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A Morphological Study of the Venom Apparatus of the spider *Allopecosa fabilis* (Araneae, Lycosidae)

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Abstract: The morphological structure of the venom apparatus of *Allopecosa fabrilis* was studied using scanning electron microscopy (SEM). The venom apparatus is situated in the prosoma and is composed of a pair of chelicerae and venom glands. Each chelicera consists of 2 parts, a stout basal part covered by hair, and a movable fang. A venom pore is situated on the subterminal part of the fang. Just below the fang, there is a cheliceral groove next to the teeth. Each side of the groove is covered with cuticular teeth. The venom glands are large and roughly cylindrical. Each gland is surrounded by completely striated muscular fibers. The venom produced in the venom glands by contraction of these muscular fibers is ejected into the fang through a canal and the venom pore.

Key Words: Venom gland, chelicerae, scanning electron microscope, *Allopecosa fabrilis*, venom

Allopecosa fabrilis (Aranea, Lycosidae) Örümceğinin Zehir Aygıtı Üzerine Morfolojik Bir Çalışma

Özet: Bu çalışmada, *Allopecosa fabrilis*'in zehir aygıtının morfolojik yapısı taramalı elektron mikroskobu kullanılarak (SEM) incelendi. Zehir aygıtı prosomada yerleşmiş olup, bir çift keliser ve zehir bezlerinden ibarettir. Her bir keliser, kıllarla kaplı kalın bir bazal kısım ve hareketli bir zehir dişi olmak üzere iki kısımdan oluşur. Zehir dişinin alt kısmında bir zehir açıklığı yer alır. Zehir dişinin hemen altında, keliser dişlerine yakın bir keliseral boşluk bulunmaktadır. Boşluğun her bir kenarı kutikular dişlerle çevrilidir. Zehir bezleri büyük ve şekil bakımından silindiriktir. Her bir bez, tamamen çizgili kas lifleri ile çevrelenmiştir. Bu kas liflerinin kasılmasıyla zehir bezlerinde üretilen zehir, bir kanal ve zehir açıklığı vasıtasıyla zehir dişine boşalmaktadır.

Anahtar Sözcükler: Zehir bezi, keliser, taramalı elektron mikroskop, *Allopecosa fabrilis*, zehir.

Introduction

The spiders are the largest group of venomous animals, represented by more than 38,000 species throughout the world. Thirty spider species are known to be harmful to humans (1,2).

Many spiders are synanthropic. Thus, human-spider encounters are not infrequent and bites occasionally occur (3,4). For example, a high number of biting events are observed in human populations at high rates by *Phoneutria nigriventer* because those spiders infest clothing and shoes (5,7). Investigations of spiders' venoms and venom apparatus have increased recently (2,8,9).

The venom apparatus is situated in the prosoma of spiders and consists of a pair of venom glands and chelicerae. Venom is produced in a pair of venom glands situated in the anterior portion of the prosoma. The size and shape of the venom glands are different in various species of spiders. The venom glands of *Loxosceles intermedia, Loxosceles reclusa, Heteropoda venatoria, Lycosa narbonensis, Lampana cylindrata* and *Agelena limbata* species are in the prosoma (10,12), while those of *Hogna tarantula* and *Plesiophirctus collinus* species are in the chelicerae (8,13,14).

In the spider embryo, the chelicerae lie behind the mouth opening. They are located in the anterior portion of the prosoma at the next growing period (2). Each chelicera consists of 2 parts, a stout basal part and a movable venom fang (15). There are mature muscles in the basal part and venom glands in some species. These muscles are involved in moving the fang. In general, the fang rests in a groove of the basal segment like the blade

of a pocket knife. When the spider bites, the venom fang moves out of the groove and penetrates the prey. At the same time, the venom is injected into the prey from a tiny opening at the tip of the venom fang. Both sides of the chelicera groove have cuticular teeth. Spiders with teeth in the groove mash their prey. Those without teeth can only suck out their victims through the small bite holes (2). The number and size of cheliceral teeth are very important diagnostic characteristics for taxonomists. Spiders use their chelicerae for defense, seizing prey, carrying egg cocoons, making noise and digging (2,15). Spider venom is obtained for use in medical treatment of such diseases as cardiac disturbance and for producing new antibacterial reagents (16,17). The aim of this study was to investigate, the morphological structure of the venom apparatus of *Allopecosa fabrilis*.

