosus</i> (Thor.)	—	—	—	2♀ 1j	—	—	—	—	2♀ 1j	3	—	—
<i>Pirata</i> spp.	—	—	12j	9j	6j	—	—	—	27j	14	1	11
<i>Trochosa</i> spp.	—	—	—	—	1j	—	—	—	1j	1	—	—
Agelenidae												
<i>Cryphoea silvicola</i> (C.L.K.)	I-IV	—	1♂	3j	1♀ 1j	—	—	—	1♂ 1♀ 4j	5	1	—
Theridiidae												
<i>Episimus angulatus</i> (Bl.)	II	—	2j	—	—	—	—	—	2j	2	—	—
<i>Robertus lividus</i> (Bl.)	I	1♀	2♂	1♀	—	—	—	—	2♂ 2♀	2	1	1
<i>R. lyriser</i> Holm	—	—	1♂	—	—	—	—	—	1♂	—	1	—
<i>Robertus</i> spp.	—	—	1j	1j	—	—	—	—	2j	2	—	—
<i>Theridion</i> spp.	—	—	5j	3j	—	—	—	—	8j	6	1	—
Tetragnathidae												
<i>Tetragnatha extensa</i> (L.)	II-IV	—	2j	8j	—	—	—	—	10j	8	2	—
<i>T. dearmata</i> Thor.	II-IV	—	1j	—	—	—	—	—	1j	—	1	—
<i>Pachygnatha clercki</i> Sundev.	I-III	—	—	—	1♀	—	—	—	1♀	—	—	1
<i>P. listeri</i> Sundev.	I	—	—	1♂ 1♀	—	—	—	—	1♂ 1♀	2	—	—
Araneidae												
<i>Araneus cornutus</i> Cl.	III-IV	—	—	1j	—	—	—	—	1j	—	—	1
<i>Araneus</i> spp.	—	—	2j	1j	—	—	—	—	3j	2	—	—
<i>Araniella cucurbitina</i> (Cl.)	II-IV	2j	7j	9j	—	—	1j	—	19j	9	3	—
<i>Singa hamata</i> (Cl.)	—	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Cercidia prominens</i> (Westr.)	I-II	—	1♂ 1j	2j	—	—	—	—	1♂ 3j	3	1	—
<i>Cyclosa conica</i> (Pallas)	II-IV	3j	—	—	—	—	—	—	4j	—	3	—
<i>Araneidae</i> spp.	—	—	3j	—	—	—	—	—	3j	—	3	—
Linyphiidae												
<i>Walckenaera antica</i> (Wider)	I	—	1♂	—	—	—	—	—	1♂	1	—	—
<i>W. cucullata</i> (C.L.K.)	I	—	1♂ 6♀	—	—	—	—	—	1♂ 6♀	7	—	—
<i>W. capito</i> Westr.	—	—	6♂	1♂	—	—	—	—	7♂	1	6	—
<i>W. nudipalpis</i> (Westr.)	I	5♀	22♂	7♂	1♂	—	—	—	30♂ 5♀	27	8	—
<i>W. obtusa</i> Bl.	I	—	2♂	2♂	—	—	—	—	4♂	4	—	—
<i>W. cuspidata</i> Bl.	I	—	6♂	2♂ 1♀	—	—	—	—	8♂ 1♀	4	5	—
<i>Dicymbium nigrum</i> (Bl.)	I	—	—	1♀	—	—	—	—	1♀	1	—	—

