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Spider (Arachnida, Aranei) Assemblages of Some Habitats from the Kola Gulf Coast: Phenological Aspect

A. A. Nekhaeva

Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, 119071 Russia
e-mail: adrealinea@gmail.com

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Abstract—Spiders were collected by pitfall traps in three habitats at the Kola Gulf west coast (Murmansk Province) during the snowless period of 2010. A total of 88 spider species were found, 8 of which were new for the Kola Peninsula. The assemblages of the birch forest and the road embankment were the most similar in their species composition but different in the sets of dominant species and the seasonal dominance structure; the assemblage of the maritime meadow was distinguished by the highest capture rates. The species number and abundance of spiders in the assemblages decreased from spring to autumn; the species evenness also decreased while the fraction of the dominants (especially some of them) increased. The most abundant species in all the habitats studied were found to have different periods of maximum activity.

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Since the first records in the araneological works of Simon (1887) and Fedotov (1912), research of spiders of the Kola Peninsula has been focused on the faunistic aspects only. There are several publications devoted to the spider fauna of the islands of the Kandalaksha Reserve and the north coast of the peninsula (Byzova et al., 1986; Tanasevitch and Rybalov, 2010; Nekhaeva and Nekhaev, 2011). The most complete faunistic data were published by Tanasevitch and Kamaev (2011), who listed 228 species for the Kola Peninsula. However, considering the recent publications (Nekhaeva, 2012; Zenkova et al., 2013), this number can be increased to 237. Data on the biotopic associations and phenology are provided in the available literature only in addition to the faunistic lists, whereas for some species they are totally absent.

The only attempt at an ecological classification of spiders in the south part of the Kola Peninsula was that of Beer (1964), who subdivided the studied species into five groups by their biotopic associations. No ecological studies of spiders were carried out in other parts of the peninsula.

The goal of this work was to study the specific features of the spider assemblages of three contrasting biotopes in the west coast of the southern segment of the Kola Gulf (the environs of Murmansk). The following specific tasks were set: to describe the species composition of the individual assemblages and the spider fauna as a whole; to reveal the biotopic associations of some mass species; to characterize the general trends in the seasonal dynamics of the dominant species and the entire taxocenes.

MATERIALS AND METHODS

This work is based on the pitfall collections made during the snowless period of 2010 in three different biotopes located on the west coast of the southern segment of the Kola Gulf, in the environs of Murmansk. The study region lies at the boundary of the northern taiga and crooked birch forests (forest-tundra) (Koroleva et al., 2011) and has a low-mountain landscape with altitudes up to 350–450 m above sea level (Yakovlev, 1961). The tops of the tallest hills are occupied by tundra communities while the slopes facing the gulf are covered with forests of the birch *Betula czerepanovii*. Maritime meadow vegetation is developed in the flat coastal areas.

Due to the proximity of the Barents Sea, the winter in the study region is warmer than in the continental part while the summer is cool, with the annual mean air temperature reaching +0.1°C. The mean temperature of February (the coldest month) is about –10°C, that of July (the warmest month), about +10°C (Yakovlev, 1961). The mean duration of the snowless period is 109 days (*Climate of the USSR…*, 1988). The duration of summer, i.e., the period of the mean daily temperatures exceeding +10°C, is only 45–60 days (Isachenko, 1985).

Three contrasting biotopes were studied:

(1) A whortleberry dwarf cornel birch forest (68°54.38′N, 33°00.97′E). The projective cover is 90%; the prevalent plant species are *Betula czerepanovii*, *Juniperus sibirica*, *Chamaepericlymenum suecicum*, *Vaccinium myrtillus*, *V. vitis-idaea*, *V. uliginosum*, *Gymnocarpium dryopteris*, *Ledum palustre*, *Empetrum hermaphroditum*, *Trientalis europaea*, *Lycopodium* sp., *Dicranum* sp., *Pleurozium schreberi*, and *Hylocomium* sp. Collections were made in 30.04–15.IX.2010.

(2) An embankment bordering the birch forest (68°54.36′N, 33°01.19′E), formed as a refuse dump during construction of a road along the gulf coast. This habitat is a recovering forest community with the prevalence of small birch coppice and herbaceous vegetation. The projective cover is about 30%; the most noticeable elements are young *Betula czerepanovii* trees 0.5–1.0 m tall, and also sparse clumps of grasses, mosses, and lichens. Collections were made in 30.04–15.IX.2010. This habitat had the most extreme conditions of all the biotopes studied and was characterized by water deficiency due to sandy soils and a low projective cover.

(3) A maritime meadow at the boundary of the littoral and supralittoral zones of Cape Stvorny, the Kola Gulf (68°54.36′N, 33°01.54′E). The projective cover is 100%; the prevalent plant species are *Leymus arenarius*, *Ligusticum scothicum*, *Comarum palustre*, *Parnassia palustris*, *Rumex acetosa*, *Chamaepericlymenum suecicum*, *Dianthus superbus*, *Festuca* sp., *Poa* sp., *Avenella flexuosa*, and *Euphrasia frigida*. Collections were made in 28.06–15.IX.2010. The traps installed in this biotope were sometimes flooded at high tide, which may to a certain extent reduce the size of some samples.

The last two habitats are characterized by early melting of snow cover due to the absence of the dense tree canopy. Maritime meadows and birch forests are among the most typical communities of the Kola Gulf coastal area.

The pitfall traps were made of plastic cups 70 mm high with an opening 55 mm in diameter, filled by one-third with 4–8% formalin solution. The traps were checked once a week, except for the last samples which were collected after a two-week gap (30.VIII–15.IX.2010). The total material comprised about 5000 trap-days; 3823 ind. of spiders were collected, of which 3266 were identified to species.

