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A Morphological Study on the Venom Apparatus of Spider *Larinioides Cornutus (Araneae, Araneidae)*

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Abstract: The morphological structure of the venom apparatus of *Larinioides cornutus* was studied using a scanning electron microscope(SEM). The Venom glands are situated in the anterior cephalic part of the prosoma, and each gland consists of a long cylindrical part and an adjoining duct, which terminates at the tip of the cheliceral fang. Each chelicera consists of 2 parts: a stout basal part covered by hair, and a movable fang. There are parallel grooves on the dorsal surface of the fang. The ventral surface has hollows like saw teeth. A venom pore is situated on the subterminal part of the fang. Below the fang, there is a cheliceral groove between the teeth. Each side of the groove is armed with cuticular teeth. Venom glands are small and similar to an aurbergine in shape. Each gland is surrounded by completely striated muscular fibers. The venom produced in the venom glands is ejected into the fang through the duct by contraction of these muscular fibers.

Key Words: *Larinioides cornutus*, venom gland, , morphology, chelicerae, scanning electron microscope (SEM)

Larinioides Cornutus (Araneae, Araneidae) Örümceğinin Zehir Aygıtı Üzerine Morfolojik Bir Çalışma

Özet: Bu çalışmada, *Larinioides cornutus*'un zehir aygıtının morfolojik yapısı taramalı electron mikroskobu (SEM) kullanılarak çalışılmıştır. Zehir bezleri, prosomada başın ön kısmında yerleşmiştir ve her bir bez, silindrik kısım ve bir keliseral dişin ucunda sonlanan bitişik bir kanaldan ibarettir. Her bir keliser kıllarla kaplı kalın bir bazal kısım ve hareketli bir zehir dişi olmak üzere iki kısımdan oluşur. Keliseral dişin dorsal yüzeyinde parallel oyuklar yer alır. Ventral yüzey testere dişi gibi oyuklara sahiptir. Zehir dişinin alt kısmında bir zehir açıklığı yerleşmiştir. Zehir dişinin hemen alt kısmında keliser dişlerinin arasında bir keliseral boşluk vardır. Boşluğun herbir kenarı kutikular dişlerle çevrilidir. Zehir bezleri küçük ve şekil bakımından patlıcanı andırmaktadır. Her bir zehir, tamaman çizgili kas lifleriyle çevrelenmiştir. Zehir bezlerinde üretilen zehir, bu kas liflerinin kasılmasıyla bir kanal vasıtasıyla zehir dişine salınmaktadır.

Anahtar Sözcükler: *Larinioides cornutus*, zehir bezi, morfoloji, keliser, taramalı electron mikroskobu (SEM)

Introduction

Spiders are the largest group of venomous animals, represented by about 4,.000 species throughout the world. Thirty spider species are know to be harmful to humans (Schimidt, 1973; Foelix, 1982). Many spiders are synanthropic. Human-spider encounters are not infrequent, and bites occasionally ocur (Futrell, 1992; Ori and Ikeda, 1998). However, biting events are observed in human populations at a high rate, for instance by *Loxosceles intermedia* because this spider prefers residential areas. These spiders infest clothing and shoes (Burcherrl, 1969:Schenone and Suarez, 1978; Wasserman and Anderson, 1984). As a result, especially on their venoms and venom apparatus, have increased recently (Foelix, 1982; Lucas, 1985).

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 gland vary among different species. The venom glands of *Loxosceles intermedia, Loxosceles reclusa, Heteropoda venatoria, Lycosa*

narbonensis, Lampana cylindrata and *Agelena limbata* are in the prosoma (Moon. 1992; Lachlan et al., 2000; Santos et al., 2000), while those of *Hogna tarantula* and *Plesiophirctus collinus* are in the chelicerae (Russel et al., 1973; Gertsch, 1979).

Each chelicera consists of 2 parts: a swollen basal part and a movable venom fang. 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 in the basal segment like the blade of a pocket knife. When the spider bites, the fang moves out of its 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 fang. Both sides of the cheliceral groove are armed with cuticular teeth. Spiders having teeth in the groove can mash their prey; however, spiders without teeth can only suck out their victims through the small bite holes (Foelix, 1982). The number and size of cheliceral teeth are important as diagnostic characteristics for taxonomists. Spiders use their chelicerae for defense, seizing prey, carrying egg cocoons, digging soil and making noise (Foelix, 1982). Spider venom is used in the medical treatment of diseases such as cardiac disturbance and for producing new antibacterial reagents (Haeberli et al., 2000; Bode et al., 2001). The aim of this study was to investigate the morphological structure of the venom apparatus of *Larinioides cornutus*.