	Horizon	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total	Kii- minki	Kuu- samo	Lumi- joki
<i>D. tibiale</i> (Bl.)	I	—	3♂ 3♀	—	—	—	—	—	3♂ 3♀	6	—	—
<i>Entlecara congenera</i> (Cbr.)	IV	—	3♀	1♀	—	—	—	—	4♀	4	—	—
<i>Tmeticus affinis</i> (Bl.)	—	150♂	71♀	1♀ 3j	—	—	—	—	150♂ 72♀ 3j	—	—	225
<i>Gongylidium rufipes</i> (Sundev.)	III-IV	—	—	—	1♂	—	—	—	1♂	—	—	1
<i>Enidia fulva</i> (Bösenb.)	—	—	—	1♀ 3j	—	—	—	—	1♀ 3j	—	—	4
<i>Gonatium rubens</i> (Bl.)	I-II	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Maso sundevalli</i> (Westr.)	I	1♀	1♀	—	—	—	—	—	2♀	2	—	—
<i>Hypselistes jacksoni</i> (Cbr.)	I	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Oedothorax retusus</i> (Westr.)	I	—	1♀	1♂	1♂ 2♀	—	—	—	2♂ 3♀	—	—	4
<i>O. tuberosus/gibbosus</i>	—	—	—	—	2♀	—	—	—	2♀	—	—	2
<i>Trichopterna menzei</i> (Simon)	I	—	—	—	2♀	—	—	—	2♀	—	—	2
<i>Pelecopsis elongata</i> (Wider)	I-IV	—	1♀	—	—	—	—	—	1♀	1	—	—
<i>Lophomma punctatum</i> (Bl.)	I	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Micrargus herbigradus</i> (Bl.)	I	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Notioscopus sarcinatus</i> (Cbr.)	I	—	1♂	—	—	—	—	—	1♂	—	1	—
<i>Erigonella hiemalis</i> (Bl.)	I	—	—	1♀	—	—	—	—	1♀	1	—	—
<i>Savignya frontata</i> Bl.	I	—	—	—	1♂ 1♀	—	3♂ 1♀	—	4♂ 2♀	—	4	2
<i>Diplocephalus picinus</i> (Bl.)	I	—	—	—	1♂	—	—	—	1♂	—	—	1
<i>Zornella cultrigera</i> (L. Koch)	I	—	—	1♂	—	—	—	4♂	5♂	2	3	—
<i>Caledonia evansi</i> Cbr.	I	2♂	10♂ 1♀	5♂	—	—	—	—	17♂ 1♀	11	5	—
<i>Diplocentria bidentata</i> (Emert.)	I	1♀	1♀	—	—	—	—	—	2♀	2	—	—
<i>Erigone atra</i> (Bl.)	I-III	—	—	1♂	—	—	—	—	1♂	1	—	—
<i>E. capra</i> Simon	—	—	1♂	—	—	—	—	—	1♂	—	—	1
<i>Drepanotylus uncatus</i> (Cbr.)	I	—	2♂ 3♀	3♂ 5♀	—	—	—	—	5♂ 8♀	7	—	6
<i>D. borealis</i> Holm	I	—	—	1♂	—	—	—	—	1♂	—	—	1
<i>Hilaira herniosa</i> (Thor.)	I	—	1♀	—	—	—	2♂	—	2♂ 1♀	2	1	—
<i>H. pervicax</i> Hull	I	—	—	—	—	—	3♂ 2♀	—	3♂ 2♀	—	5	—
<i>Aphileta misera</i> (Cbr.)	I	—	—	1♂	—	—	—	—	1♂	1	—	—
<i>Porrhomma pygmaem</i> (Bl.)	I-II	—	1♀	1♂ 1♀	2♂ 2♀	—	—	—	3♂ 4♀	3	—	4
<i>P. pallidum</i> Jackson	I	—	—	1♂ 1♀	—	—	—	—	1♂ 1♀	2	—	—
<i>Meioneta rurestris</i> (C.L.K.)	I	—	1♀	—	—	—	—	—	1♀	1	—	—
<i>Microneta viaria</i> (Bl.)	I	—	15♂ 15♀	4♂ 8♀	—	—	—	—	19♂ 23♀	42	—	—
