

Studies on the Association Between the Spiny-Tailed Lizard *Uromastyx aegyptius* (Agamidae) and the Black Scorpion *Androctonus crassicauda* (Buthidae)

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ABSTRACT. The spiny-tailed lizard *Uromastyx aegyptius* and the black scorpion *Androctonus crassicauda* are frequently found together in nature. This relationship has been studied under laboratory conditions. No interactions were observed between the diurnal lizard and the nocturnal scorpion either during the day or the night. These animals are mutually tolerant, and immunological studies confirmed that the scorpion never stings the lizard. The lizard furnishes shelter for the scorpion in a location full of cohabiting prey and the scorpion provides protection for the lizard by stinging its enemies.

The spiny tail lizard *Uromastyx aegyptius* Blanford, 1874 which is known locally as the "Dhub", is the largest agamid lizard in Saudi Arabia (800-1250 g adult body mass). It is widespread in Saudi Arabia and is also found both in Jordan and Iraq (Arnold 1986). These lizards colonize flat plains and hard sandy stretches of land. They are mainly herbivorous but may also feed on insects, especially beetles (Gallagher 1971). They are diurnal, with the main peak of activity during the warm part of the day. Depending on the type of soil, the animals dig individual spiral-shaped burrows with their large and strong claws to a distance of about 1 to 2 meters below the ground.

Several animals species co-habit the same burrows with the Dhub including beetles, spiders and some other lizards. However, scorpions are the most dangerous to human beings of the co-habitants of Dhub burrows. There are about 25 scorpion species belonging to four families in Arabia (El-Hennawy 1993), but the black scorpion *Androctonus crassicauda* (Oliver 1807) is found in 30-50% (n = 116) of

Dhub burrows. The black scorpion occurs mainly in central and northern parts of Saudi Arabia (Vachon 1979), and its distribution is exclusively within the habitat range of the Dhub.

It has long been known, especially to Dhub hunters in central Saudi Arabia, that scorpions often inhabit Dhub's burrows, indeed some hunters have been stung by them, sometimes fatally (Al-Sadoon personal communication). The present study was undertaken to investigate whether there is an inter-relationship between the Dhub and its co-habitant the black scorpion.

Materials and Methods

Six Dhubs and eight black scorpions were collected from Ar-Romhiya, about 120 Km north of Riyadh in central Saudi Arabia. Each Dhub was maintained in a plexiglass box (80 x 60 x 60 cm) whose bottom was covered with a substratum of sand 3 cm deep. Light and heat were provided by a 100 W heating lamp with a daily light: dark cycle of 12:12 hrs. The boxes were kept in a room with an ambient temperature of $23 \pm 2^\circ\text{C}$. Food (mainly lettuce) was provided *ad libitum*. The scorpions were separately maintained in glass jars until required and were fed on mealworms.

Potential interactions between the Dhub and the scorpion were tested by introducing a scorpion into the Dhub's box for five days, and the animals were observed for five hrs during the days and for three hrs during the nights.

Subsequently, venom was extracted from each scorpion by an 8-12 volts electrical shock applied to the terminal three segments of the scorpion's metasoma. The protein content of the venom was determined by the method of Lowry *et al.* (1951). Dhub blood (1-2 ml) was collected by cardiac puncture in three stages and was allowed to clot at room temperature ($23 \pm 2^\circ\text{C}$) for three hrs. Serum was separated by centrifugation, and was then stored at -20°C until use.

Blood was collected from six Dhubs immediately after their arrival in the laboratory from the desert (1st stage). The same amount of blood was collected four weeks after each Dhub had been allowed to remain in the same cage with a scorpion for five days (2nd stage). Subsequently, blood was collected following immunization of the Dhubs with scorpion venom according to the method of Vaitukaitis (1981) (3rd stage). About 120 μg of scorpion venom protein diluted with 120 μl distilled water were mixed with an equal volume of complete Freund's Adjuvant and were injected subcutaneously in several sites of the Dhub's body. A booster dose of about 60 μg of venom in 60 μl distilled water mixed with an equal volume of incomplete

Freund's Adjuvant was used four weeks following the initial injections. The agarose double diffusion test (Ouchterlony 1949) was used for the detection of antivenom antibodies in the collected Dhub's sera.

Results

The introduction of the scorpion into the Dhub's cage had no effects whatsoever on the behaviour of the Dhub. The scorpion explored the cage but, when it came close to the Dhub's body, the lizard neither moved nor took any defensive action. After several circuits of the cage, the scorpion not only came close to the Dhub's body, but it even took refuge beneath its thigh without the lizard showing any reaction. It was observed that the scorpion generally rested close to Dhub's body, either next to its abdomen or under its neck on most nights, and close to one of the cage corners during the day. During the night, the scorpion moved around the cage without any interaction with the Dhub which merely closed its eyes when the scorpion walked on its head.