Materials and Methods

Twenty *Larinioides cornutus* (Clerck, 1757) specimens were collected from the Barla a village in Eğirdir (Isparta) in June 2003. They were anesthetized with ether at the laboratory of Kırıkkale University, and their venom glands were dissected from the prosoma under a stereomicroscope (nıkon SMZ 10A). The venom glands and chelicerae were washed with 0.2 M sodium phosphate buffer (pH 7.2); then the venom glands were fixed in 3% gluteraldehyde buffer at 4 ^{0}C for 2 h. After rinsing in sodium phosphate (pH 7.2) buffer 3 times for 10 minute, each was fixed in 1% osmium tetroxide with the same buffer at 4 ^{0}C for 1 h. Samples were left in the sodium phosphate buffer to remove the osmium tetroxide; then they were dehydrated in the following alcohol series for 10 min: 50%, 60%, 70%, 80%, 90%, 95% and 99%. After the dehydration stages, the samples were transferred to petri dishes and dried in an oven at 40 ^{0}C. Dried samples were placed on stubs, then coated with gold by "Polaron 500" sputter coater and examined using a scanning electron microscope (Jeol 5600) (Hayat, 1981; Karnovsky, 1985).

Results

The venom apparatus of *Larinioides cornus* consists of a pair of venom glands in the prosoma. In *Larinioides cornutus,* The venom glands are like an aubergine in shape (Figure 1). The dorsal surfaces of the glands are surrounded by striated muscular fibers spirally arranged (Figure 2). The gland is composed of a cylindrical stem part and a canal connected to it. The canal extends to the anterior part of the chelicerae. The glands were determined to be one lobed and each lobe was divided into small lobes. The average length of the glands was 712 mm and width was 258 mm (Figure 1).

Each chelicera was observed to have 2 parts: a stout basal part and a movable venom fang (Figures 3, 4). The basal part is covered by slight hairs. A pore for releasing the venom is located near the tip of the fang (Figure 5). The upper surface of the fang is covered by tiny parallel glooves (Figure 6). The subsurface is hollowed like a saw (Figure 7). Each fang sits in a groove at the apical part of the chelicerae. The margins of the grooves are supported by cheliceral teeth (Figure 8). These teeth are used for holding and crushing the prey.

Discussion and Conclusion

Kaston (1978) 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, Lycosa indagastrix, Heteropoda venatoria*, *Loxosceles reclusa*, *Cuppiennius salai*, *Dolomedes tenebrosus, Agelena limbata*, *Latrodectus mactans* and *Lycosa narbonensis* (Foil et al., 1979; Ridling and Phanuel, 1986; Moon, 1992; Gümüşoğlu, 2000; Santos et al., 2000) it was reported that the venom glands are in the prosoma, and in *Plesiophirctus callinus* and *Hogna tarantula* (Russell et al.,1973; Kaston, 1978; Mali et al., 2000) they are in the chelicerae. In this study, the venom gland of *Larinioides cornutus* species is situated in the prosoma and extends through the chelicerae via a pair of canals.

Differences in the shape and position of the gland in

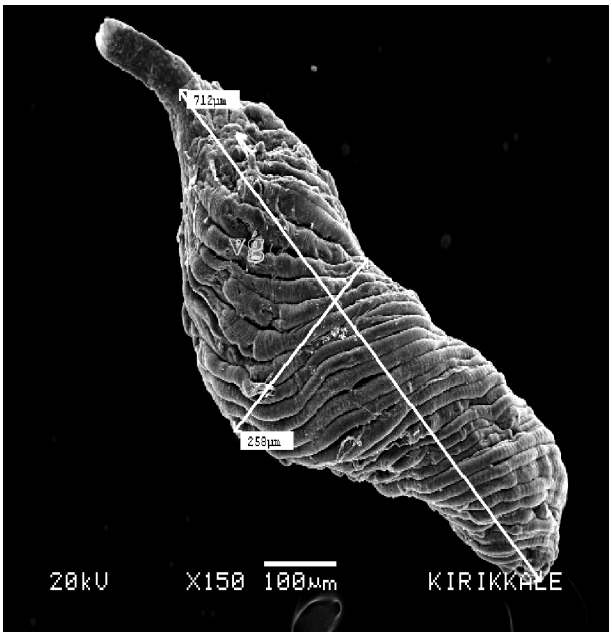

Figure 1. The general appearance of the venom gland (vg).

