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Natural prey of the jumping spider *Philaeus chrysops* (Araneae: Salticidae) in different types of microhabitat

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Summary

The natural prey of the jumping spider *Philaeus chrysops* (Poda, 1776) was studied in different microhabitats on Absheron Peninsula, Azerbaijan. The percentage of specimens of *P. chrysops* found while feeding was low in most microhabitats (<10%). However, on a wall near a food refuse dump the percentage of spiders found in possession of prey was significantly higher than in other microhabitats, probably related to a high abundance of potential prey at this site. Investigation has shown that *P. chrysops* is a polyphagous predator, with representatives of ten arthropod orders found in its diet. The primary food of *P. chrysops* was Diptera, which accounted for half of the total prey (50.2%). An especially high proportion of dipterans was recorded in the diet of spiders inhabiting the stone wall, where they were the only significant prey type. Diptera was also among the dominant prey groups of *P. chrysops* in other types of microhabitat, except for bare ground at Shagan. However, in these microhabitats some other arthropod orders, such as Araneae, Coleoptera, Homoptera, and Hymenoptera, contributed comparable portions to the diet of spiders. The length of prey killed by *P. chrysops* ranged between 0.65 and 20.00 mm (mean 4.03 mm) and constituted from 8.1 to 266.7% (mean 58.1%) of the length of their captors. The most frequently captured were small arthropods not exceeding half the length of their captors (57.6%), followed by medium-sized prey (from 50–100% of spider body length) (27.2%), and large prey exceeding the length of the spiders (15.2%). This tendency was characteristic of spiders in all microhabitats, except for shrubs, where medium-sized prey predominated.

Introduction

Despite the Salticidae (jumping spiders) being the largest family of spiders, including over 5,000 described species (Platnick, 2008), little is known about their natural prey. A survey of the spider literature revealed that more or less detailed quantitative data are available for only a dozen species (Bartos, 2004; Dean *et al*., 1987; Horner *et al*., 1988; Jackson, 1977, 1988 a, b; Jackson & Blest, 1982; Nyffeler *et al*., 1990; Richman & Whitcomb, 1981; Wesołowska & Jackson, 2003; Young, 1989; Żabka & Kovac, 1996). To contribute to the knowledge of natural prey of jumping spiders I have studied the diets of various species occurring in Absheron Peninsula, Azerbaijan (Guseinov, 2004, 2005; Guseinov *et al*., 2004; Huseynov, 2005, 2006; unpubl. data; Huseynov *et al*., 2005, 2008). These salticids inhabit different types of microhabitats, such as bark of shrubs, herbaceous vegetation, grass litter, bare ground, stone walls, and spaces under stones (Guseinov, 2003). As a rule, individuals of each species are found in a single, species-specific type of microhabitat and only rarely visit other types. A similar tendency has been reported for salticids from Zimbabwe (Cumming & Wesołowska, 2004) and Australia (Rienks, 1992), suggesting that microhabitat specialisation is a common phenomenon in jumping spiders. It seems reasonable to assume, therefore, that differences between the diets of salticids are partly influenced by their microhabitat preferences, because of the different assortment of potential prey available in different microhabitats. To evaluate the effect of microhabitat specialisation on the prey composition of jumping spiders I studied the natural prey of *Philaeus chrysops* (Poda, 1776) which, unlike other salticids, was found to be a common occupant of different types of microhabitat in Absheron Peninsula.