<i>Centromerus sylvaticus</i> (Cbr.)	I	—	1♀	—	—	—	—	—	1♀	—	1	—
<i>C. expertus</i> (Cbr.)	I	1♂	12♂ 9♀	28♂ 7♀	—	—	—	—	41♂ 16♀	54	1	2
<i>C. incilius</i> (L. Koch)	I	1♂	13♂ 8♀	6♂ 1♀	—	—	—	—	20♂ 9♀	26	3	—
<i>Centromerita bicolor</i> (Bl.)	I-II	—	2♂	3♂ 10♀	—	—	—	—	5♂ 10♀	14	1	—
<i>C. concinna</i> (Thor.)	I	—	1♀	—	—	—	—	—	1♀	—	1	—
<i>Macrargus rufus</i> (Wider)	I	3♂ 3♀	77♂ 120♀	14♂ 16♀	1♂ 1♀	—	—	—	95♂ 140♀	222	3	—
<i>M. carpenteri</i> (Cbr.)	I	1♀	23♂ 9♀	18♂ 1♀	1♂	—	1♂	—	43♂ 11♀	25	28	—
<i>M. multesimus</i> (Cbr.)	I	1♀	1♂	—	—	—	—	—	1♂ 1♀	—	2	—
<i>M. boreus</i> Holm	I	—	11♂ 24♀	7♂ 4♀	—	—	1♂	—	19♂ 28♀	44	—	—
<i>Kaestneria pullata</i> (Cbr.)	I-III	—	1♀	2♂ 7♀	1♂	—	—	—	3♂ 8♀	9	—	2
<i>Diplostyla concolor</i> (Wider)	I	—	1♂ 1♀	2♀	—	—	—	—	1♂ 3♀	4	—	—
<i>Bathyphantes approximatus</i> (Cbr.)	—	—	5♂	3♂ 5♀	1♂ 2♀	—	—	—	9♂ 7♀	—	—	16
<i>B. parvulus</i> (Wider)	I	—	1♂	1♂	—	—	—	—	2♂	1	—	1
<i>B. nigrinus</i> (Westr.)	II	—	1♂ 1♀	1♂	—	—	—	—	2♂ 1♀	—	2	1
<i>Pityophantes phrygianus</i> (C.L.K.)	IV	3j	9j	1j	6j	—	2j	1j	22j	16	5	—
<i>Bolyphantes alliceps</i> (Sundev.)	II-III	—	6♂ 22♀	2♀	—	—	—	—	6♂ 24♀	26	1	—
<i>B. luteolus</i> (Bl.)	I-II	—	13♂ 3♀	—	—	—	—	—	13♂ 3♀	—	16	—
<i>B. index</i> (Thor.)	II-IV	—	1♂ 2♀	4♂ 3♀	—	—	28♂ 7♀	108♂ 37♀	141♂ 49♀	38	152	—
<i>B. crucifer</i> (Menge)	I	—	—	3♀	—	—	—	—	3♀	3	—	—
<i>Lephyphantes alacris</i> (Bl.)	I-IV	1♀	14♂ 23♀	3♂ 3♀	2♀	1♂	—	1♀	18♂ 30♀	40	6	—
<i>L. cristatus</i> (Menge)	—	2♂ 3♀	25♂ 25♀	26♂ 11♀	—	—	13♂	1♂	67♂ 39♀	104	1	—
<i>L. menzei</i> Kulcz.	I	6♀	2♂ 31♀	1♀	—	—	—	—	2♂ 38♀	31	7	—
<i>L. tenebricola</i> (Wider)	I-II	—	1♀	1♀	—	—	—	—	2♀	1	1	—
<i>L. angulatus</i> Cbr.	I	2♂	1♂ 4♀	1♂ 1♀	1♂ 3♀	—	—	—	5♂ 8♀	6	2	4
<i>L. angulipalpis</i> (Westr.)	I	—	1♂	4♂ 1♀	—	—	1♂	—	6♂ 1♀	7	—	—
<i>L. antroniensis</i> Schenkel	I	—	1♂	1♀	—	—	—	—	1♂ 1♀	1	1	—
<i>Helophora insignis</i> (Bl.)	II-III	—	2♂ 35♀	1♂ 5♀	—	—	—	—	3♂ 40♀	34	6	—
<i>Nerene clathrata</i> (Sundev.)	I-II	—	2♂ 1♀ 2j	2♀ 1j	—	—	—	—	2♂ 3♀ 3j	7	1	—
<i>Microlinyphia pusilla</i> (Sundev.)	II-III	—	4j	9j	—	—	—	—	13j	9	4	—
<i>Allomengea scopigera</i> (Grube)	—	—	1♀	—	—	—	—	—	1♀	—	1	—
Linyphiidae spp.	—	1j	99j	50j	45j	—	—	—	197j	51	8	130
Total	—	48	1158	504	129	1	69	204	2113	1216	377	448