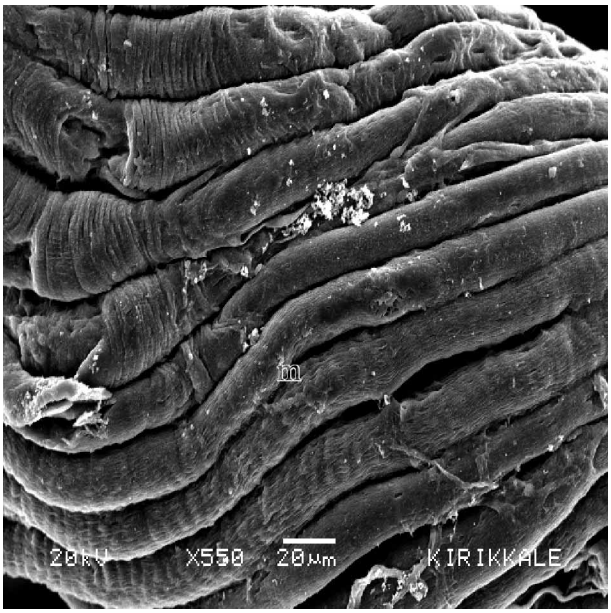

Figure 2. The appearance of numerous striated muscular fibers (m) surrounding the venom glands.

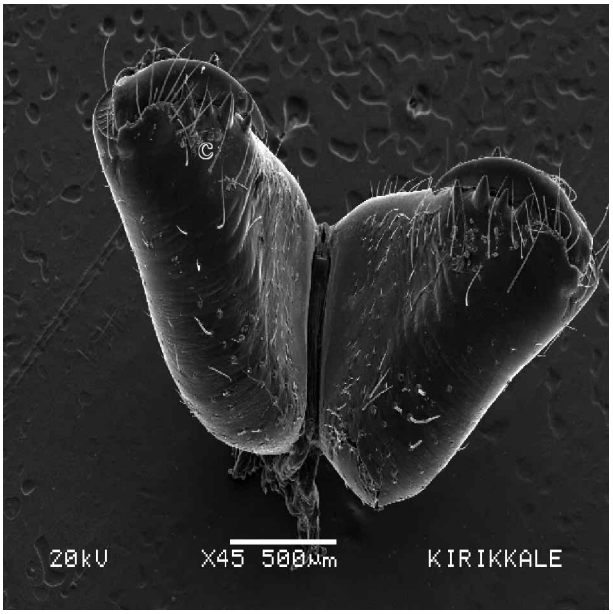

Figure 3. The general appearance of the chelicerae (c).

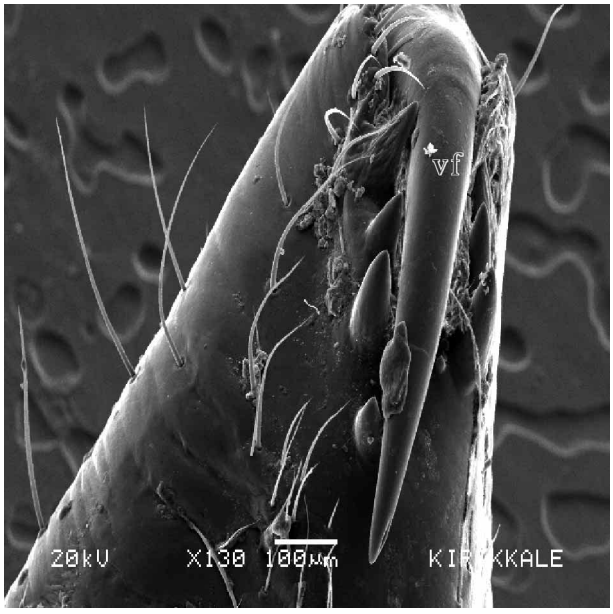

Figure 4. The appearance of the basal part and fang (vf).