Philaeus chrysops has a Trans-Palaearctic range, from Portugal in the west to the Russian Far East and Korea in the east (Logunov & Marusik, 2000). It is one of the largest species among European salticids, with gravid females reaching up to 13 mm in body length. Adult males are slightly smaller, up to 10 mm in length. The different sex/age groups of *P. chrysops* have very different coloration, so that inexperienced observers may recognise them as separate species. Young juveniles have a white body with two black spots on the carapace and black or brown markings on the dorsum of the abdomen. The cephalothorax of older spiders is black. Late instars and adult females have a grey or brown abdomen with a black median band and two white stripes surrounding it, while adult males have a bright red abdomen with a black median band. In Azerbaijan, *P. chrysops* occurs in a wide range of habitats, from semidesert and the lowland steppe zone to the mid-mountain forest belt (Logunov & Guseinov, 2002), where adults and late instar immatures are commonly found on cliffs, fences and the outside walls of buildings, as well as on small stones scattered on the ground, trunks of shrubs and hardened pieces of bare ploughed soil (Guseinov, 2003). Moreover, young juveniles (white spiders) occur almost exclusively on herbaceous vegetation, mainly dwarf shrubs. In contrast to many other salticids, which each day build a new nest for spending the night, females and immatures of *P. chrysops* have permanent nests, which they use for a long period of time (Thomas, 1929; Bonnet, 1933). The spiders spend most of their time within a few centimetres of their nests (Huseynov, unpubl. data). Because of the presence of permanent refuges, individuals of *P. chrysops* do not need to match their background so precisely as other jumping spiders, which usually have cryptic coloration, adaptive to a specific type of substrate (Rienks, 1992). Thus the unusual manner of nest exploitation is probably a key factor allowing *P. chrysops* to occupy a wide range of microhabitats.

Material and methods

The investigation was carried out in Absheron Peninsula, Azerbaijan. There were four study sites located near the villages Mardakyan, Shagan and Bina, and near Ganly-gyol Lake. The study sites represented areas of ephemeral semidesert planted with pine trees, *Pinus eldaricus* Medw., and shrubs, *Elaeagnus angustifolia* D. Sosn. and *Syringa vulgaris* L. Detailed descriptions of the study sites are given elsewhere (Guseinov, 2004, 2005; Huseynov, 2006). The prey of spiders was sampled in five types of microhabitat:

1. A stone wall at Mardakyan (*c.* 109 m long, 2.5 m high). In this microhabitat, spiders were observed during three successive years: 1997 (2 February–14 June and 6 October–20 December), 1998 (12 March–6 June), and 1999 (3 March–27 April). A total of 54 surveys were conducted during these periods which took a total of about 96.5 h. There was a food refuse dump near one end of the wall which had a significant influence on the composition of the arthropod fauna inhabiting the adjacent part of the wall. Thus observations made in this part of the wall (area B=*c.* 1/9 of total wall area) were analysed separately from the rest of the wall (area A).

2. Rows (*c.* 1 m wide) of hardened ploughed soil with vegetation removed (bare ground) at Shagan. In this microhabitat, spiders were observed in 1997 (22 March–27 April) and 1998 (2 and 12 April). A total of 9 surveys were conducted during these periods which took a total of about 12.5 h.

3. Rows (*c.* 1 m wide) of hardened ploughed soil with sparse vegetation (sparsely covered ground) at Bina. In this microhabitat, spiders were observed in 1997 (18 April–10 May), 1998 (2 and 7 April), and 1999 (3 March). A total of 8 surveys were conducted during these periods which took a total of about 12 h.

4. Upper surface of small stones (15–50 cm in diameter) scattered throughout dense grass near Ganly-gyol Lake. In this microhabitat, spiders were observed in 1997 (4–30 April) and 1998 (9 April). A total of 8 surveys were conducted during these periods which took a total of about 6 h.

5. Bark of *Elaeagnus angustifolia* shrubs near Ganly-gyol Lake. In this microhabitat, spiders were observed in 1996 (3 May–7 June and 27 September–8 October), 1997 (14 March–5 June), 1998 (9 April–14 May), 1999 (29 March–11 May), and 2000 (24 April and 2 May). A total of 30 surveys were conducted during these periods which took a total of about 37 h.

All surveys were done in daylight hours between 11:00 and 19:00. During the surveys the microhabitats were thoroughly searched for *P. chrysops*, and the mouthparts of each individual found were inspected with a hand-lens of $\times 4$ magnification to avoid overlooking small prey. Spiders with prey in their chelicerae were captured with a transparent cup, placed in separate vials containing 75% ethyl alcohol, and brought back to the laboratory for measurement and prey identification. Spiders without prey were released near the point of first sighting. At the same time, all observed spiders were classified into two groups, (1) adult males and (2) large immatures and adult females, which could be easily distinguished by their coloration (see Introduction). All immatures were late instars (mostly >5 mm in body length) because young instars occur only on grassy plants which were not censused during this study.