Materials and Methods

Twenty specimens of *Allopecosa fabrilis* (18) were collected from the town of Yahşihan near Kırıkkale in July. The spiders were anesthetized with ether and their venom glands in the prosoma were dissected under a stereo microscope (Nikon SMZ 10A). The venom glands and chelicerae were washed with 0.2 M sodium phosphate buffer. The venom glands were fixed in 3% gluteraldehyde buffer at 4 °C for 2 h. After rinsing in sodium phosphate buffer (pH 7.2) 3 times for 10 min, they were fixed in 1% osmium tetroxide with the same buffer at 4 °C. Samples were left in sodium phosphate buffer to remove osmium tetroxide, and then were dehydrated in the following alcohol series for 10 min; 50%, 60%, 70%, 80%, 90%, 95% and 99%. After dehydration, the samples were transferred to petri dishes and dried on air. Dried samples were placed on stubs, then coated with gold using a Polaron 500 sputter coater and examined using a scanning electron microscope (19,21).

Results

In our studies, the venom apparatus of *Allopecosa fabrilis* consists of a pair of venom glands in the prosoma (Figure 1). In *Allopecosa fabrilis*, the venom glands are cylindrical. The gland is composed of a cylindrical stem and a canal connected it. The canal extends through the outer surface of the chelicerae. The glands were determined to be one lobed (Figure 1). The average

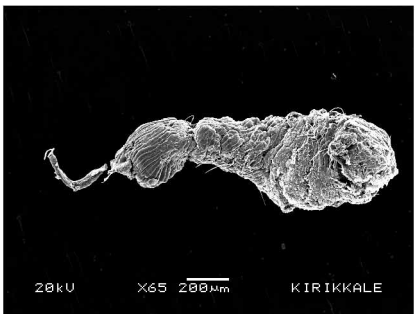

Figure 1. The general appearance of venom gland (vg).

length of the glands was 1.38 mm and the width was 490 µm (Figure 2). The outer surfaces of the glands are surrounded by numerous spirally arranged striate muscular fibers (Figure 3).

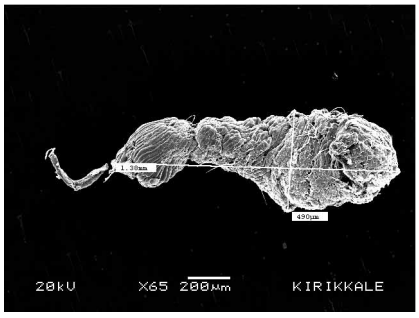

Figure 2. The appearance of diameter and length of venom gland.

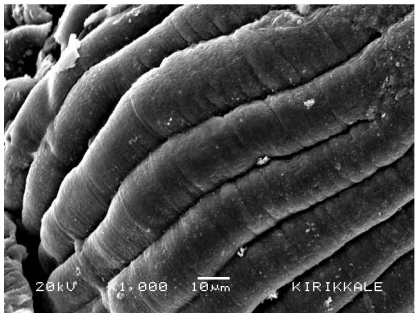

Figure 3. The appearance of numerous striated muscular fibers (m) surrounding venom gland.

Each chelicera was observed to have 2 parts, a stout basal part and a movable venom fang (Figure 4). The basal part is covered by long hairs. Each fang is observed to sit in a groove at the base of the chelicera. Outside this groove, just below the venom fang, chelicerae teeth are reciprocally arranged (Figure 5). These teeth are used for holding and crushing prey. There is a pore to release the venom produced near the tip of the venom fang (Figure 6).

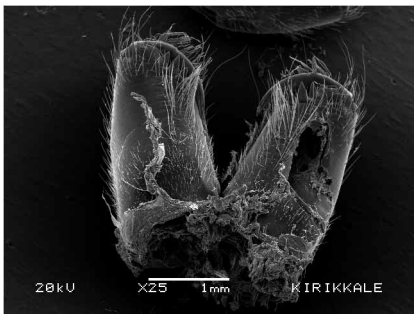

Figure 4. The appearance of basal part (bp) and venom fang (vf).