Since the pitfall trap method mostly reveals the herpetobiont fauna, we additionally carried out repeated qualitative collections (manually and with a sifter) in the above biotopes and in a number of other habitats near Murmansk in 2009–2011. This material was used to compile a preliminary list of spider species of Murmansk area. Only mature individuals identified to species were taken into account; some other cases are considered in the text below.

The dominance structure was characterized using the scale of Engelmann (1978): the species comprising 1.3–3.9% in the sample were regarded as recedents, 4.0–12.4%, subdominants, 12.5–39.9%, dominants, 40.0–100%, eudominants.

We considered three seasons: spring, summer, and autumn, distinguished after Isachenko (1985) and Yakovlev (1961). In particular, spring (April 30–June 21) is marked by the stably positive mean daily temperatures, the appearance of thawed patches, and daily insolation snowbreaks; summer (June 21–August 17), by the mean daily temperatures stably exceeding 10°C and complete thawing of the snow cover; autumn (August 17–September 15), by the daily temperatures dropping below 10°C and the leaf color change.

The similarity of the spider populations in different seasons was estimated by the Bray-Curtis index. The faunistic similarity between the spider assemblages of different biotopes was estimated by the Dice index. The calculations were performed in PAST 1.97 software (Hammer et al., 2001). The dendrogram was built by the UPGMA method; for convenience, the whole study period was divided into two-week intervals. The evenness of the species structure of samples was determined by the Pielou index (see Potapov and Kuznetsova, 2011).

RESULTS AND DISCUSSION

The General Characteristic of the Fauna

In all, 88 species of spiders were collected during the study period, whereas almost twice as many species were recorded in the forest-tundra of the northernmost part of Finland (Koponen, 2012). Nine of the species in our material were absent in the pitfall samples from the model biotopes but were collected manually or with a sifter in other habitats (Table 1). Representatives of the family Linyphiidae constituted the core of the spider fauna (69% of species: 61 spe-

Table 1. Species composition of spiders in the environs of Murmansk, based on the collections of 2009–2011

Species	Biotope				Range		Collection period
	Emb	BF	MM	other	Lon	Lat	
Family Agelenidae (1)							
Tegenaria domestica (Clerck, 1757)*				1	C	s	June 2010
Family Araneidae (1)							
Araneidae gen. sp.*				4			4.VI.2011
Family Clubionidae (1)							
Clubiona kulczynskii Lessert, 1905	2				H	p	21.VI–11.VII
Family Cybaeidae (1)							
Argyroneta aquatica (Clerck, 1757)*				2	P	p	12.IX.2011
Family Dictynidae (1)							
Dictyna uncinata Thorell, 1856	1				P	b-n	23–30.V
Family Gnaphosidae (2)							
Gnaphosa lapponum (L. Koch, 1866)*				1	E	b	4.VI.2011
Haplodrassus soerenseni (Strand, 1900)	2	1			P	p	6–28.VI
Family Hahniidae (2)							
Cryphoeca silvicola (C.L. Koch, 1834)	1	31		8	P	b-n	8.V–15.IX
Hahnia ononidum Simon, 1875	2	24			H	b-n	23.V–15.IX
Family Linyphiidae (61)							
Agnyphantes expunctus (O.P.-Cambridge, 1875)		1		1	P	b	3–11.VII
Agyneta cauta (O.P.-Cambridge, 1902)	9	4			E		23.V–28.VI
A. conigera (O.P.-Cambridge, 1863)	1				P	b-n	21–28.VI
A. gulosa (L. Koch, 1869)	7				P	b-n	16.V–11.VII
Allomengea scopigera (Grube, 1859)	8	1	533		P-WN	b-n	19.VII–15.IX
Bathyphantes eumenis (L. Koch, 1879)	3	9	2	3	H	a-b	23.V–3.VIII
B. gracilis (Blackwall, 1841)			1		H	p	3–11.VII
B. setiger F.O.P.-Cambridge, 1894			1	1	P	b-n	3–11.VII
Bolyphantes luteolus (Blackwall, 1833)	1				P	p	30.VIII–15.IX
Centromerus arcanus (O.P.-Cambridge, 1873)	3	11	1		WP	p	30.V–26.VII
C. sylvaticus (Blackwall, 1841)	12	75	52	2	H	p	19.VII–15.IX
Ceratinella brevipes (Westring, 1851)	2	1			P	p	16.V–6.VI
Decipiphantes decipiens (L. Koch, 1879)		1		3	F-S	b	16–23.V
Diplocentria rectangulata (Emerton, 1915)		1			H	b	13–21.VI
Diplocephalus cristatus (Blackwall, 1833)			1		H	b-n	3–11.VII
Drepanotylus borealis Holm, 1945			9		F-S	b	26.VII–15.IX
Entelecara acuminata (Wider, 1834)*				1	WP		4.VI.2011
Erigone arctica maritima Kulczynski, 1902			56	4	WE-A	b	28.VI–19.VII
E. atra Blackwall, 1833	83	1	17	1	H	p	30.04–15.IX
E. longipalpis (Sundevall, 1830)			766	29	P	b-n	28.VI–15.IX
Flagelliphantes bergstroemi (Schenkel, 1931)		1			F-S	b	6–13.VI

Table 1. (Contd.)