To determine the dietary diversity of the spiders inhabiting different types of microhabitat, a niche breadth coefficient (β) was computed, using the formula proposed by Levins (1968):

$$\beta = \frac{1}{\sum_{l=1}^{n} \rho_l^2}$$

where ρ_l is the proportion of the l prey type used.

To assess the extent of similarity between the diets of spiders inhabiting different types of microhabitat, a niche overlap coefficient (α) was computed with the equation proposed by Pianka (1974):

$$\alpha_{jk} = \frac{\sum_{l=1}^{n} \rho_{lj}\,\rho_{lk}}{\sqrt{\sum_{l=1}^{n} \rho_{lj}^2 \sum_{l=1}^{n} \rho_{lk}^2}}$$

where ρ_{lj} and ρ_{lk} represent the proportions of the l prey type used by the j and k groups of spiders respectively.

To avoid seasonal effects, only data obtained in spring 1997, when large fractions of prey were collected from spiders in all microhabitats, were used for calculating coefficients. Since the prey sample size in shrubs was small, all the data were included in the calculation of dietary overlap. It should be noted, however, that all but one of the prey items in shrubs were collected in different springs and half of these in spring 1997. Because the sample sizes in all types of microhabitat were not large, both coefficients were calculated based upon classification of prey to order level.

Results

Altogether, 2,665 individuals of *P. chrysops* were observed, 236 of which (8.9%) had prey in their chelicerae. Among these, 2,508 immatures and females (235 with prey [9.4%]) and 157 males (1 with prey [0.6%]) were recorded. The difference in percentage of feeding specimens between these two groups is highly significant ($\chi^2=12.900$; df=1; $p<0.001$). Because males fed significantly less frequently than females and immatures and their relative abundance varied considerably between different microhabitats (0–22%, Table 1), only the data on immatures and females were used for comparison of the feeding percentage between microhabitats. The percentage of immatures and females found while feeding was highest on the wall near the food refuse dump, area B (18.3%), followed by small stones (11.7%), ground at Bina (9.6%), wall without dump, area A (9.1%), shrubs (8.7%), and ground at Shagan (5.9%) (Table 1). Analysis of these data with a χ^2 test of independence indicated that on the wall near the food refuse dump the percentage of spiders found with prey was significantly higher than in other microhabitats (wall, area A: $\chi^2=10.135$; df=1; $p=0.001$, ground at Bina: $\chi^2=8.110$; df=1; $p<0.01$, ground at Shagan: $\chi^2=19.494$; df=1; $p<0.001$, shrubs: $\chi^2=4.375$; df=1; $p<0.05$), except for small stones where the difference was not significant ($\chi^2=2.588$; df=1; $p>0.1$). On the other hand, on the ground at Shagan this value was significantly lower than in other microhabitats (wall, area A: $\chi^2=3.947$; df=1; $p<0.05$, ground at Bina: $\chi^2=4.448$; df=1; $p<0.05$, stones: $\chi^2=6.525$; df=1; $p<0.05$), except for shrubs ($\chi^2=0.882$;

Type of microhabitat	No. of spiders observed			No. of spiders found feeding			% of spiders found feeding		
	J♀	♂	Σ	J♀	♂	Σ	J♀	♂	Σ
Wall (area A)	898	86	984	82	0	82	9.1	0	8.3
Wall (area B)	142	30	172	26	0	26	18.3	0	15.1
Stones	230	1	231	27	0	27	11.7	0	11.7
Shrubs	126	36	162	11	1	12	8.7	2.8	7.4
Ground (Bina)	638	4	642	61	0	61	9.6	0	9.5
Ground (Shagan)	474	0	474	28	0	28	5.9	0	5.9
Total	2508	157	2665	235	1	236	9.4	0.6	8.9

Table 1: Number and percentage of *Philaeus chrysops* individuals found while feeding in different types of microhabitat. J♀=immatures+females.

df=1; $p>0.3$). There were no statistically significant differences in this respect between other pairs of microhabitats.