Table 2. Depth of snow, temperature on snow surface and numbers of spiders collected by systematic sampling in Kiiminki 1976—77.

Date	Nov													Total										
	7	8	17	18	20	21	22	4	9	11	12	2	7		20	24	31	Apr	Total					
Depth of snow, cm	2			1	3	8	20	1	2	4		2		5	±0	-1	-4	+1	±0	40				
Temperature °C			-2.5	-1	+1	+1	+1		+1					±0	-4	+1	+2				40			
<i>Dictyna pusilla</i>					3♀	1♂	1♀						1♀										5♀ 1♂	
<i>Agroeca brunnea</i>	1♂			1♀																			1♂ 1♀ 2♂	
<i>Zora spinimana</i>			2♀ 2♂																				1♂ 6♀ 6♂	
<i>Xysticus cristatus</i>			2♂	1♂																			4♂	
<i>Pardosa</i> spp.			1♂	2♂			2♂ 4♀																84♂	
<i>Walckenaera cucullata</i>	12♂		1♂						1♂														1♂ 6♀	
<i>W. obtusa</i>	1♂																						15♂	
<i>W. cuspidata</i>																							3♂	
<i>Dicymbium tibiale</i>	3♂ 2♀																						2♂ 1♀	
<i>Caledonia evansi</i>	2♂																						3♂ 3♀	
<i>Porrhinoma pygmaeum</i>																							1♂ 5♀	
<i>Macroneta viaria</i>	3♂ 1♀		5♂ 4♀	2♂ 1♀	5♂	9♀	1♀																15♂ 16♀	
<i>Centronerus expertus</i>	9♂ 8♀	1♀																					12♂ 10♀	
<i>C. incilius</i>	9♂ 3♀			1♂	1♂	1♂	1♂																13♂ 7♀	
<i>Macaragus rufus</i>	38♂ 42♀	2♂ 2♀	5♂ 4♀	14♂ 20♀	13♂	31♀																	73♂ 114♀	
<i>M. carpenleri</i>	1♂						1♀																3♀ 1♀	
<i>M. borcus</i>	3♂ 3♀		1♂ 4♀	2♂ 5♀	4♂	10♀																	11♂ 22♀	
<i>Bolyphantés alticeps</i>	5♂ 19♀						1♀																5♂ 20♀	
<i>B. index</i>																							25♂ 6♀	
<i>Leplyphantes alacris</i>																							3♂ 15♀	
<i>L. cristatus</i>	15♂ 9♀		3♀	6♀	2♂	13♀	1♂																38♂ 31♀	
<i>L. mengei</i>	2♂ 8♀		2♀	1♀	11♀																		2♂ 23♀	
<i>L. angulatus</i>																							1♂ 2♀	
<i>L. angulipalpis</i>			1♂		4♂	1♀																	6♂ 1♀	
<i>Heliphora insignis</i>	1♂ 25♀					1♀																	1♂ 26♀	
<i>Neritene clathrata</i>	1♀		1♂		1♂																		1♂ 26♀	
Linyphiidae spp.	4♂		1♂	1♂	6♂																		2♂ 3♀ 1♂ 1♀	
Total	272	6	55	101	172	8	1	6	10	7	24	1	1	41	4	1	3	1	41	4	1	3	1	708