Species	Biotope				Range		Collection period
	Emb	BF	MM	other	Lon	Lat	
Gonatium rubellum (Blackwall, 1841)		1			P	b-n	19–26.VII
Helophora insignis (Blackwall, 1841)	5	5	1		H	p	3.VIII–15.IX
Hilaira herniosa (Thorell, 1875)	4	81	2	6	H	b	16.V–15.IX
H. pervicax Hull, 1908			1		P	b-n	19–26.VII
Hypselistes jacksoni (O.P.-Cambridge, 1902)*				1	P-WN	p	11.VI.2011
Kaestneria pullata (O.P.-Cambridge, 1863)			2		H	p	3.VII–10.VIII
Leptorhoptrum robustum (Westring, 1851)	1	11	21	1	P-WN	b-n	30.V–15.IX
Leptothrix hardyi (Blackwall, 1850)	9				E		3.VIII–15.IX
Macrargus multesimus (O.P.-Cambridge, 1875)	1	8		3	H	b	30.04–30.V
M. rufus (Wider, 1834)	5	18		10	E	b-n	8.V–10.VIII
Maso sundevalli (Westring, 1851)	1	4			H	p	3.VII–30.VIII
Mecynargus borealis (Jackson, 1930)*				2	H	b	11.VI.2011
M. morulus (O.P.-Cambridge, 1873)*				1	E	b-n	11.VI.2011
M. paetulus (O.P.-Cambridge, 1875)	1		1		H	b-n	23.V–3.VII
Micrargus herbigradus (Blackwall, 1854)		8			P	p	30.V–21.VI
Microlinyphia pusilla (Sundevall, 1830)			1		H	p	26.VII–3.VIII
Microneta viaria Simon, 1897	12	15		2	H	p	16.V–26.VII
Oreoneta sinuosa (Tullgren, 1955)*				1	F	b	11.VI.2011
Oreonetides vaginatus (Thorell, 1872)	3	17		2	H	b	8.V–19.VII
Oryphantes angulatus (O.P.-Cambridge, 1881)	9	61	1	13	E	b-n	8.V–11.VII
Oedothorax apicatus (Blackwall, 1850)			34		E-AM	p	28.VI–26.VII
O. retusus (Westring, 1851)			45	5	P	p	28.VI–15.IX
Palliduphantes antroniensis (Schenkel, 1933)		20			E	b-n	16.V–28.VI
Panamomops mengei Simon, 1926		1			WP	b-n	11–19.VII
Perregrinus deformis (Tanasevitch, 1982)	1				F-S-N	b	16–23.V
Pocadicnemis pumila (Blackwall, 1841)	1	1			H	p	23.V–21.VI
Savignia frontata Blackwall, 1833			16	1	WP	p	28.VI–10.VIII
Semljicola faustus (O.P.-Cambridge, 1900)	1				E	b	19–26.VII
Silometopus reussi (Thorell, 1871)			4		P	b-n	3–11.VII
Tallusia experta (O.P.-Cambridge, 1871)	3	1			P		16.V–17.VIII
Tapinocyba pallens (O.P.-Cambridge, 1872)		26		3	E	b-n	23.V–21.VI
Tenuiphantes alacris (Blackwall, 1853)	1	97		16	P	p	30.04–15.IX
T. mengei (Kulczynski, 1887)	10	8	6		P	p	3.VII–15.IX
T. nigriventris (L. Koch, 1879)		5			P	b-n	11.VII–30.VIII
T. tenebricola (Wider, 1834)		100			P	b-n	23.V–15.IX
Walckenaeria cuspidata Blackwall, 1833	4	2		2	P	p	8.V–21.VI
W. karpinskii (O.P.-Cambridge, 1873)	4	19			F-S-N	a-b	23.V–17.VIII

Table 1. (Contd.)

Species	Biotope				Range		Collection period
	Emb	BF	MM	other	Lon	Lat	
W. nudipalpis (Westring, 1851)	1	5			P	p	23.V–26.VII
W. unicornis O.P.-Cambridge, 1861	1	1			WP	b-m	23–30.V
Zornella cultrigera (L. Koch, 1879)	1	45	1	5	H	b	30.04–15.IX
Family Liocranidae (1)							
Agroeca proxima (O.P.-Cambridge, 1871)	1	1			E		26.VII–3.VIII
Family Lycosidae (10)							
Alopecosa aculeata (Clerck, 1757)	10	7	1		H	p	30.V–17.VIII
Pardosa cf. *agrestis* (Westring, 1861)			1		P	p	3–11.VII
P. amentata (Clerck, 1757)	1		27	3	WP	b-n	21.VI–15.IX
P. hyperborea (Thorell, 1872)	3	1	1	2	H	b-n	30.V–3.VIII
P. lugubris (Walckenaer, 1802)	103	102	2	10	P	p	16.V–15.IX
P. palustris (Linnaeus, 1758)	10	1	5	2	H	p	30.V–24.VIII
P. cf. *plumipes* (Thorell, 1875)			36	7	P	b-m	28.VI–15.IX
P. riparia (C.L. Koch, 1833)	1				E	b-n	13–21.VI
P. sphagnicola (Dahl, 1908)			9	1	P	p	3–26.VII
Pirata piraticus (Clerck, 1757)	1		43	1	H	p	28.VI–30.VIII
Family Mimetidae (1)							
Ero furcata (Villers, 1789)	1	1			P		6–28.VI
Family Tetragnathidae (1)							
Tetragnatha cf. *extensa* (Linnaeus, 1758)			2		H	p	19.VII–30.VIII
Family Theridiidae (2)							
Robertus lividus (Blackwall, 1836)	6	1	1		P-WN	b-n	16.V–15.IX
R. scoticus Jackson, 1914	1				WP	b-n	16–23.V
Family Thomisidae (3)							
Ozyptila trux (Blackwall, 1846)	15	12			P	p	23.V–15.IX
Xysticus luctuosus (Blackwall, 1836)	4				H	b-n	30.V–21.VI
X. obscurus Collett, 1877	3	3			H	p	16.V–21.VI
Number of species	**51**	**48**	**36**	**38**			
Number of genera	**37**	**38**	**23**	**28**			