Fifteen prey items were lost during the process of spider capturing (6 at area A and 1 at area B of the wall, 4 on stones, 3 on the ground at Bina and 1 on the ground at Shagan). However, eight additional prey items were collected during non-quantitative observations (2 at area A and 5 at area B of the wall and 1 on the ground at Shagan). Thus a total of 229 prey items were sampled for dietary analysis. These were distributed among ten orders of arthropods, including seven from class Insecta and three from class Arachnida (Table 2).

All the prey can be divided into three groups according to their abundance in the diet of *P. chrysops*. The first group includes Diptera, which was by far the most abundant prey order constituting half of the total prey. Dipterans were among the dominant prey types in all microhabitats, except for bare ground at Shagan. They were especially abundant in the diet of the wall-dwelling spiders, constituting >60 and 90% of total prey at sites A and B respectively. On the wall nematocerans were captured more frequently than brachycerans (58.2 vs. 41.8%). The bulk of nematocerans here consisted of two species, an unidentified sciarid midge and *Scatopse* sp. (Scatopsidae) (24 and 19 prey records respectively). The remaining nematocerans comprised two Chironomidae and one Psychodidae. The majority of brachyceran prey on the wall consisted of relatively large synanthropic flies, Fanniidae (10 prey records), Calliphoridae (8), Scatophagidae (6), Sarcophagidae (2) and Muscidae (2). Other brachycerans were 2 Syrphidae, 1 Sphaeroceridae and 2 unidentified small flies. Diptera was also the most common prey group in the diet of ground-dwelling spiders at Bina (36.2%). Here Nematocera predominated too, but the dominant prey species was the bibionid *Bibio hortulanus* (Linnaeus) (10 prey records), followed by 5 Sciaridae, 1 Psychodidae, and 1 Lemestriidae. Brachyceran prey at Bina comprised 1 Sarcophagidae, 1 Therevidae and 2 unidentified small flies. On shrubs dipteran prey consisted exclusively of nematocerans: 2 Chironomidae, 1 Scatopsidae and 1 Limoniidae. In contrast, Brachycera (2 Sarcophagidae, 1 Scatophagidae, 1 Syrphidae, 1 Phoridae and 1 unidentified fly) were more common than Nematocera (1 Tipulidae and 1 unidentified midge) in the diet of *P. chrysops* inhabiting stones. Diptera captured on the ground at Shagan comprised 1 Sarcophagidae, 1 Scatophagidae and 1 unidentified nematoceran.

The second prey group consisted of the orders Hymenoptera, Homoptera, Coleoptera and Araneae, which ranged from 10 to 12% of the total diet. All these prey orders were found in the diet of spiders from all microhabitats, except for shrubs where Hymenoptera and Homoptera were missing, probably because of the small prey sample in this microhabitat; Homoptera were also lacking from stones. Each of these prey orders was among the dominant prey in at least two types of microhabitat. Hymenoptera were the major prey on stones (43.5%) and among the dominants on the ground at Shagan (17.9%). The majority of hymenopterans captured were parasitic wasps (85.2%). Of these the most common were Ichneumonidae (1 on wall, 3 at Bina and 5 on stones) and Braconidae (1 on wall, 2 at Bina, 3 at Shagan and 5 on stones). Other parasitic hymenopterans were Chalcidoidea (2 on the wall and 1 at Shagan). Stinging hymenopterans comprised 1 Halictidae at Shagan, 1 Bethylidae at Bina, 1 winged ant (Formicidae) and 1 unidentified on the wall. Coleoptera were among the dominant prey types on shrubs (25.0%) and on the ground at Shagan (17.9%). Most of the coleopterans captured were adult beetles (87.0%). The most frequently eaten were Chrysomelidae (2 at Bina, 2 at Shagan, 1 on shrubs), followed by Merylidae (2 at Bina, 1 at Shagan, 1 on shrubs), Ipidae (1 at Bina, 1 at Shagan, 1 on stones), Anobiidae (1 on wall, 1 on stones), Coccinellidae (2 on wall), Anthicidae (2 at Bina), Cleridae (1 on wall), and an unidentified beetle at Shagan. Additionally, three unidentified coleopteran larvae were captured by spiders on the wall, stones and shrubs. Homoptera were among the dominant prey orders at Bina (19.0%) and Shagan (21.4%). Homopterans were represented by aphids and leafhoppers. Aphidinea were more frequent than Cicadinea on the ground at Bina (8 vs. 3 prey records). In contrast, on the wall and on the ground at Shagan Cicadinea prevailed (4 vs. 2 and 5 vs. 1 respectively). Araneae was the dominant prey order on the ground at Shagan (25.0%) and on shrubs (41.7%). The most frequently captured were Salticidae (1 at Shagan, 2 on the wall, 4 on shrubs, 5 at Bina) followed by Philodromidae (1 on wall, 1 at Shagan), Oecobiidae (1 at Shagan, 1 at Bina), Theridiidae (2 on wall), Gnaphosidae (1at Bina), Lycosidae (1 on shrubs), Thomisidae (1 on stones), and Araneidae (1 on stones). Four spiders could not be identified to the family level because of severe damage to their corpses.