In addition: *Dictyna arundinacea* 12 Dec. 1♂, *Haplodrassus* spp. 20 Nov. 1♂, 4 Dec. 1♂, *Gnaphosa* spp. 20 Nov. 2♂, *Clubiona* spp. 20 Nov. 2♂, 12 Dec. 1♂, *Philotromus aureolus* 20 Nov. 1♂, *Pirata* spp. 7 Nov. 7♂, *Epispinus angulatus* 7 Nov. 1♂, 20 Nov. 1♂, *Robertus lividus* 7 Nov. 1♂, *Robertus* spp. 20 Nov. 1♂, *Theridion* spp. 7 Nov. 1♂, 17 Nov. 1♂, *Aranus* spp. 7 Nov. 1♂, *Aranella cucurbitina* 1 Dec. 1♂, 12 Dec. 1♂, *Cercidia prominens* 12 Dec. 1♂, *Walckenaera antica* 7 Nov. 1♂, *Entelcara congenera* 20 Nov. 3♀, *Maso sundevalli* 7 Nov. 1♀, *Pelecepis elongata* 17 Nov. 1♂, *Zornella cultrigera* 19 Apr. 1♂, *Diplocephala bidentata* 20 Nov. 1♀, *Drepanophylus uncutus* 4 Dec. 1♀, *Hylla hirtosa* 20 March 2♂, *P. pallidum* 12 Dec. 1♂, *Diplosiyla concolor* 17 Nov. 1♂, 20 Nov. 1♀.

(33.5 %) were collected in Kiiminki in winter 1976—77. The entire material from Kiiminki amounts to 57.6 % of the total. The rest was collected in Kuusamo (736: 60°, 66° 22'N, 29° 21' E; 377 specimens), in Lumijoki (720: 41°, 64° 53'N, 25° 8'E; 488 specimens), or unsystematically in Kempele, Oulu, Oulunsalo, Pudasjärvi and Taivalkoski.

The spiders were identified to species whenever possible, except juveniles of the family Linyphiidae *s. lat.*, which formed an unimportant part of the material. Systematics and nomenclature are according to Lockett, et al. (1974).

3. Results

A. Species composition

The spider fauna collected on snow was unexpectedly diverse (Table 1). Altogether 102 species were found, including those identified only to genera. Of these 69 belong to the family Linyphiidae *s. lat.*, comprising 80 % of the total numbers. The three most abundant species were *Macrargus rufus*, *Tmeticus affinis* and *Bolyphantes index*. Outside Linyphiidae *Pardosa* was the most numerous represented genus. The differences between the faunae of Kiiminki, Kuusamo and Lumijoki are partly explained by the geographical distribution of the species, and partly by the differing distribution of the various habitats in the localities. Bogs and cultivated land are poorly represented in Kuusamo. *Microseta viaria*, *Centromerus expertus*, *Macrargus rufus*, *Leptyphantes cristatus* and *Pardosa* spp. were only occasionally found in Kuusamo, while *B. index* was especially abundant there (Table 1). The samples collected in Lumijoki are of special interest because of the superdominant position of *Tmeticus affinis*. According to Palmgren (1976), the habitat preference (as yet unknown) of this species may be very specialized. The samples were taken in a stand of reeds (*Phragmites communis*) on 20 November 1970, 29 December 1972 and 8 January 1971. Almost all *T. affinis* were found on the first date.

Females were generally more numerous in the material, but males predominated in *T. affinis*, *B. index*, *L. cristatus*, *Macrargus carpenteri*, *Walckenaera* spp. and *Centromerus* spp.