Notes: Biotopes: Emb, road embankment; BF, birch forest; MM, maritime meadow; Lon, longitudinal characteristic: C, cosmopolitan; E, European; E-AM, European-Ancient Mediterranean; F, Fennoscandian; F-S, Fennoscandian-Siberian; F-S-N, Fennoscandian-Siberian-Nearctic; H, Holarctic; P, Palaearctic; P-WN, Palaearctic-West-Nearctic; WE-A, West-European-Altaian; WP, West Palaearctic; Lat, latitudinal characteristic: a-b, arctoboreal; b, boreal; b-m, boreomontane; b-n, boreo-nemoral; p, polyzonal; s, synanthropic. The longitudinal and latitudinal (landscape-zonal) characteristics of ranges are given after Marusik et al., 2000; Esyunin, 2005; Tanasevitch and Koponen, 2007; Marusik and Eskov, 2009; Tanasevitch and Kamaev, 2011; Tanasevitch, 2013. For the biotopes Emb, BF, and MM, the number of specimens collected in pitfall traps is given. Data for *O. apicatus* and *O. retusus* refer to males only. The "other" column lists the specimens collected manually or with a sifter in 2008–2011 in the three specified biotopes and in other habitats. Species collected only manually or with a sifter are marked with asterisks.

cies, 43 genera) while the second place belonged to the family Lycosidae (11%: 10, 3), which is generally typical of the spider fauna in the north of Eurasia (Mikhailov, 1997; Marusik and Eskov, 2009; Koponen, 2012). A high fraction of Linyphiidae in the total species diversity was also reported for the north of Norway (Aakra et al., 2000), the Khibiny Mountains, and the Pasvik Reserve (Zenkova et al., 2013; Nekhaeva, unpublished data). The remaining 12 families were mostly represented by 1–3 species each. The

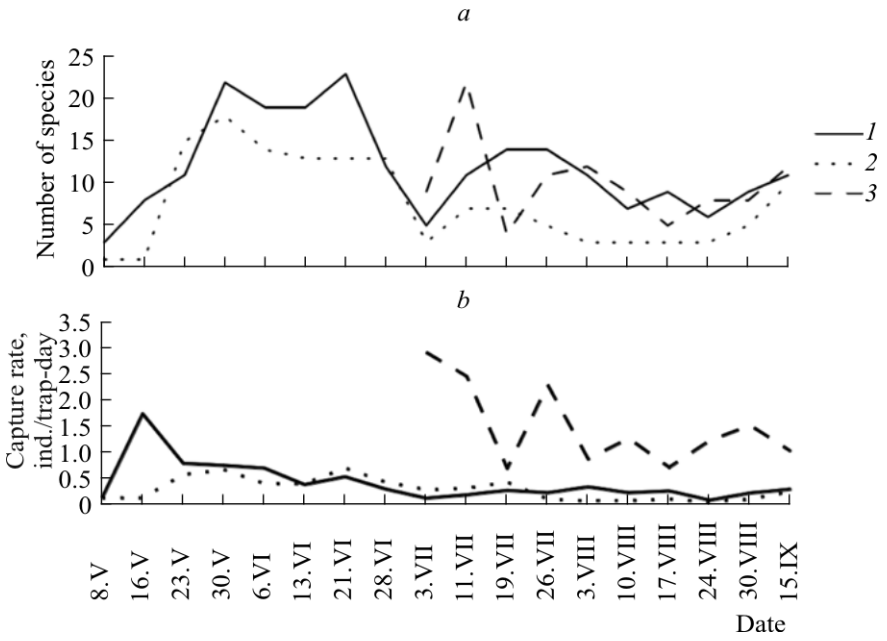

Fig. 1. Seasonal dynamics of the number of species (*a*) and the capture rates (*b*) of spiders in the environs of Murmansk in 2010: *1*, birch forest; *2*, embankment; *3*, maritime meadow.

most diverse were one genus of wolf spiders, namely *Pardosa* (8 species), and two genera of sheet weavers, *Tenuiphantes* and *Walckeaeria* (4 species each).

The most abundant in our collections were also the representatives of Linyphiidae, which comprised 2778 ind., or 85% of the total number of spiders collected, and Lycosidae with 364 ind. (11%). The most common of the recorded species were *Erigone longipalpis* (with 766 ind. collected in all the biotopes during the entire study period), *Allomengea scopigera* (542), *Pardosa lugubris* (207), *Centromerus sylvaticus* (139), *Erigone atra* (101), *Tenuiphantes alacris* (107), *T. tenebricola* (100), and *Oedothorax* spp. (317 ind.). Of the latter genus, 34 males of *O. apicatus* and 45 males of *O. retusus* were identified, whereas the females which comprised the majority could not be identified. The representatives of Araneidae were juveniles which could not be identified, either.

Entelecara acuminata, *Flagelliphantes bergstroemi*, *Gonatium rubellum*, *Leptothrix hardyi*, *Microlinyphia pusilla*, *Ero furcata*, *Pardosa* cf. *plumipes*, and *Argyroneta aquatica* are recorded here for the first time for the fauna of the Kola Peninsula. The latter species was recorded by Beer (1964) on Velikiy Island (Kandalaksha Bay, White Sea); it represents the family Cybaeidae which is also new for the Kola Peninsula. *Clubiona kulczynskii*, *Dictyna uncinata*, and *Tegenaria domestica* were previously reported from Murmansk Province only by Fedotov (1912), and *Pardosa riparia*, only by Beer (1964).

The spider fauna of the three model biotopes was mostly formed by species with broad ranges (89% of the total number), among which spiders with Holarctic (33%) and Palaearctic (35%) distribution were best represented. Species with narrow European ranges constituted only 11%. Analysis of the landscape and zonal associations revealed absolute prevalence of polyzonal (42%), boreo-nemoral (37%), and boreal (16%) species, whereas arctoboreal species comprised only 3% of the total number. This arealogical structure is also characteristic of the Kola Peninsula as a whole (Tanasevitch and Kamaev, 2011).