The third group of prey included the orders Heteroptera, Orthoptera, Lepidoptera, Opiliones and Acari.

	Wall, site A	Wall, site B	Ground, Bina	Ground, Shagan	Stones	Shrubs	Total N	%
Diptera	[52]	[27]	[21]	[3]	[8]	[4]	[115]	[50.2]
Brachycera								
Calliphoridae	6	2					8	3.5
Fannidae	4	6					10	4.4
Muscidae		2					2	0.9
Sarcophagidae	2		1	1	2		6	2.6
Scatophagidae	2	4		1	1		8	3.5
Syrphidae	1	1			1		3	1.3
Therevidae			1				1	0.4
Sphaeroceridae		1					1	0.4
Phoridae					1		1	0.4
Unknown	2		2		1		5	2.2
Nematocera								
Sciaridae	24		5				29	12.7
Scatopsidae	8	11				1	20	8.7
Lemestriidae			1				1	0.4
Psychodidae	1		1				2	0.9
Bibionidae			10				10	4.4
Chironomidae	2					2	4	1.7
Limoniidae						1	1	0.4
Tipulidae					1		1	0.4
Unknown				1	1		2	0.9
Hymenoptera	[6]	[0]	[6]	[5]	[10]	[0]	[27]	[11.8]
Braconidae	1		2	3	5		11	4.8
Ichneumonidae	1		3		5		9	4.0
Chalcidoidea	2			1			3	1.3
Bethylidae			1				1	0.4
Formicidae	1						1	0.4
Halictidae				1			1	0.4
Unknown	1						1	0.4
Coleoptera	[5]	[0]	[7]	[5]	[3]	[3]	[23]	[10.0]
Coccinellidae	2						2	0.9
Anobiidae	1				1		2	0.9
Cleridae	1						1	0.4
Merylidae			2	1		1	4	1.7
Anthicidae			2				2	0.9
Chrysomelidae			2	2		1	5	2.2
Ipidae			1	1	1		3	1.3
Unknown imago				1			1	0.4
Unknown larvae	1				1	1	3	1.3
Homoptera	[4]	[2]	[11]	[6]	[0]	[0]	[23]	[10.0]
Cicadinea	2	2	3	5			12	5.2
Aphidinea	2		8	1			11	4.8
Heteroptera	[2]	[0]	[1]	[0]	[0]	[0]	[3]	[1.3]
Coreidae	1		1				2	0.9
Lygaeidae	1						1	0.4
Lepidoptera	[2]	[0]	[2]	[0]	[0]	[0]	[4]	[1.7]
Unknown larvae	2		2				4	1.7
Orthoptera	[0]	[0]	[2]	[0]	[0]	[0]	[2]	[0.9]
Tettigonoidea			2				2	0.9
Unknown Insecta	[2]	[1]	[0]	[0]	[0]	[0]	[3]	[1.3]
Araneae	[5]	[0]	[7]	[7]	[2]	[5]	[26]	[11.3]
Salticidae	2		5	1		4	12	5.2
Theridiidae	2						2	0.9
Philodromidae	1			1			2	0.9
Oecobiidae			1	1			2	0.9
Gnaphosidae			1				1	0.4
Araneidae					1		1	0.4
Thomisidae					1		1	0.4
Lycosidae						1	1	0.4
Unknown				4			4	1.7
Opiliones	[0]	[0]	[1]	[1]	[0]	[0]	[2]	[0.9]
Phalangiidae			1	1			2	0.9
Acari	[0]	[0]	[0]	[1]	[0]	[0]	[1]	[0.4]
Prostigmata				1			1	0.4
Total	78	30	58	28	23	12	229	100.0

Table 2: Prey composition of *Philaeus chrysops* in different types of microhabitat.

