

Gregarious interactions in a small buthid scorpion, *Compsobuthus wernerii judaicus*: a case of quasi-sociality?

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Summary

The cohabitation of scorpions of the small buthid species *Compsobuthus wernerii judaicus* (Birula, 1905), was studied in the field throughout the year for several years (1988–1999). Altogether 398 specimens were collected. Numerous individuals (142 or 35.7%) were found to share the same shelter during the period between August and April (i.e. most of the year). This is by far the highest percentage of shared sheltering found in any scorpion species inhabiting the eastern Mediterranean region. In spite of this, in laboratory experiments, when pairs of scorpions were put together 5 out of 40 were found mutilated or dead, and when two family groups were introduced a total of 5 out of 50 scorpions were killed or mutilated. No mortality was noted when 3, 4 or 5 individual scorpions were put together. Overall, only 4.8% of the experimental animals were attacked.

Introduction

Scorpions are usually markedly solitary, and often aggressive as adults except during mating (Polis & Lourenço, 1986; Warburg, 1998, 2000; Benton, 2001; Mahsberg, 2001). However, mothers of *Euscorpisus carpathicus* (L.) shelter their young for about one post-parturial month (Vannini & Ugolini, 1980), and in *Pandinus imperator* (C. L. Koch) there is even evidence of some parental care (Mahsberg, 2001). In this sense, scorpions can be defined as subsocial animals since members of two or more generations, belonging to the same species, share the same microhabitat (Polis & Lourenço, 1986; Mahsberg, 1990). This subsocial state sometimes develops into a quasi-social state when members of the same cohort (i.e. generation) continue sharing the same shelter even after reaching maturity (Buskirk, 1981). One possibility is that aggregation in scorpions could be a result of a limited number of shelters (Buskirk, 1981). However, since in habitats occupied by scorpions within the Mediterranean region, shelters (e.g. suitable stones) are usually abundant, they are not likely to be a limiting factor of selective significance (Hornung & Warburg, 1996). Moreover, during spring *Compsobuthus wernerii judaicus* retreats into the ubiquitous cracks in the dry soil.

Several accounts of mature adult scorpions belonging to the same species occurring together (presumably under the same shelter) can be found in the literature (see reviews in Polis & Lourenço, 1986; Benton, 2001; Mahsberg, 2001). In most cases this gregariousness lasts for a limited period during the breeding season or during hibernation. These observations were made on *Centruroides sculpturatus* (Ewing), *C. vittatus* (Say), *Mesobuthus confucius* Simon, and *Compsobuthus schmiedeknechti* Vachon (McAlister, 1966; Zinner &

Amitai, 1969). In addition, accounts are given in the literature describing aggregation in the immature stages of *Opisthacanthus caryaporum* Vellard, *Pandinus imperator*, and *Heterometrus spinifer* (Ehrenberg) (Mahsberg, 2001; Polis & Lourenço, 1986). It is not always clear from these studies whether the authors meant that the scorpions were found sharing merely the same habitat for any length of time, or whether they were sharing the same shelter within that habitat. In most previous studies, no quantitative account is given. Thus, there are no accurate data on dates, numbers or gender of the gregarious scorpions.

I have recently analysed the intraspecific and inter-specific gregarious habits of certain scorpion species sharing the same habitat under field and laboratory conditions (Warburg, 2000). Only 18.7% of the 700 scorpion specimens (belonging to five species) that were studied were found to co-habit in the same shelter (stone) intraspecifically. In 81.3% of the records, scorpions remained solitary under a stone. One species (*Leirus quinquestriatus* (Ehrenberg)) was found very rarely sharing the same stone with any other scorpion.

In the present account, an attempt is made to provide quantitative data on the apparently quasi-social behaviour of a very small buthid species, *Compsobuthus wernerii judaicus* (Birula, 1905) (its mass ranges between 60–130 mg, and body length 20–32 mm according to Levy & Amitai, 1980), which inhabits the Mediterranean region of northern Israel. The study includes both field and laboratory observations.