These general trends were preserved within individual biotopes, although the fraction of European species in the maritime meadow decreased to 3% while that of polyzonal species increased to 50%.

The Species Structure and Capture Rates

The number of species collected in the birch forest and on the embankment increased during the first month after snowmelt, reached its maximum by May 30, and only slightly varied till the end of June (Fig. 1*a*). After an abrupt drop recorded on July 3, the diversity increased again by July 11–19; it also increased insignificantly in all the three biotopes at the end of August.

Table 2. Complexes of dominant spider species in three biotopes in the environs of Murmansk

Species and season	Spring: 30.IV–21.VI		Summer: 21.VI–17.VIII		Autumn: 17.VIII–15.IX	
	N	%	*N*	%	*N*	%
Birch forest						
Tenuiphantes alacris	**61**	**13.6**	31	11.4	5	3.8
Oryphantes angulatus	**58**	**12.9**	3	1.1	0	0
Pardosa lugubris	54	12.1	**48**	**17.6**	0	0
Tenuiphantes tenebricola	1	0.2	**84**	**30.8**	15	11.5
Centromerus sylvaticus	0	0	5	1.8	**70**	**53.8**
Hilaira herniosa	37	8.3	30	11	14	10.8
Zornella cultrigera	28	6.3	9	3.3	8	6.2
Cryphoeca silvicola	27	6	2	0.7	2	1.5
Tapinocyba pallens	26	5.8	0	0	0	0
Palliduphantes antroniensis	19	4.2	1	0.4	0	0
Macrargus rufus	18	4	0	0	0	0
Others	119	26.6	60	22	16	12.3
Total number of ind.	448	100	273	100	130	100
Total number of species	38		28		13	
Pielou index E	79.2		70.9		64.5	
Road embankment						
Pardosa lugubris	**50**	**24.9**	**52**	**40.9**	1	2.1
Erigone atra	**49**	**24.4**	**33**	**26**	1	2.1
Allomengea scopigera	0	0	2	1.6	**6**	**12.5**
Centromerus sylvaticus	0	0	0	0	**12**	**25**
Leptothrix hardyi	0	0	1	0.8	**8**	**16.7**
Tenuiphantes mengei	0	0	1	0.8	**9**	**18.8**
Microneta viaria	11	5.5	1	0.8	0	0
Agyneta cauta	9	4.5	0	0	0	0
Oryphantes angulatus	9	4.5	0	0	0	0
Ozyptila trux	2	1	11	8.7	2	4.2
Helophora insignis	0	0	0	0	5	10.4
Others	71	35.3	26	20.5	4	8.3
Total number of ind.	201	100	127	100	48	100
Total number of species	36		24		12	
Pielou index E	74		62.3		83.3	
Maritime meadow						
Erigone longipalpis	–	–	**751**	**48.2**	15	3.5
***Oedothorax* spp.**	–	–	**308**	**19.8**	8	1.9
Allomengea scopigera	–	–	**211**	**13.5**	**322**	**75.2**
Centromerus sylvaticus	–	–	1	0.1	51	11.9
Others	–	–	287	18.4	32	7.5
Total number of ind.	–	–	1558	100	428	100
Total number of species	–		34		15	
Pielou index E	–		50.5		37.3	

Notes: *N* is the number of spiders collected in the biotope in the given season; % is the fraction of the species in the total population in the given season; "Others" refers to the remaining (not common) species; dashes indicate the absence of data. Species included in the dominant complex in some seasons are shown in bold.

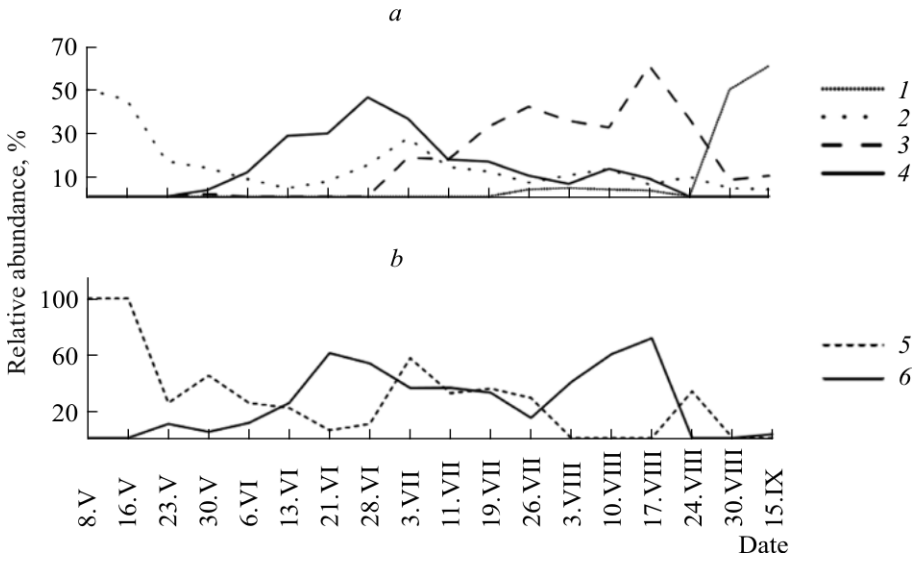

Fig. 2. Dynamics of activity of the common spider species in the birch forest (*a*) and on the road embankment (*b*): *1*, *Centromerus sylvaticus*; *2*, *Tenuiphantes alacris*; *3*, *T. tenebricola*; *4*, *Pardosa lugubris*; *5*, *Erigone atra*; *6*, *P. lugubris*. Ordinate: fractions of species in the sample.