Microhabitats	Wall (area A)	Wall (area B)	Ground (Bina)	Ground (Shagan)	Stones	Shrubs
Wall (area A)		0.980	0.897	0.429	0.787	0.664
Wall (area B)			0.840	0.291	0.673	0.565
Ground (Bina)				0.728	0.798	0.693
Ground (Shagan)					0.665	0.686
Stones						0.607
Shrubs						

Table 3: Overlap (niche overlap coefficient=α) in prey orders captured by *Philaeus chrysops* in different microhabitats in spring 1997, except for shrubs where value of α is calculated for total prey sample.

Each of these prey types was captured in no more than 2 types of microhabitat and always in very small numbers. These prey included 2 coreid (1 on wall, 1 at Bina) and 1 lygaeid (on wall) bug, two tettigonid grasshoppers (at Bina), four lepidopteran larvae (2 on wall, 2 at Bina), two phalangiid harvestmen (1 at Bina, 1 at Shagan) and a prostigmatic mite (at Shagan).

The greatest diet breadth was characteristic of *P. chrysops* inhabiting the ground at Shagan (β=5.45), followed by those inhabiting the ground at Bina (β=4.24), stones (β=3.13), shrubs (β=2.88), the main part of the wall (β=1.93), and the wall near the dump (β=1.08). The greatest dietary overlap was found between wall-dwelling spiders and ground-dwelling spiders at Bina (α>0.8). In contrast, ground-dwelling spiders at Shagan exhibited the lowest dietary overlap with wall-dwelling spiders (α<0.5). Other pairs of microhabitats were characterised by moderate to relatively high overlaps (0.5<α<0.8) in the diets of spiders inhabiting them (Table 3).

Two hundred and seventeen prey items were measured (Table 4). Their length varied from 0.65 to 20.00 mm (mean ± SD: 4.03 ± 2.94) and constituted from 8.1 to 266.7% (58.1 ± 39.3) of the length of their captors, which ranged from 4.00 to 12.00 mm (6.84 ± 1.08). The mean lengths of spiders in different microhabitats varied from 6.50 to 7.65 mm and the mean relative lengths of prey they captured ranged from 42.2 to 64.5% (Table 4). The size distribution of the prey in relation to the sizes of their captors is shown in Fig. 1. The most abundant were small prey, not exceeding half the size of the spiders, which accounted for over half of the total prey measured (57.6%). Approximately one quarter of the prey of *P. chrysops* (27.2%) consisted of medium-sized arthropods (from 50–100% of spider body length). Large prey, exceeding the length of the spiders, were present in smaller proportions (15.2%). Most of the large prey did not exceed 150% of their captors' length and only three were larger. It is remarkable that this general pattern (i.e. small prey were most abundant, followed by medium-sized and large prey) was characteristic of prey length spectra of the spiders in all microhabitats, except for shrubs (Fig. 2).

Discussion

In most of the microhabitats the percentage of specimens of *P. chrysops* found while feeding was low (<10%), as is typical of jumping spiders (Jackson, 1977; Dean *et al*., 1987; Young, 1989; Guseinov, 2004, 2005; Guseinov *et al*., 2004; Huseynov, 2006; Huseynov *et al*., 2005). The significantly higher rate of prey capture on the wall near the food refuse dump (site B) was because the decaying organic waste provided a very favourable environment for various dipterans which reached high densities at this site. On the other hand the significantly lower feeding percentage among spiders inhabiting the ground at Shagan is probably due to the low prey abundance in this microhabitat. This suggestion seems reasonable because of the lack of any vegetation at this site, making it unattractive to numerous herbivorous insects as well as their predators which are potential prey of spiders.

