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SHORT COMMUNICATIONS

Arachnids (Arachnidae) in a Spring Wheat Agrocenosis in Southern Sverdlovsk Oblast and the Effect of Treatment with Decis, a Pyrethroid Insecticide, on Their Populations

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Arachnids are active predators. Due to their abundance, they are an important component of arthropod communities in both natural and man-made ecosystems. It has been proposed to use some species of spiders as indicators of the effects of various economic activities on the state of the environment. In particular, this concerns pesticide treatment, a powerful factor of anthropogenic impact on ecosystems (Everts *et al.*, 1986; Pristavko and Zhukovets, 1987; Aukema *et al.*, 1990; Esyunin and Batalin, 1995). Russian publications on the species composition of arachnids in agrocenoses and their responses to the effects of pesticides are scarce, and the corresponding data on Sverdlovsk oblast are absent. Such studies are important both for determining the type and strength of responses to toxic influences and for choosing proper indicator species of arachnids.

The purpose of this work was to study the species composition of arachnids (true spiders and harvestmen) in a spring wheat agrocenosis and the responses of their populations to crop treatment with Decis, a pyrethroid insecticide. Our tasks were as follows: to amend the list of spider and harvestmen species inhabiting the spring wheat fields in the vicinity of Yekaterinburg, to study the seasonal population dynamics of individual species in the corresponding agrocenosis, and to determine the patterns of their responses to the treatment of wheat crops at the booting stage with Decis.

For two years, we studied the species composition and population dynamics of arachnids—true spiders (Aranei) and harvestmen (Opiliones)—and changes in these parameters under the effect of crop treatment with Decis (UCLAF, France) at a concentration of 2.5% of the active substance (deltamethrin). Studies were performed in the same field located 5 km southeast of the village of Kol'tsovo (the suburb of Yekaterinburg). This field, with dark gray forest soil of the heavy loam type (characteristic of arable lands in Sverdlovsk oblast) was under spring wheat in 1998 and under wheat and clover in 1999. The density of spiders on the vegetation was low: two to three specimens per 100 movements of a sweep net or five specimens per 100 plants. Hence, seasonal population dynamics and responses to insecticide treatment were studied in herpetobiontic species, which were caught using pitfall traps. Wheat crops were treated with Decis at the stage of booting. The relative abundance of arachnid species was determined from their proportions in catches, as well as using a logarithmic scale (Pesenko, 1982). The procedure of census, methods and dates of insecticide treatment, and methods of mathematical data processing were described in detail previously (Bel'skaya *et al.*, 2002).

The community of predatory herpetobiontic arthropods in the spring wheat field was represented by the following taxa: Aranei (true spiders), Opiliones (harvestmen), Carabidae (ground beetles), and Staphylinidae (road beetles). In 1999, the proportion of arachnids in the community of predatory herpetobionts was only 3% at the phase of wheat tillering (the first and second ten-day periods of June) and decreased to 33% at the flowering phase (the second ten-day period of July).

Over the study period, 1594 true spiders and 262 harvestmen were caught (a total of 1856). The most numerous group included spiders living in the open and hunting without making a web—species of the genus *Pardosa* (*P. agrestis* Westring, *P. plumipes* Thorell, and *P. palustris* L.)—and web-spinning spiders of the genus *Erigone* (*E. dentipalpis* Wider and *E. atra* Blackwall) and *Oedothorax apicatus* Blackwall. According to the indices of relative abundance (5 for *P. agrestis* and 4 for other species), this group was classified as dominant; *Agyneta rurestris* C.L. Koch, with an index of 3, was subdominant. The species represented by single or a few specimens were as follows: *Drassylus praeficus* L. Koch, *Drassylus pusillus* C.L. Koch, *Haplodrassus signifer* C.L. Koch, *Micaria silesiaca* L. Koch, *Zelotes* spp. (Gnaphosidae); *Araeoncus humilis* Blackwall, *Carorita limnaea* Crosby et Bishop, *Diplocephalus*

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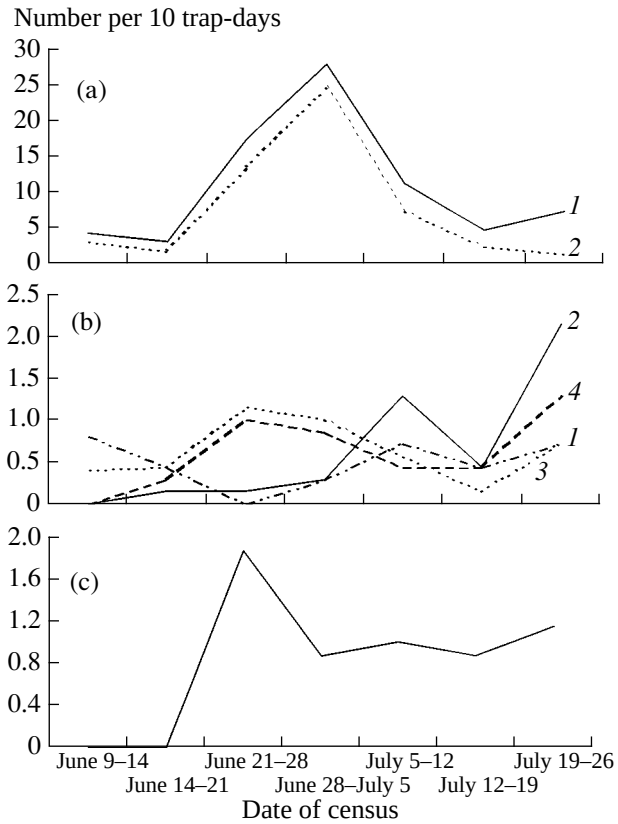