Material and methods

Collections of *C. w. judaicus* were made at least once monthly over the years 1988–1999 in the Lower Galil Mts. and on Mt. Carmel in the Mediterranean region of northern Israel (see also Warburg, 1997). Winter rainfall in that region is about 600–800 mm and the soil is terra rossa. Altogether 398 specimens of *C. w. judaicus* were collected. Of these 256 (64.3%) were alone when found, while 142 (35.7%) were collected in groups of two or more sharing the same shelter (e.g. under the same stone).

All the scorpions were weighed on a Sartorius balance accurate to ± 0.1 mg. After the experiments, they were dissected (for other purposes, see Warburg, 2001) and their sex determined.

For the laboratory experiments described here only freshly collected, well fed, unharmed and non-moulting scorpions were used. Scorpions participated only once in these experiments, so that any effect of possible habituation or learning was avoided. We tried to evaluate the nature of the interaction between two or more specimens. The experiments were of two kinds:

1. Two scorpions of similar mass (difference in mass not exceeding 5 mg) but from different localities, were marked by a small drop of enamel paint to make them distinguishable to us, and placed overnight on sieved, sterilised soil in a large petri dish measuring 13.5 cm in diameter. Their behavioural responses were observed for 30 min (Fig. 1), following which they remained together

for a total of 24 h. On the following morning they were examined for the effects of possible aggressive interaction (e.g. mutilation or death). Similar experiments were also performed using 3, 4 or 5 scorpions in the same petri dish.

2. Groups consisting of 2 or more individuals each (possibly families; ultimate dissection revealed that they usually included one adult male, 1–2 adult females, and some smaller nymphs), that were originally found sharing the same shelter in the field, were studied for possible aggressive interaction between two such groups. Each group was marked by one colour and placed in a plastic shelter measuring 10 × 10 cm containing a substrate of sieved, sterilised terra rossa soil and which had an