B. Phenology

The numbers of species and individuals were clearly highest in early winter (the peaks in November; Tables 1 and 2). Species diversity was high; up to 30 species were found at one sampling, and the numbers of specimens were distributed relatively evenly between many species (Table 2). The numbers decreased steeply towards midwinter: only one specimen was collected in February. Aitchison (1978) reported a similar change in the activity of spiders under snow. After that the activity of spiders increased again, but this was due mainly to one species, *Bolyphantes index*, which comprised as much as 71 % of the total numbers in April. This was the only species showing a peak occurrence in late winter (the values indicative of this in Table 1 are each based on one sampling only). Palmgren (1975) also noted the frequent occurrence of *B. index* on snow in early spring.

C. Influence of weather conditions

Spiders were found on snow almost exclusively in mild weather. The lowest ambient temperature at which spiders were found was -2.6°C , and at below-zero temperatures captures were generally sporadic. Activity was highest at temperatures several degrees above zero. Spiders were captured at temperatures (measured on the snow surface with a mercury thermometer) ranging from -2 to $+2^{\circ}\text{C}$, except for one record of $+6^{\circ}$ in strong sunshine. During early winter the activity of spiders decreased continuously: samples taken in Kiiminki in 1976—77 at similar ambient temperatures contained successively fewer spiders. During the same period the thickness of the snow cover increased, which was probably at least partly responsible for the result (Table 2). In mid-winter the number of spiders on snow dropped practically to zero.

It is interesting to note that a corresponding increase in activity was not recorded during late winter. The catch of *B. index* was highest at the first sampling in March, and in spite of higher temperatures the species was absent from some later samples. Unfortunately, sampling was not performed during the mild period before March 20 (Fig. 1). In Kuusamo, *B. index* was abundant only in April.

¹ Coordinates of the grid system used for biological recording in Finland; see Heikinheimo & Raatikainen (1971).

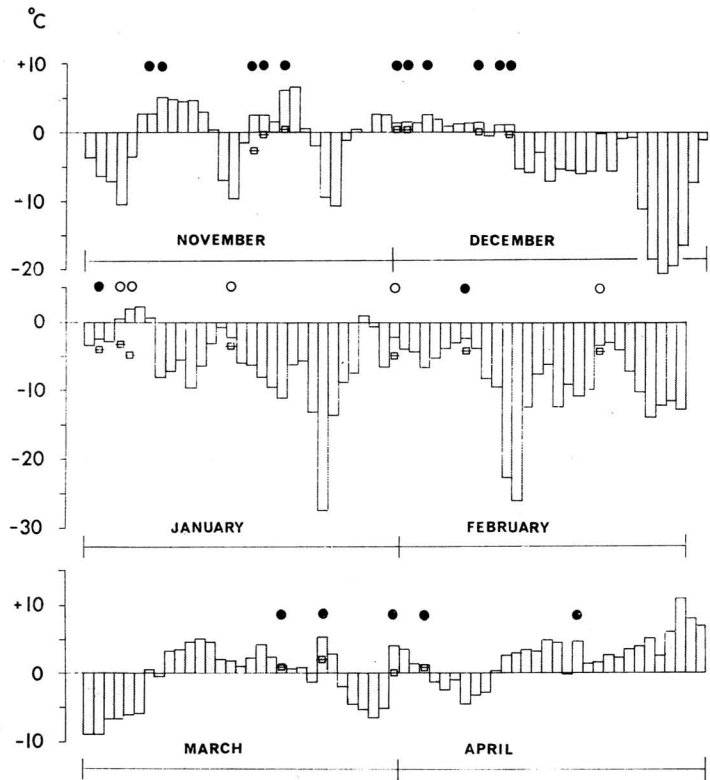


Fig. 1. Daily maximum temperatures at Oulu airport during winter 1976—77, when systematic sampling was performed in Kiiminki. Temperatures measured on the snow surface at sampling are indicated by squares with a horizontal line in the middle. Circles denote dates when samples were collected (open circles = no spiders).