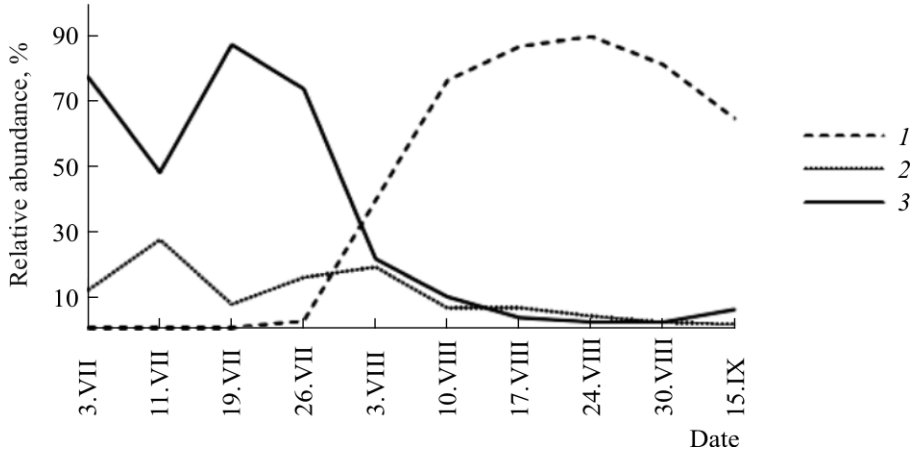

Fig. 3. Dynamics of activity of the common spider species in the maritime meadow: *1*, *Allomengea scopigera*; *2*, *Oedothorax* spp.; *3*, *Erigone longipalpis*. *Ordinate*: fractions of species in the sample.

The total number of species recorded on the road embankment and in the birch forest was approximately the same: 51 and 48, respectively. These biotopes were also the most similar by their taxonomic composition (Dice index 0.7), which may be accounted for by their adjoining position. *Clubiona kulczynskii* (Clubionidae) and *Dictyna uncinata* (Dictynidae) were found only on the embankment, but they are likely to be recorded in the forest as well in the course of further research.

The fauna of the maritime meadow was the most isolated (Dice index 0.4 when compared with each of the two other biotopes). Despite the relatively small number of species recorded (36), possibly due to a later beginning of collections, this fauna revealed the highest diversity of Lycosidae (9) and the greatest fraction of this family in the total number of species (25%). The species found only in the meadow (17) constituted almost half of the total number of species in this biotope (47%), whereas in the forest and on the embankment there were only 11 such species (23 and 22%, respectively) (Table 1).

Despite periodical flooding at high tide, the highest capture rates were recorded in the maritime meadow, where 2299 ind. (including juveniles) were collected from June 28 to September 15, the mean rate being 180 ind./100 trap-days. During the same period, only 441 ind. were collected in the forest and 212 ind., on the embankment, so that the mean capture rate was about 30 ind./100 trap-days in both biotopes. The high activity of spiders in the maritime meadow is probably

