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Feeding behavior of the Iranian dangerous scorpion species in the laboratory

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Abstract

Annually, scorpions sting a large number of other animals and humans. Given the importance of scorpions in medicine, this study was carried out to investigate the feeding behavior of dangerous Iranian scorpions in the laboratory. In a descriptive study, *Hemiscorpius lepturus*, *Androctonus crassicauda*, *Mesobuthus eupeus*, and *Odontobuthus doriae* species were captured from their natural habitats, held in solitary in laboratory conditions, and fed with the German cockroach, woodlouse, locust and larvae of flies and beetles. To observe their cannibalism and carnivorous behavior, different species were put together. Feeding behavior of these species was then compared to each other. Under laboratory conditions, hunting was similar between *H. lepturus*, *A. crassicauda*, *M. eupeus*, and *O. doriae*. They sting their victims to control bigger and more resistant preys. Overeating in *O. doriae*, carrion-eating in *M. eupeus*, cannibalism in *M. eupeus* and *O. doriae*, carnivorous in *A. crassicauda* and *O. doriae* and newborn-eating in *H. lepturus* and *O. doriae* were observed. *A. crassicauda* did not use water. Feeding behavior of the Iranian dangerous scorpion species are different. This can be used for their control.

Keywords: Feeding behavior, dangerous species, scorpions, laboratory, Iranian

1. Introduction

Venom is a mixture of different biochemical compounds that has been created during evolution of venomous animals as a weapon for defense and feeding. Scorpions are a group of animals armed with venom [1]. Scorpions sting many people in tropical and arid parts of the world. Every year, several cases of scorpion stings are reported from various countries. In 2008, 1.2 million scorpion sting cases with 250 deaths, and in 2012, 1.5 million scorpion stings with 2600 deaths were reported [2, 3]. Mexico ranks first with regard to scorpion sting and its related deaths [4]. More than fifty thousands of scorpion stings are reported from various parts of Iran every year, some of which lead to death [5]. Official statistics show that about 80% of stings and the same number of deaths occur in Khuzestan province. However, the rate is apparently underestimated.

About fifty-one species of scorpions are reported in Iran, of which *Hemiscorpius lepturus*, *Androctonus crassicauda*, and *Mesobuthus eupeus* are the main dangerous ones. However, cases stung by *Buthotus saulcyi*, *Odontobuthus doriae*, *Buthotus schach*, *Olivierus caucasicus*, and *Apistobuthus pterygocercus* also sporadically reported [6]. Scorpion stings can cause a wide range of clinical manifestations in humans. In some cases, the stung person develops mild or severe allergies that may even lead to anaphylactic shock [7]. Scorpions are hunters and feed on different animals. They often hide under rocks or in holes in the ground during the day and hunt at night. These creatures eat little and are very resistant to hunger and thirst so that they can survive for months without food and water [8]. Scorpions have three ways for hunting; waiting somewhere subject to traffic of the prey, actively searching for the prey, and waiting for prey at the entrance of their holes and shelters [8, 9]. The most common method is to leave their shelters early in the evening, wait for the victim, and feed on them inside or outside their shelters after hunting. Scorpions hunt the prey when it is close enough to stimulate their sensitive receptors. A number of scorpions use their holes to trap the prey. That is, scorpions remain very quiet in their shelters and hunt insects that enter the shelters [10]. Field observations have shown that some scorpions may hunt during the day. Insects that are active alongside or below sheep dung and animal manure are hunted. Not to be exposed to the scorching heat of the sun and due to the nocturnal activity of many of their victims, scorpions generally hunt at night. Therefore, the activities of these hunters are adapted to their victims [8].

Scorpions can identify their victims' location from a distance of 50 cm using their receptor organs on their shoulders. They can even identify a victim's movement under sand and drag it out using their pedipalps [11]. Other than their pedipalps, the other sensitive organs include the hair on their body especially on their legs and pedipalps which help them in hunting. Field and laboratory observations show that the faster is the victim, the faster is the scorpions' reaction [12, 13]. Almost 95% of the stung cases and almost all of the dead cases in Iran are due to *H. lepturus*, *A. crassicauda*, *M. eupeus*, and *O. doriae* [5, 6, 14].