Fig. 1. Changes in the numbers of arachnids trapped in the spring wheat field untreated with insecticides (1999): (a) *1*, total number; *2*, species of the genus *Pardosa* (*P. agrestis*, *P. palustris*, and *P. plumipes*); (b) *1*, Agyneta rurestris; *2*, species of the genus *Erigone* (*E. atra* and *E. dentipalpis*); *3*, *Oedothorax apicatus*; *4*, other species; (c) *Phalangium opilio.*

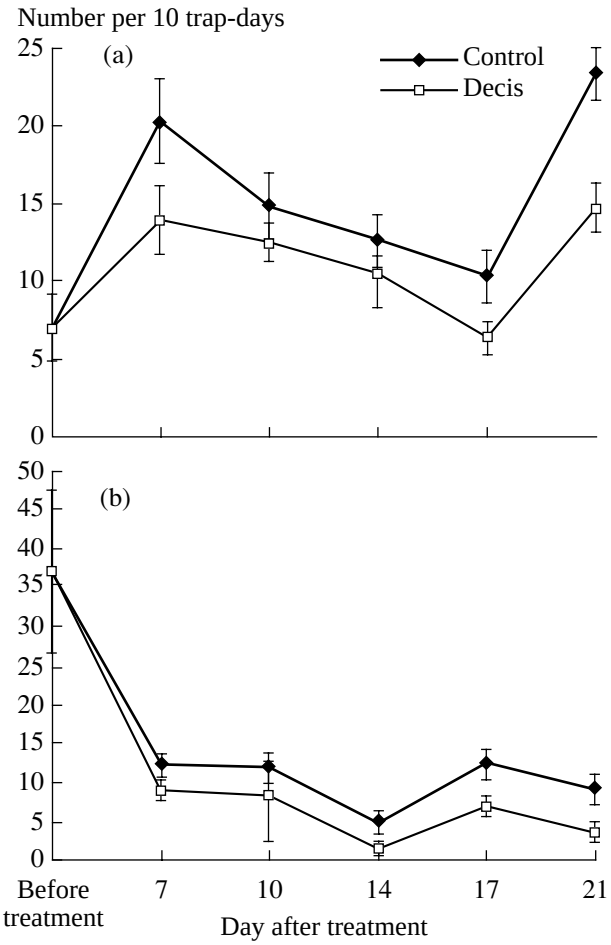

Fig. 2. Changes in the numbers of arachnids trapped in the spring wheat field after treatment with Decis in (a) 1998 and (b) 1999.

connatus Bertkau, *Hypselistes jacksoni* O.P.-Cambridge, *Oedothorax agrestis* Blackwall, *Porrhomma pygmaeum* Blackwall, *Walckenaeria vigilax* Blackwall (Linyphiidae); *Pardosa fulvipes* Vollett, *Pardosa riparia* C.L. Koch, *Pirata piraticus* Clerck, *Trochosa ruricola* DeGeer, *Xerolycosa nemoralis* Westring (Lycosidae); *Pachygnatha degeeri* Sundevall (Tetragnathidae); *Achaearanea riparia* Blackwall, *Robertus arundineti* O.P.-Cambridge, *Steatoda albomaculata* DeGeer (Theridiidae); and *Xysticus cristatus* Clerck (Thomisidae). Harvestmen were represented by only one species, *Phalangium opilio* L.

During the observation period (from the beginning of June to the end of July), the total abundance of spiders gradually increased, reaching a peak in late June–early July, and then decreased (Fig. 1a). This was due to changes in the capture rate of actively hunting spiders of the genus *Pardosa*. Its values in 1998 and 1999 were similar. The capture rate of linyphiid spiders of the genus *Erigone* increased throughout the observation period (Fig. 1b), and its absolute values were much higher in 1998 than in 1999: up to 10 vs. 2 ind./10 trap-days. This fact could be explained by differences in environmental conditions. The beginning and middle of summer in 1999 were relatively dry: the amounts of precipitation in June and July were 46.4 and 69.5 mm, compared to 119.3 and 88.5 mm, respectively, in 1998. Moreover, clover sown in addition to wheat in 1999 increased the density of plant cover. This fact is relevant, as linyphiids *E. dentipalpis* and *E. atra* are photo- and hygrophilic. The numbers of *E. dentipalpis* falling into traps are lower in the areas with a tall and dense grass stand or dry soil than in the areas with a thinner stand or moist soil (Pristavko and Zhukovets, 1987; Jagers op Akkerhuis, 1994). The capture rate of harvestmen in the growing period did not exceed two specimens per 10 trap-days (Fig. 1c).