The low percentage of males found while feeding is probably due to the peculiarity of their life-style that emphasises mating and only opportunistically involves feeding. In contrast, females and immatures, which need a high intake of food for yolk production and growth respectively, spend much of their time searching or waiting for prey. It is not surprising, therefore, that males of *P. chrysops* were observed with prey significantly less frequently than immatures and females. A similar tendency has been recorded in other jumping spiders (Jackson, 1977; Givens, 1978; Sathiamma *et al*., 1987; Guseinov, 2004), with the exception of *Menemerus taeniatus* (L. Koch, 1867) (Huseynov, 2005).

Type of microhabitat	N	Length of spiders (mm)		Length of prey (mm)		Length of prey (%)	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Wall	103	4.00–12.00	6.65 ± 1.12	0.85–14.00	4.17 ± 2.92	13.3–224.0	61.5 ± 38.8
Ground (Bina)	55	4.75–8.50	6.95 ± 0.99	0.65–10.40	3.92 ± 2.76	8.1–150.0	56.1 ± 38.5
Ground (Shagan)	26	5.00–8.50	6.50 ± 0.75	1.00–11.00	2.76 ± 2.21	16.7–146.7	42.2 ± 32.1
Stones	21	5.00–10.00	7.65 ± 1.14	0.85–20.00	5.00 ± 4.30	13.1–266.7	64.5 ± 55.1
Shrubs	12	6.00–9.00	7.21 ± 0.91	2.25–6.90	4.41 ± 1.49	28.1–98.6	61.6 ± 20.0
Total	217	4.00–12.00	6.84 ± 1.08	0.65–20.00	4.03 ± 2.94	8.1–266.7	58.1 ± 39.3

Table 4: Length of prey of *Philaeus chrysops* in different types of microhabitat.

This investigation has shown that *P. chrysops* is a polyphagous predator feeding on a wide range of insects and arachnids. However, only five orders of arthropods in various combinations constituted the bulk of prey in all microhabitats. This fact is responsible for considerable overlap at prey order level between the diets of spiders from most of the microhabitats. The only low dietary overlap was found between wall-dwelling spiders and ground-dwelling spiders at Shagan. This is because of quite different proportions of dipterans in the diets of spiders from these microhabitats. Spiders occurring on the wall have the most specialised diet, characterised by the strong prevalence of a single prey type, namely dipterans. Such a narrow food niche breadth is due to the peculiarity of their microhabitat. The stone walls are poor environments with limited food resources and extreme microclimatic conditions. Relatively few groups of arthropods are adapted to this habitat. Synanthropic flies using the wall surfaces as resting sites are one of the most abundant components of the local entomofauna (Klausnitzer, 1990). The presence of organic waste further increased the rate of dipteran capture by *P. chrysops* inhabiting part of the wall (area B). A similar tendency has been recorded in *Menemerus semilimbatus* (Hahn, 1827) inhabiting the same wall (Guseinov, 2004). In contrast, the percentage of Diptera captured by the spiders occurring on bare ground at Shagan was low, while several other arthropod orders contributed the main portion of their prey, resulting in a high diet breadth in this subpopulation. This is similar to observations on other epigeic salticids which have been rarely found feeding on Diptera (Guseinov *et al.*, 2004; Huseynov *et al.*, 2005, 2008). However, in the diet of *P. chrysops* inhabiting the ground with sparse vegetation at Bina the percentage of Diptera was high. It should be noted that most of the dipterans caught by these spiders were Bibionidae. These slow-moving, clumsy flies visited the flowering plant *Hirschfeldia incana* in large numbers and frequently fell down onto the ground where they were easily captured by *P. chrysops.* It is worth mentioning that before the start of flowering of *H. incana* the prey composition of *P. chrysops* at Bina was similar to that at Shagan. Thus the presence of a single plant species influenced a significant difference between the diets of two ground-living subpopulations. The diets of spiders from the two other microhabitats could be considered as intermediate between the diets of wall- and ground-living spiders. Here, the percentages of Diptera were high, but some other prey taxa were present in comparable proportions. Despite the stone-living spiders occurring at ground level (i.e. epigeic), the stone surfaces were frequently used for settling by flies, which probably influenced their high abundance in the diet of spiders in this microhabitat. At the same time, because of the presence of dense vegetation surrounding the small stones, other prey taxa (e.g. Hymenoptera) were readily available to spiders. The number of prey collected from *P. chrysops* occurring on shrubs is too small to make any certain conclusion.