different species of spiders have been described by Berkau (1891). For example, in the genus *Atypus* the glands are composite (Berkay, 1891), in *Filistata* they are multilobular and in *Scytodes* they are bilobular (Kavoor and Munoz, 2000; Santos, 2000). The venom glands of *Loxosceles reclusa* (Foil et al., 1979) and *Loxosceles intermedia* are bulbous (Santos et al., 2000); in *Heteropoda venatoria* (Ridling and Phanuel, 1986), , *Latrodectus mactans* (Smith and Russell, 1967) and *Lycosa indagastrix* (Ridling and Phanuel, 1986) they are

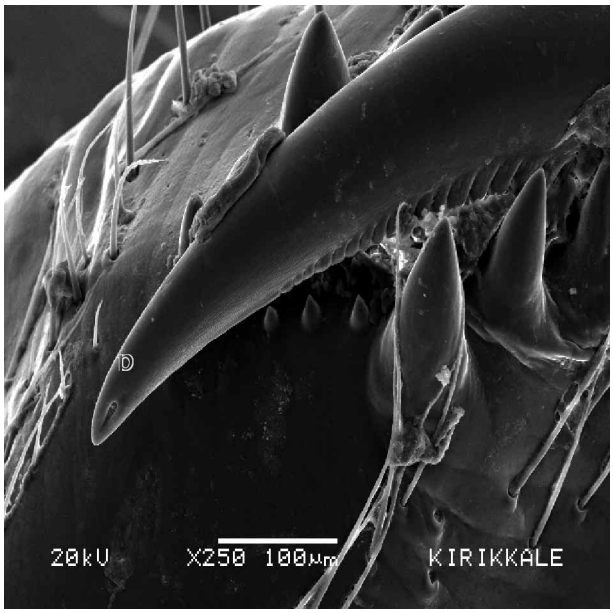

Figure 5. The appearance of the pore (p) through which venom is released to the outside.

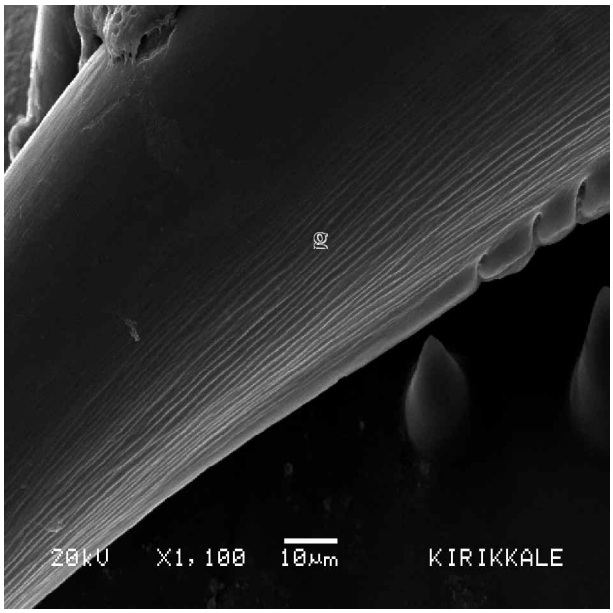

Figure 6. The appearance of grooves (g) situated on the surface of the fang.

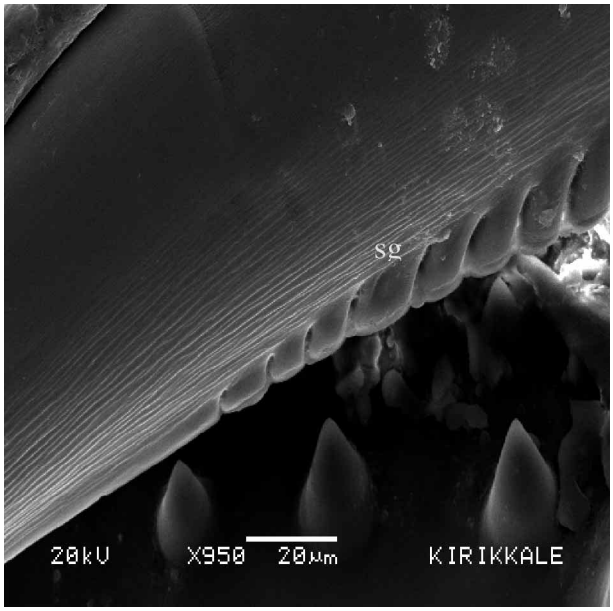

Figure 7. The appearance of saw-like grooves (sg) situated at the subsurface of the fang and teeth in the chelicerae groove.