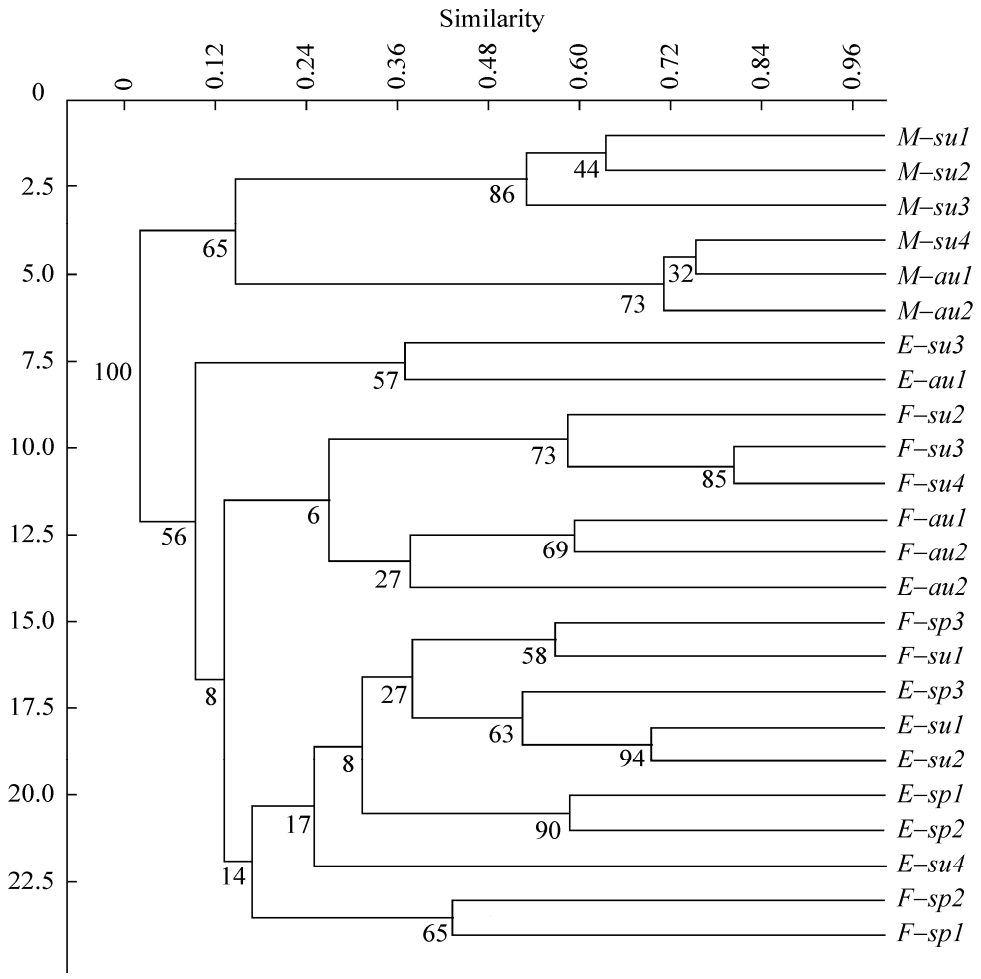

Fig. 4. A similarity dendrogram of spider samples taken from the model biotopes in different seasons. The number at each node is the support value of bootstrap analysis using 100 random samples. Biotopes: *F*, birch forest; *M*, maritime meadow; *E*, embankment. Seasons and periods: *sp*, spring: *1*, 30.IV–23.V; *2*, 23.V–6.VI; *3*, 6–21.VI; *su*, summer: *1*, 21.VI–3.VII; *2*, 3–19.VII; *3*, 19.VII–3.VIII; *4*, 3–17.VIII; *au*, autumn: *1*, 17–30.VIII; *2*, 30.VIII–15.IX. Due to the later start of collections in the maritime meadow, the period *M–su1* includes only one week: 28.VI–3.VII.

related to the great quantities of quickly decomposing organic remains which serve as a substrate for development of numerous invertebrates providing an abundant food resource.

Judging by the fraction of a given species in the total number of spiders collected in a biotope during each season, the assemblages of the forest and the embankment included 11 species each which were at least once present in the dominant complex (Table 2). Despite the high faunistic similarity of these biotopes, their dominant complexes shared only three species: *Oryphantes angulatus*, *Pardosa lugubris*, and *Centromerus sylvaticus*. The assemblage of the maritime meadow had fewer dominant species but the fraction of each species and, correspondingly, the dominance class, was greater.

The diversity and number of the spiders collected in the assemblages decreased from spring to autumn. This was accompanied by a decrease in the evenness of the species structure and an increase in the fraction of the dominant species (73–71–82% in the birch forest, 64–76–88% on the embankment, 82–87% in the meadow) and the significance of some of the dominants (Table 2).

The Seasonal Population Dynamics

In the birch forest, we observed a distinct growth in the spider capture rates in spring (May 16), which was determined by high activity of Linyphiidae (Fig. 1*b*). On the embankment the spider activity increased more slowly in spring and remained at approximately the same level of 50 ind./100 trap-days until mid-July.

Table 3. Seasonal dynamics of pitfall captures of the dominant spider species (ind./100 trap-days) in different biotopes in the environs of Murmansk in 2010

Collection period	Spring							Summer								Autumn		
	30.IV–8.V	8–16.V	16–23.V	23–30.V	30.V–6.VI	6–13.VI	13–21.VI	21–28.VI	28.VI–3.VII	3–11.VII	11–19.VII	19–26.VII	26.VII–3.VIII	3–10.VIII	10–17.VIII	17–24.VIII	24–30.VIII	30.VIII–15.IX
Birch forest																		
Tenuiphantes alacris	6.3	79.2	13	10	5.7	1.4	3.8	4.3	3.2	2.5	3.1	1.4	3.3	2.9	1.4	0.7	0.8	0.9
Oryphantes angulatus	0	4.2	10.4	11.4	20.7	2.1	0.6	0.7	0	1.3	0	0	0	0	0	0	0	0
Pardosa lugubris	0	0	0	2.1	7.9	10.7	15.6	13.6	4.2	3.1	4.4	2.1	2	2.9	2.1	0	0	0
Tenuiphantes tenebricola	0	0	0	0.7	0	0	0	0	2.1	3.1	8.8	9.3	11.8	7.1	15.7	2.9	1.7	2.8
Centromerus sylvaticus	0	0	0	0	0	0	0	0	0	0	0	0.7	1.3	0.7	0.7	0	10.8	17.8
Hilaira herniosa	0	0	3.9	10.7	3.6	3.6	5.6	1.4	0	0.6	0.6	1.4	7.9	7.1	1.4	1.4	2.5	2.8
Zornella cultrigera	3.1	12.5	13	3.6	2.9	2.1	1.3	2.1	0	1.3	0.6	0.7	0.7	0.7	0	1.4	1.7	1.3
Cryphoeca silvicola	0	29.2	13	4.3	2.1	0	0.6	0	0	0	0	0.7	0	0	0.7	0.7	0	0.3
Tapinocyba pattens	0	0	0	10	5	2.1	1.3	0	0	0	0	0	0	0	0	0	0	0
Pattiduphantes antroniensis	0	0	3.9	3.6	3.6	0.7	3.1	0.7	0	0	0	0	0	0	0	0	0	0
Macrargus rufus	0	25	9.1	2.9	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0
Road embankment																		
Pardosa lugubris	0	0	5.7	2.9	4.3	10	42.5	22.9	10	11.3	13.8	1.4	2.5	4.3	7.1	0	0	0.6
Erigone atra	12.5	12.5	14.3	30	10	8.6	3.8	4.3	16	10	15	2.9	0	0	0	1.4	0	0
Attomengea scopigera	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	1.4	3.3	1.9
Centromerus sylvaticus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.7	6.9
Leptothrix hardyi	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0	1.4	1.7	3.8
Tenuiphantes mengei	0	0	0	0	0	0	0	0	0	1.3	0	0	0	0	0	0	0	5.6
Microneta viaria	0	0	7.1	2.9	2.9	1.4	1.3	1.4	0	0	0	0	0	0	0	0	0	0
Agyneta cauta	0	0	0	2.9	7.1	1.4	1.3	0	0	0	0	0	0	0	0	0	0	0
Oryphantes angulatus	0	0	4.3	4.3	2.9	1.4	0	0	0	0	0	0	0	0	0	0	0	0
Ozyptila trux	0	0	0	2.9	0	0	0	1.4	2	2.5	7.5	1.4	0	0	0	0	1.7	0.6
Helophora insignis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.1
Maritime meadow																		
Erigone longipalpis	–	–	–	–	–	–	–	–	226	117.8	60	169	18.5	12.1	2.2	2.2	2.6	5.7
Oedothorax spp.	–	–	–	–	–	–	–	–	34	66.9	5	35.7	16.3	7.7	4.4	4.4	2.6	1
Attomengea scopigera	–	–	–	–	–	–	–	–	0	0	0	4.8	34.2	96.7	61.5	109.9	123.1	65.6
Centromerus sylvaticus	–	–	–	–	–	–	–	–	0	0	0	0	0	0	1.1	0	12.8	21.4