The knowledge on aspects of scorpion life is not complete. The detailed study and identification of the environmental behavior of these creatures enables us to understand their activities better. The current study has been conducted to determine the feeding behavior (grabbing the prey, carrion eating, overeating, swallowing, cannibalism, carnivorism and water use) of the Iranian dangerous scorpions in the laboratory.

2. Material and Methods

In this descriptive study, *H. lepturus*, *A. crassicauda*, *M. eupeus*, and *O. doriae* species were captured from their natural habitats in the provinces of Khuzestan, Fars, and

Isfahan. They were delivered to the entomology laboratory of Kashan University of Medical Sciences for an accurate identification of the species. The samples were kept in a temperature between 26 to 31 centigrade degrees. To study the feeding behavior of different species of scorpions, the researchers kept the samples in the laboratory conditions in glass containers separately and fed them with the German cockroach, woodlouse, locust and wing-cut flies. To observe the behavior of cannibalism and carnivorism, the researchers put the different species together in a glass aquarium with a length of one meter, height of 30 cm, and a width of 25 cm. Afterwards, the feeding behavior of these scorpions was compared with each other.

3. Results

3.1. Grabbing the prey

Feeding behavior of the scorpions was investigated during the day time. The hunting methods of *H. lepturus*, *A. crassicauda*, *M. eupeus*, and *O. doriae* were the same in the laboratory conditions. These scorpions usually made their prey motionless using their pedipalps. In case the victims struggled, they were disabled by the sting. There is always a direct relationship between the severity of envenomation and victims' attempt to escape (Table 1).

Table 1: Feeding behavior of the Iranian dangerous scorpion species in the laboratory conditions

	Newborn eating	Overeating	Carnivorism	Cannibalism	Water consumption	Carrion-eating
<i>Hemiscorpius lepturus</i>	+				+	
<i>Androctonus crassicauda</i>			+			
<i>Odonthobuthus doriae</i>	+	+	+	+	+	
<i>Mesobuthus eupeus</i>			+	+	+	+

3.2. Carrion-eating and overeating

In case of hunger, we observed that *M. eupeus* fed on dead arthropods and small pieces of fresh mutton flesh attracted the second instars of this species (Fig. 1). Our observations showed that *O. doriae* was an overeater and in the laboratory conditions. It ate to the point that its abdomen swelled and abdominal rings from the side membrane became significantly dilated and swollen. Due to overeating, these creatures lost their symmetry especially in the lateral plates (pleuron) which were membranous and softer compared to their dorsal and ventral plates (notum and sternum). Our study showed that female scorpions ate more than twice the male scorpions. This was observed and recorded by giving many preys, separately, to females and males.



Fig 1: Carrion-eating in *M. eupeus* species

3.3. Swallowing

Swallowing was both observed at night and day times. It was performed very slowly and usually took half an hour to four hours. All species smashed the prey's body using their chelicerae and endeavored it using their oral foamy

secretions.

When eating hard preys, *O. doriae* expelled the non-absorbable components in the form of trash with bigger pieces conjoined to each other with foam. During the laboratory observation and investigation under the stereo microscope, the non-absorbable components of the preys given to the scorpions were identified. They were observed in various forms with high roughness which could be separated with even a slight pressure after some time. A few of the above-mentioned trashes were significantly related to body size and the age of the scorpion. Their diameter reached 2 to 3 mm and their color depended on the food consumed. However, when fed on the softer preys, the scorpions did not produce food trash. The study showed that the scorpions cleaned their pedipalps, telson and chelicerae with their oral secretions after swallowing the prey.