None of sera collected from the Dhubs during the first and second stages, or after the booster of 15 μ g venom, had any antivenom antibodies. Antivenom antibodies were detected only in the sera of the Dhubs immunized with the scorpion's venom (Fig. 1).

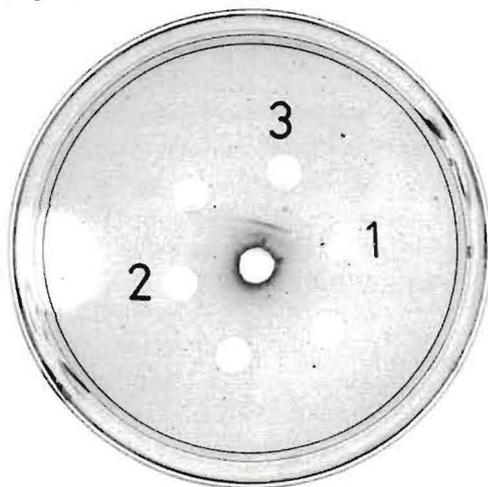


Fig. 1. The detection of *Androctonus crassicauda* antivenom antibodies in the serum of the Dhub by Ouchterlony double diffusion test. Wells 1, 2 and 3 respectively contain Dhub serum collected on arrival from the desert into the laboratory, Dhub serum collected four weeks after the lizards had been allowed to remain with the scorpion in same cage for 5 days and Dhub serum collected from animals immunized with the scorpion venom. The central well contains *A. crassicauda* venom. Note the reaction arc between the central well and well 3 only.

Discussion

The behaviour of *A. crassicauda* and *U. aegyptius* suggests that the relationship between the two species is mutual. The scorpion never attempted to attack the Dhub either during the day or at night. Likewise, the Dhub never showed any apparent caution or apprehension in response to the scorpion next to it.

The nature of the mutual behaviour between Dhubs and scorpions was further investigated by searching for antivenom antibodies in Dhub serum at three different stages. The absence of antivenom antibodies in sera collected during the first and second stages of blood collection, and their presence only after the Dhub had been immunized (3rd stage) with scorpion venom, indicates that the scorpion did not sting the Dhubs either in the desert or after they were confined together in same cage. The amount required to stimulate the production of antibodies was about 50% LD50 of *A. crassicauda* venom (Al-Sadoon, personal communication).

Mutualism is an association which confers benefits such as food resources on protection from enemies to individuals of different species (Begon *et al.* 1986). The observed scorpion-Dhub mutual link is probably obligatory to the scorpion and facultative in the case of the Dhub. This is because *A. crassicauda*, like most other members of the family Buthidae (Hadley 1974), is incapable of digging its own burrow, and has to use those of other animals. The Dhub's burrow seems to be the most suitable for this species as it provides a vital food resource in the desert habitat.

In the field, *A. crassicauda* has been observed usually to occupy the first 20-30 cm of the Dhub's burrow. This is a position most suitable for detecting moving prey, as in the case of many other desert animals that detect their prey by utilizing vibratory cues (Cloudsley-Thompson 1991). Other scorpions, such as *Paruroctonus mesaensis*, can even determine both the direction and the distance of prey moving 15 cm away (Brownell and Farley 1979).

The position of the scorpion at the Dhub's burrow entrance is advantageous to the Dhub by protecting it from predators. Many Dhub hunters have been stung by a scorpion when they reached with their hands into the Dhub's burrow to grasp its head or tail. Some of these encounters have been fatal (Al-Sadoon personal communication).

Acknowledgements

We would like to thank Prof. H.S. Hussein for his critical comments on the manuscript and Mr. M. Yousuf for technical assistance.

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(Received 09/06/1993;
in revised form 27/12/1994)

علاقة التعايش بين الضب *Uromastix aegyptius*
 (عائلة العظايا) والعقرب السوداء *Androctonus crassicauda*
 (عائلة بوثدي)

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ص.ب. (٢٤٥٥) - الرياض ١١٤٥١ - المملكة العربية السعودية

تمت دراسة علاقة التعايش بين الضب *Uromastix aegyptius* والعقرب السوداء *Androctonus crassicauda* تحت ظروف المختبر . لم يلاحظ خلال فترة الدراسة أي تفاعل بين الضب «النهارى المعيشة» والعقرب السوداء «الليلية المعيشة» خلال فترة النهار أو الليل ، وكان كل منهما محتملاً للآخر . وقد أيدت الدراسة المناعية ما لوحظ خلال الدراسة السلوكية ولم يحدث أن لدغت العقرب الضب خلال فترة وجودها معه . إن علاقة التعايش بين الحيوانين توفر للضب الحماية من الاعداء وبخاصة الصيادين وفي نفس الوقت توفر للعقرب المأوى والفرائس التي تحتاجها في تغذيتها .