Spiders comprise the group of predatory arthropods that is highly sensitive to pyrethroid insecticides, which has been confirmed in laboratory and field investigations (Basedow, 1985; Pekar, 1997; Thomas *et al.*, 1990). In our study, treatment with Decis at the booting stage coincided with a peak of population density in arachnids. In the areas treated with this insecticide,

Changes in the proportions of mass arachnid species in the spring wheat field under the effect of Decis (data of pitfall-trap census)

Species	1998				1999			
	Control		Decis		Control		Decis	
	number	proportion, %	number	proportion, %	number	proportion, %	number	proportion, %
First week								
Genus *Erigone*	5	4.0 ± 1.7	4	2.8 ± 1.4	9	11.2 ± 3.5	0	0*
Oedothorax apicatus	0	0	0	0	4	5.0 ± 2.4	1	1.8 ± 1.8
Agyneta rurestris	2	1.6 ± 1.1	2	1.4 ± 1.0	5	6.2 ± 2.7	0	0*
Genus *Pardosa*	98	77.8 ± 3.7	80	55.9 ± 4.2*	52	65.0 ± 5.3	37	66.1 ± 6.3
Phalangium opilio	19	15.1 ± 3.2	49	34.3 ± 4.0*	7	8.8 ± 3.2	13	23.2 ± 5.6*
Other species	2	1.6 ± 1.1	8	5.6 ± 1.9	3	3.8 ± 2.1	5	8.9 ± 3.8
Total	126		143		80		56	
Number of traps	10		20		10		10	
Second week								
Genus *Erigone*	46	27.2 ± 3.4	2	1.5 ± 1.0*	3	8.8 ± 4.9	0	0
Oedothorax apicatus	14	8.3 ± 2.1	2	1.5 ± 1.0*	1	2.9 ± 2.9	0	0
Agyneta rurestris	5	3.0 ± 1.3	4	2.9 ± 1.4	3	8.8 ± 4.9	3	21.4 ± 11.0
Genus *Pardosa*	75	44.4 ± 3.8	100	73.0 ± 3.8*	18	52.9 ± 8.6	9	64.3 ± 12.8
Phalangium opilio	25	14.8 ± 2.7	20	14.6 ± 3.0	6	17.6 ± 6.5	2	14.3 ± 9.4
Other species	4	2.4 ± 1.2	9	6.6 ± 2.1	3	8.8 ± 4.9	0	0
Total	169		137		34		14	
Number of traps	20		20		10		10	
Third week								
Genus *Erigone*	134	55.8 ± 3.2	44	29.3 ± 3.7*	15	28.3 ± 6.2	1	2.8 ± 2.8*
Oedothorax apicatus	43	17.9 ± 2.5	21	14.0 ± 2.8	5	9.4 ± 4.0	0	0*
Agyneta rurestris	5	2.1 ± 0.9	12	8.0 ± 2.2 *	5	9.4 ± 4.0	0	0*
Genus *Pardosa*	30	12.5 ± 2.1	41	27.3 ± 3.6*	11	20.8 ± 5.6	24	68.6 ± 7.8*
Phalangium opilio	22	9.2 ± 1.9	28	18.7 ± 3.2*	8	15.1 ± 4.9	5	14.3 ± 5.9
Other species	6	2.5 ± 1.0	4	2.7 ± 1.3	9	17.0 ± 5.2	5	14.3 ± 5.9
Total	240		150		53		35	
Number of traps	20		20		10		10	

* Differences from the control are significant at $p < 0.05$.

compared to the control areas, the capture rate of arachnids decreased by 27–32% after one week and by 37–59% after three weeks (Fig. 2). The numbers of *E. dentipalpis*, *E. atra*, and *O. apicatus* were reduced most markedly (table). According to pooled data (1998 and 1999), the relative abundance of these species decreased after treatment from grade 4 to grade 3. The capture rate of linyphiids in the treated area became lower due to a decrease in the numbers of males, which usually prevailed in catches. Field studies on *E. atra* have shown that pyrethroids have a stronger effect on males, whose locomotor activity is higher, and a relatively weak effect on females and immature spiders (Dinter and Poehling, 1990); moreover, insecticide treatment affects mainly the activity of spiders, rather than their survival (Cocquempot *et al.*, 1991). A long-term population decline in web-spinning spiders of the genus *Erigone* after Decis treatment could be explained by their high sensitivity to pyrethroids and low migrational activity.

In spiders of the genus *Pardosa*, the capture rate decreased during one or two weeks after insecticide treatment and then began to increase, eventually exceeding the control rate. The proportion of these spiders in catches increased significantly (table). The three most numerous species (*P. agrestis*, *P. plumipes*, and *P. palustris*) responded to treatment in the same way. We believe that actively moving species of the genus

Pardosa can more rapidly restore their local populations due to migration from the neighboring (untreated) areas of the field. An increase in their numbers in pitfall traps set in the area treated with Decis, compared to the control, may be explained by the effect of small doses (traces) of the pyrethroid, which stimulate the locomotor activity of migrating spiders.

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