4. Discussion

The large number of spiders belonging to ca. 100 species captured on snow indicates that many more spiders than hitherto believed are active at temperatures near the freezing point. Probably this is not a special property of certain "winter-active" species but indicates that, when environmental conditions are appropriate, almost any species present in the community may be found on snow. A considerable proportion of the species found live permanently on the ground or in litter (Table 1), and these must have penetrated the snow, for example by climbing along stems of trees and bushes. The presence of tree-living species may be explained by involuntary dropping, but this cannot be the main reason for species encountered regularly on snow. The present data do not shed light on the biological meaning of this activity. It may be a search for final overwintering quarters (tree-living species wandering to the ground, ground-living species making horizontal migrations), but this probably takes place before

the onset of winter conditions. Alternative explanations are escape from water-logged soil during thaw weather, or simply a continuation of normal activity in spite of low temperatures.

Nevertheless, there remains a group of species that have their main period of activity during the winter, and these probably constitute the bulk of the total numbers. *Macrargus rufus*, *M. carpenteri*, *Centromerita bicolor*, *Centromerus expertus*, *C. sylvaticus*, *C. incilius*, *Drepanotylus uncatu*, *Lepthyphantes cristatus* and *Trachynella nudipalpis* have been placed in this category by Tretzel (1954), Broen & Moritz (1963), Buche (1966) and Schaefer (1971, 1977 a, b). Hågvar (1973) showed that *Bolyphantes index* carries on its normal activities on the snow surface: web-building, feeding and copulation. Winter activity is a special adaptation to avoid competition with other species and to utilize the resource offered by winter-active insects. Life cycles and temperature reactions of some of these species have been studied in detail by Buche (1966), Hågvar (1973) and Schaefer (1976, 1977 a, b). In our material the species mentioned above

constitute ca. half of all adult Linyphiids, and many further species may in fact belong to the same category.

5. Taxonomic note

Macrargus boreus and *M. multesimus* are very similar species which, according to Palmgren (1975), should be regarded as geographical races in terms of modern taxonomy. The only distinctive feature is the shape of the lamella characteristic of the male palp; otherwise the species are hardly distinguishable. In the present material from Kiiminki, the shape of the lamella is variable, some specimens being identical to those from southern or central Finland, but many showing reduction

of the lower branch of the lamella as in *M. multesimus* (Fig. 2). The only male found in Kuusamo is clearly of the type of *M. multesimus* (upper branch of lamella rounded). There remains a gap between Kiiminki and Kuusamo (no males in the collections), but further material from northern Finland might reveal a continuous variation, in which case the species should be synonymized.

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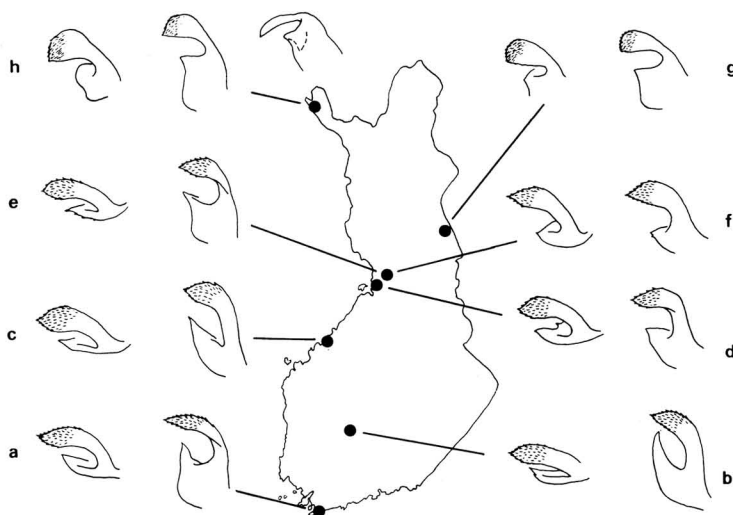


Fig. 2. Lamellae characteristic of male palps of *Macrargus boreus* Holm (a-f) and *M. multesimus* (Cbr.) collected from different parts of Finland. Each lamella viewed from above and from the side, h also from below. d to g from the present material, others from the collections of the Zoological Museum, University of Helsinki.

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