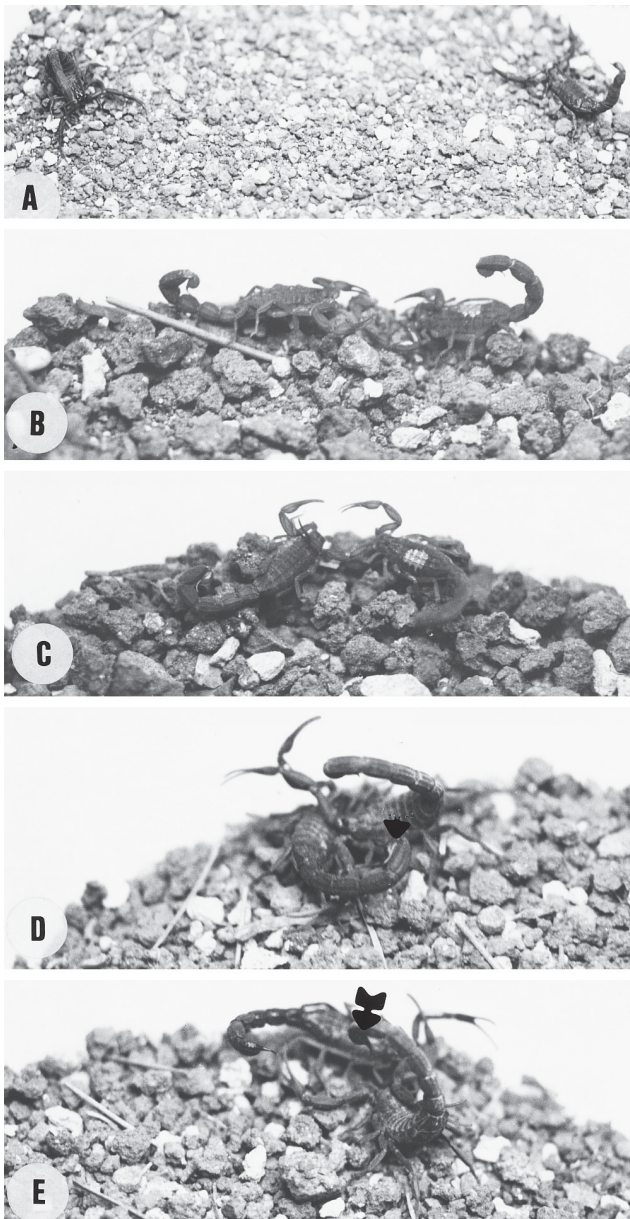


Fig. 1: Encounters between two adult scorpions (*C. w. judaicus*) in a large petri dish. Body length *c.* 2.5 cm. **A** The scorpions become aware of each other's presence; **B** Approaching each other, the scorpion on the right assumes an aggressive posture with tail lifted; **C** Just before contact; **D** Aggressive impact. The scorpion on the left tries to sting its opponent in the pleurite region (arrowhead); **E** The scorpion on the right prepares to sting its opponent (arrowhead).

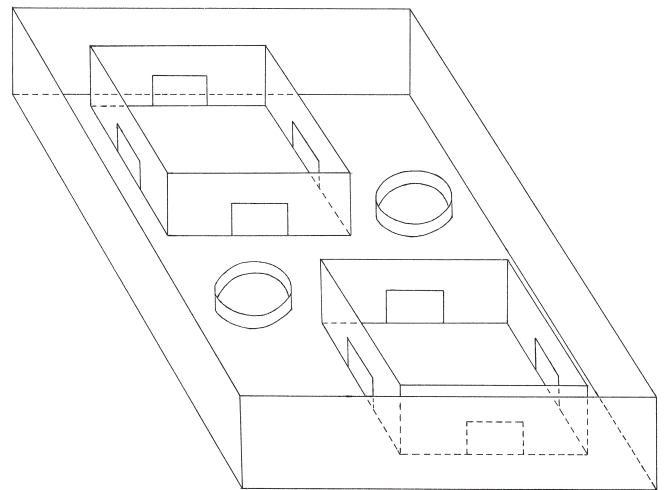


Fig. 2: Experimental set-up for studying "families" (specimens that were found under the same shelter and were kept together). Note the two house-like containers (measuring 10 × 10 cm) with openings on four sides, and two petri dishes: one containing food, the other water, placed in the centre of the plastic container (measuring 22 × 29 cm).

opening on each side. Two such shelters were then placed on similar soil in a large plastic container measuring 22 × 29 cm, together with two small petri dishes, one containing water and the other small mealworm larvae (Fig. 2). The soil was changed between experiments in order to avoid the possible effects of pheromones. Experiments were begun in the afternoon and lasted overnight.

The results were analysed statistically using chi-squared and t-tests.

Results

Cohabitation in the field

Cohabitation by more than one specimen of *C. w. judaicus* under a single shelter in the field was observed on 52 occasions, and included a total of 142 scorpions. Up to 9 specimens were found under the same shelter, and many animals were found in groups of two or three (Table 1). Most groups were found between November and April (Fig. 3). There was a significant difference between the numbers of scorpions found singly and those found in groups ($p < 0.0001$; chi-square). Likewise, there was a significant difference in the phenological pattern. The number of scorpions found cohabiting

No. of specimens	No. of times
2	30
3	16
4	3
5	1
6	–
7	–
8	1
9	1
Total	52

Table 1: Number of times two or more specimens of *Compsobuthus wernerii judaicus* were found together.

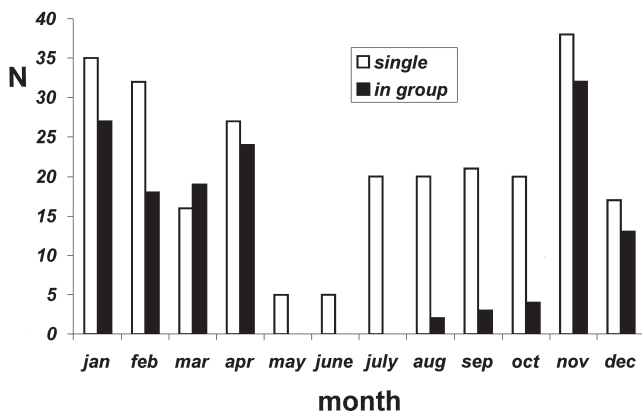


Fig. 3: Phenology of scorpions collected in the field, of which the dates of collection are known. Shaded bars=individuals cohabiting under the same shelter; unshaded bars=individuals found singly. Scorpions were found only singly during May–July.

between November and April differed significantly from those found between May and October ($p < 0.0001$; chi-square).