3.4. Cannibalism and carnivorism

The cannibalism and carnivorism behavior were observed in newborns and adults from the same species. In the cannibalism, the attacking scorpion grabs the victims' tail using one of its pedipalps and uses the other pedipalp to grab the victim's pedipalp on the same side starting eating the victim with smashing and eating the first pair of legs. In this situation, victim is not able to move and if it tries to move, it would be stopped by getting stung. Thus, eating mainly starts from mesosoma and cephalothorax (prosoma). Due to the largeness of the prey, some parts such as tail and back segments and some parts of the legs remains. Feeding on an adult scorpion took up to four hours. This type of cannibalism was observed in *O. doriae* and *M. eupeus* species which fed on other species. *H. lepturus* and *O. doriae*, but not other species, fed on newborns. Carnivorism

behavior was observed in *A. crassicauda*, *O. doriae* and *M. eupeus* species (Fig. 2).



Fig 2: Carnivorism behavior in *A. crassicauda* species

3.5. Scorpions' water consumption

In the laboratory conditions, where the scorpions were not in their natural habitats, they would be in need of water. In this situation, *H. lepturus*, *A. crassicauda*, *M. eupeus*, and *O. doriae* moved toward the wet cottons and juicy fruit pieces such as melon and put their chelicerae on them. After the first molting in the laboratory, newborn scorpions were attracted to the wet cottons and stuck their lower chelicerae to them for 15 to 20 minutes and consumed water. *A. crassicauda* used the least water among the species.

4. Discussion

Our study showed that under laboratory conditions, the studied scorpions fed depending on the prey available. Field and laboratory observations indicated that the scorpions usually hunted in long intervals. Therefore, they need to eat every two weeks on average. In some species, hunting and eating intervals between two meals range from 5 to 68 days. These figures depend on temperature, relative humidity, and food availability^[10]. Under normal circumstances, scorpions periodically need to feed. Frequency is determined depending on prey size, temperature, relative humidity and physical activity of the scorpions^[8]. Our study showed that the scorpions hunted almost every animal which they could feed on. Studies have shown that insects, arachnids, other arthropods, and snails are the scorpions' food resources. Scorpions can choose their prey. These options can be set on the basis of their hunting ability^[15].

Scorpions are not carrion eaters. However, our study shows that under laboratory conditions and excessive hunger, *M. eupeus* can feed on dead arthropods. Moreover, under the same conditions, small particles of fresh mutton attract second instars of *M. eupeus*. Our study also showed cannibalism or newborn eating behavior in three species (Table 1). When hungry, scorpions dominate other scorpions especially smaller ones. Large scorpions feed on small vertebrates, larvae of butterflies, silverfishes, long-legged mosquitoes, termites, terrestrial spiders, gryllus, locusts, bugs, cockroaches, larvae of the beetles, and millipedes. Some scorpions like *Hadrurus arizonensis* feed on small mice, lizards, snakes or their newborns, earthworms, and crustaceans such as woodlouse. Part of their food supply is provided from cannibalism^[8].

Scorpion's venom is vital for their survival. In our study, scorpions did not sting small flies and beetles. In contrast, they stung their preys if they were large, strong, or active.

This finding is consistent with studies of other researchers^[16-18]. Stinging is performed to immobilize the prey or defend themselves against the enemy. However, in some species, such as *Parabuthus transvaalicus*, venom is sprayed as a defensive response^[19].

Our study showed that after swallowing the prey, scorpions clean themselves (pedipalps, telson and chelicerae) with their oral secretions and with the first pair of their legs. Other studies confirm this^[8, 9, 20].

We showed that scorpions and newborn scorpions- after the first molting in the laboratory- are attracted to the wet cottons and stick their lower chelicerae to them for 15 to 20 minutes and consume water. *A. crassicauda* uses the least water among these species. Little consumption on wet cotton may be due to the thickness of their shells and resistance against moisture deficit. In other species, the air dryness is studied in the laboratory conditions of Kashan city. In this region and other tropical areas such as Khuzestan province, scorpions normally rest at the end of their holes, where the soil is damp and they do not need to use water directly^[21, 22]. However, in Khuzestan, one trick to catch scorpions is to drop a wet sack in the corner of the yard. At night, they are attracted to the wet sack to supply water and a number of them remain there. Then, they could be collected and destroyed in the morning^[23].

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