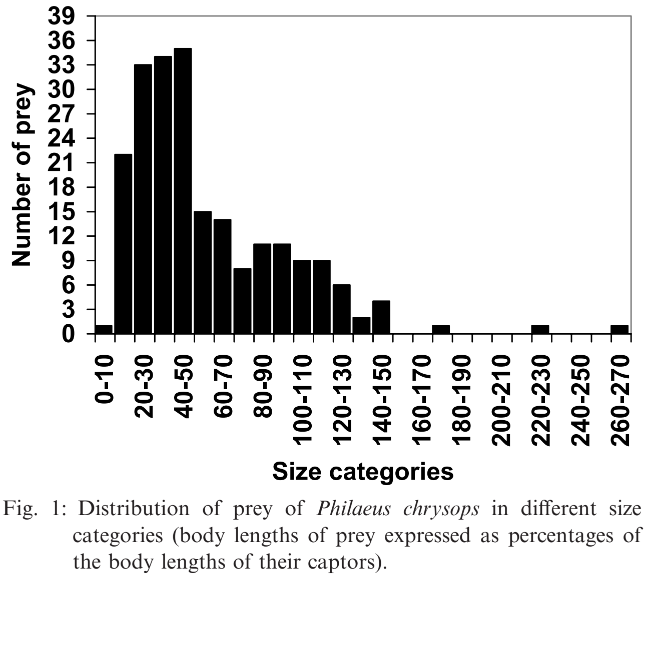

Fig. 1: Distribution of prey of *Philaeus chrysops* in different size categories (body lengths of prey expressed as percentages of the body lengths of their captors).

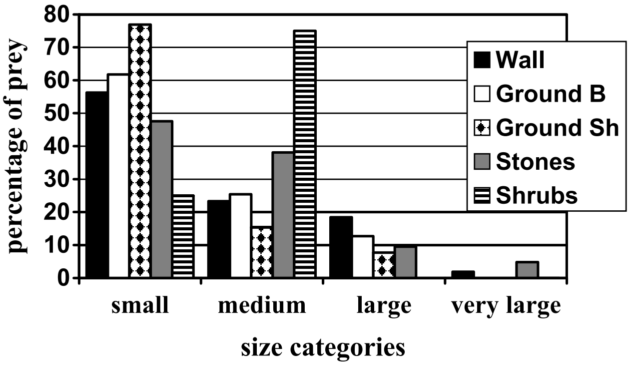

Fig. 2: Relative proportions of different size categories of prey of *Philaeus chrysops* in different types of microhabitat. Small prey ≤50% of spider length, medium prey >50 ≤100%, large prey >100 ≤150%, very large prey >150%. "Ground B" and "Ground Sh" refer to ground at Bina and Shagan respectively. "Wall" includes observations from both areas of the wall (A+B).

The study of prey size preference in spiders has shown that most cursorial spiders, including salticids, do not catch prey that exceeds 150% of their own body length. The preferred prey length tends to be equal to or less than the length of the spider (Nentwig & Wissel, 1986). The findings reported here agree with this generalisation. Most of the prey of *P. chrysops* (*c.* 85%) were smaller than the spider, while those that were larger than their captors usually did not exceed 150% of the spider's length. It is remarkable that, except for shrubs where only a limited number of prey were collected, there was no considerable difference in prey size spectrum between spiders inhabiting different microhabitats. The consistent prevalence of prey not exceeding the lengths of their captors in the diet of the spiders from all microhabitats suggests that *P. chrysops* prefers this category of prey over large prey. On the other hand the differences in relative proportions of small and medium-sized prey between the diets of different subpopulations probably reflect the differences in relative abundance of prey of these two size classes available in the spiders' microhabitats.

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