Encounters between two or more specimens placed together

Usually, when two specimens of *C. w. judaicus* were placed in a large petri dish they either ignored one another (Fig. 1A), or examined each other (Fig. 1B). Aggressive behaviour was rarely observed, and then it took the form of pedipalp grasping (Fig. 1C) and tail thrusting (Fig. 1D, E), culminating in stinging (Fig. 1E).

Signs of aggression were noticed in 25% of the experiments where 2 specimens were tested, resulting in the mutilation or death of 12.5% of the scorpions (Table 2). Likewise, 10% of the scorpions were killed or damaged in encounters between two groups of 2–3 individuals (possibly members of one family) which had been found under two different shelters; an entire family would be annihilated during these encounters. On the other hand, there was no evidence of aggressiveness when three, four or five individual scorpions were placed together in the same petri dish. In total, only 4.8% of the scorpions were killed or mutilated during these experimental encounters. Statistical analysis of the data showed non-aggressiveness to be significantly more prevalent than aggressiveness ($p < 0.0001$, chi-square or t-test).

Discussion

In the present study, 37.5% of individual *C. w. judaicus* were found to be gregarious. This is a much higher percentage than has been found in any other species

within the Mediterranean region (18.7% in Warburg, 2000). The number of specimens found together in the field was not usually more than three. Zinner & Amitai (1969) described groups of 3–7 specimens, and sometimes, especially during hibernation, aggregations of 12–23 specimens of *Compsobuthus schmiedekneichti* were found under the same shelter in the Negev desert. In the present study, conducted in the eastern Mediterranean region, although the scorpions shared the same shelter during winter and spring, they did not hibernate. On the other hand, they were never seen to share a shelter (e.g. a stone) during the summer, at which time they find shelter in cracks in the dry soil. Throughout the summer, scorpions could only be found singly.

McAlister (1966) found up to 10 specimens (usually 2–3) of *Centruroides vittatus* together inside a rotten log. Polis & Lourenço (1986) mention aggregates of 20–30 specimens of *Centruroides sculpturatus*, and 5–10 specimens of *Mesobuthus confucius*. In a recent study on the cohabitation of five scorpion species inhabiting the same habitat in the Mediterranean region, some of them showed both intraspecific and interspecific cohabitation. This phenomenon was not limited to the breeding season (August–September), and species differed in their seasonal gregarious patterns (Warburg, 2000). Two scorpion species were found to cohabit even in July. Cohabitation of mates during the mating season has been recorded by several authors (reviewed in Benton, 2001).

In no other study has any attempt been made to describe scorpion gregariousness quantitatively in the field or test it experimentally in the laboratory. However, there are descriptions of mate guarding and parental care (see e.g. Mahsberg, 2001; Benton, 2001).

Intraspecific aggressive behaviour in the laboratory has previously been described in four scorpion species (Warburg, 1990, 1998). For 79–99.8% of the time no aggressive behaviour was observed. The four species differed significantly in the amount of time allocated to intraspecific aggressive displays. In the present study, an attempt has been made to analyse experimentally the intraspecific behaviour in an apparently quasi-social scorpion.

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No. of scorpions in experiment	2	3	4	5	Groups*	Total
No. of experiments	20	10	10	10	10	60
No. of scorpions	40	30	40	50	50	210
No. mutilated or dead	5	0	0	0	5	10
% mutilated or dead	12.5	0	0	0	10	4.8

Table 2: Aggression between different numbers of individual scorpions put together, and between groups of *Compsobuthus werneri judaicus* (*=possibly family groups).

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