The capture rates in these two biotopes dropped by autumn. In the maritime meadow, where collections started only on June 28, the maximum captures were observed already during the first weeks (July 3–11), due to high activity of such species as *Oedothorax* spp., *Erigone arctica maritima*, *E. longipalpis*, *Pirata piraticus*, *Pardosa* cf. *plumipes*, and *P. amentata*, which were found only in this biotope. In general, as mentioned above, the spider activity in the maritime meadow was 2–6 times as high as in the two other biotopes.

The capture rates of the dominant species also varied during the study period (Table 3). In the forest, the highest rates were recorded for *T. alacris* in spring (79 ind./100 trap-days., the maximum value for this biotope), for *P. lugubris* in late spring and for *T. tenebricola* in late summer (about 16 ind./100 trap-days each), and for *C. sylvaticus* in autumn (18 ind./100 trap-days.). These four species were the only ones that developed the maximum abundance in the assemblage, i.e., reached the eudominant position. The peaks of relative abundance occurred in succession: *T. alacris*, *P. lugubris*, *T. tenebricola*, and *C. sylvaticus* (Fig. 2*a*).

The capture dynamics of *P. lugubris* revealed similar trends on the embankment and in the forest: the activity of these spiders increased since the end of May (May 16–23) and reached its maximum by June 21, then it decreased by the end of summer, and after August 24 the species "disappeared" from the assemblage (Table 3). On the embankment *P. lugubris* showed a higher activity, reaching the eudominant position twice during the study period and keeping it for a longer time (Fig. 2*b*). Such differences may be determined by the fact that only two out of 11 dominant species, namely *P. lugubris* and *E. atra*, were able to reach the maximum abundance parameters (Table 2). In addition, the sparse vegetation may have increased the probability of spiders getting into the traps. Similar to the dominant species in the forest, *P. lugubris* and *E. atra* on the embankment had alternating peaks of activity (Fig. 2*b*).

Among the dominant species in the maritime meadow, the highest capture rates were observed for *E. longipalpis* and *A. scopigera*: 226 and 123 ind./100 trap-days, respectively (Table 3). Similar to the other biotopes, the most abundant species had their activity peaks in different seasons (Fig. 3): *E. longipalpis* was the eudominant until the beginning of August, and *A. scopigera*, from mid-August to the end of the study period. As can be seen from the relative abundance plots, one eudominant form was usually present in each assemblage at any given moment.

It should be noted that most of the species mentioned in this chapter, except for *P. lugubris*, were common in only one biotope but were also represented by occasional findings in the other biotopes. Strict biotopic association was observed only for *Oedothorax* spp. and *E. longipalpis*, which were found only in the maritime meadow, and also for *T. tenebricola*, which was not recorded outside the birch forest.

Cluster analysis of samples revealed two large groups (Fig. 4), one including the spider population of the maritime meadow, the other, that of the birch forest and the road embankment. Within the first cluster the data were grouped by the collection dates. In the second cluster the seasonal subdivision was less distinct. This cluster consisted of two subgroups: the spring-summer one, including samples from the forest and the embankment, and the summer-autumn one, in which samples from the forest were clearly clustered by the collection dates. It should be noted that bootstrap analysis using 100 random samples confirmed the significance of the large clusters, whereas all the other clusters (with support values of 90% or smaller) were non-significant.

Several phenological groups could be distinguished among the mass species. Such species as *Macrargus rufus*, *Tapinocyba pallens*, *Oryphantes angulatus*, and *Cryphoeca silvicola* were mostly recorded in spring, until June 13; *C. sylvaticus* had distinct autumn peaks of activity in all the three biotopes, its capture rates increasing abruptly since August 24; *P. lugubris* was recorded during the entire study period but predominantly in late spring and summer, from May 16 to August 24. There were also multiseasonal species, for example, *Zornella cultrigera*, *T. alacris*, and *Hilaira herniosa*.

Our data on the seasonal occurrence of some species in the environs of Murmansk are similar to the available data for the hemiboreal and middle taiga subzones of southern Finland (Palmgren, 1972; Niemelä et al., 1994) and for the Nizhne-Svirsky Reserve (Oliger, 2010), where the autumn activity of *C. sylvaticus* and the summer-autumn activity of *A. scopigera* were also observed. The capture rates of *E. atra* males in the biotopes studied by us reached the

maximum in spring, whereas in the environs of Tvärminne (Finland) it increased by autumn. The early spring activity of *T. alacris*, recorded in the Nizhne-Svirsky Reserve and in southern Finland, was not observed in the environs of Murmansk, whereas the peak of abundance of *T. tenebricola* was shifted from late spring (southern Finland)–early summer (Nizhne-Svirsky Reserve) to August.

CONCLUSIONS

(1) A preliminary list including 88 species of spiders was compiled for the environs of Murmansk.

(2) The assemblages of the birch forest and the road embankment were the most similar in the species composition but had different sets of dominants (with only 3 shared species) and different dominance structures during the study period; the assemblage of the maritime meadow had particularly high capture rates.

(3) The species diversity and the number of spiders collected in these assemblages decreased from spring to autumn; at the same time, the evenness of the species structure also decreased while the fraction of the dominant species and the role of some of them increased.

(4) The most abundant species in all the biotopes had different periods of maximum activity.

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