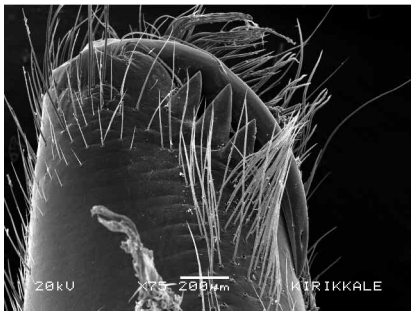

Figure 5. The appearance of chelicerae teeth (ct).

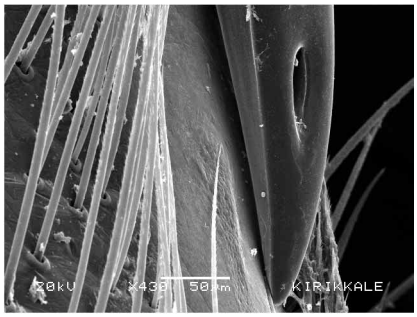

Figure 6. The appearance of the pore (p) through which venom is released.

Discussion

Kaston (22) stated that the venom glands of spiders are generally found in the prosoma, and rarely in the chelicerae, except for the families Uloboridae and Holarchaidae, which lack venom glands entirely. In the species *Loxosceles intermedia, Ctnedus medius, Lycosa indagastrix, Heteropoda venatoria, Loxosceles reclusa, Cuppiennius salai, Dolomedes tenebrosus, Agelena limbata, Latrodectus mactans* and *Lycosa narbonensis narbonensis* (11,12,23,25) it was reported that the venom glands are in the prosoma, and in *Plesiophirctus callinus* and *Hogna tarantula* (13,22,26) they are in the chelicerae. In this study, the venom gland of *Allopecosa fabrilis* species is situated in the prosoma and extends through the outside of the chelicerae with a pair of canals.

Previous studies showed that the venom glands vary in shape and position (27). For example, in the genus *Atypus* the glands are composite, in *Filistata* they are multilobular and in *Scytodes* they are bilobular (11,28,29). The venom glands of *Loxosceles reclusa* and *Loxosceles intermedia* are bulbous; in *Heteropoda venatoria, Latrodectus mactans, Lycosa indagastrix* they are cylindrical; in *Ctnedus medius* they are purse-like; in *Plesiophirctus collinus* they are carrot-like; and in *Agelena labyrinthica* they are aubergine in shape (11,30, 32). The venom glands of *Allopecosa fabrIlis* have one lobe as is also the case in *Loxosceles intermedia, Lycosa indagastrix, Heteropoda venatoria, Loxosceles reclusa, Cuppiennius salai, Dolomedes tenebrosus, Agelena limbata, Latrodectus mactans* and *Lycosa narbonensis* (11,12,23,25), and they are cylindrical.

The size of the venom gland is not necessarily related to the size of the spider. For example, large theraphosid spiders and tarantulas have very small glands, whereas most small labidognath species possess comparatively large glands (1,2). In our research, although *Allopecosa fabrilis* has a small body, the size of its venom gland is rather large.

The movement of the chelicerae differs between in the 2 large suborders Labidognatha and Orthognatha. The chelicerae are situated under the prosoma in the Labidognatha members. The chelicerae are opposite, like the arms of the letter V. In the Orthognatha members, the chelicerae are connected with the anterior of the prosoma and the venom fangs lie parallel to each other. They move up and down (33). Based on its chelicera movement, *Allopecosa fabrilis* belongs to the suborder Labidognatha.

Collatz (34) reported that although some spiders have cheliceral teeth, some do not. For example, the Araneidae, Tetragnatidae, Agelenidae and Avuculariadae members have chelicerae covered with large teeth, whereas the Theridiidae and Thomisidae members do not have teeth. In terms of the size of the teeth, *Allopecosa fabrilis* is similar to the Araneidae, Tetragnatidae, Agelenidae and Avicularidae members.

Studies showed that the number of chelicera teeth plays an important role in taxonomy. For example, while there is only one tooth at the posterior of the chelicera tooth groove in the female *Enoplognatha* (Theriididae), there are 6-7 large teeth in the *Tapinopa* (Linyphiidae) (22). Four pairs of teeth are present on the chelicerae of *Allopecosa fabrilis* in an opposite arrangement. In this study, it was determined that the morphological structure of the venom apparatus of *Allopecosa fabrilis* resembles those of related species, but there are some small differences.

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