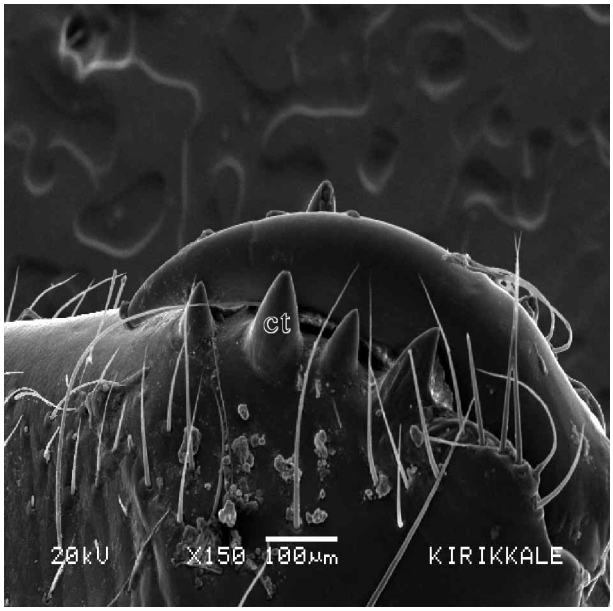

Figure 8. The appearance of the chelicerae teeth (ct).

cylindrical; in *Ctnedus medius* they are purse-like (Brazil and Vellard, 1925); in *Plesiophirctus collinus* they are carrot-like; and in *Agelena labyrinthica* they are aubergine-like in shape (Çavuşoğlu et al., 2003). The venom glands of *Larinioides cornutus* are one lobe as also observed in *Loxosceles intermedia* (Santos, 2000), *Lycosa indagastrix* (Ridling and Phanuel, 1986), *Heteropoda venatoria* (Ridling and Phanuel, 1986), *Loxosceles reclusa* (Foil et al., 1979), *Cuppiennius salai*, *Dolomedes tenebrosus*, *Agelena limbata* (Moon, 1992), *Latrodectus*

mactans and *Lycosa narbonensis* (Gümüşoğlu, 2000), and they are like aubergine in shape.

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 (Schimidt, 1973; Foelix, 1982). In our research, *Larinioides cornutus* has a relatively small body, and the size of its venom gland is also small.

The movement of the chelicerae is different in the 2 large suborders Labidognatha and Orthognatha. Chelicerae are situated on the underside of the prosoma in the Labidognatha members. The direction of the chelicerae is downward. In the Orthognatha members, the chelicerae are forward and connected with the anterior of the prosoma. They move up and down (Levi and Levi, 1990). *Larinioides cornutus* is in suborder Labidognatha.

The pores and grooves located on the surface of the venom fang of spiders are determined to be taxonomically important (Foelix, 1982). In *Larinioides cornutus* species, in addition to the paralel grooves that cover the dorsal and lateral sides of the fang (as in *Agelena labyrinthica*), there are saw-like groves on the ventral surface of the venom fang.

In a study, ıt was seen that the venom fang of Filistatidae, Pholcidae and Scytodidae families was determined to be smaller than basal part [23]. The venom fang of *Larinioides cornutus* investigated in this study was observed that it is not smaller than basal part.

Collatz (1982) reported that although some spiders have chelicera teeth, others do not. For example, in the members of the Araneidae, Tetragnatidae, Agelenidae and Avucularidae the chelicerae are supported by large teeth, while Theridiidae and Thomisidae do not have teeth. In terms of the strength of the teeth, *Larinioides cornutus* is similar to the Araneidae, Agelenidae and Avicularidae (Kaston1978).

Studies showed that the number of cheliceral teeth plays an important role in taxonomy (Foelix, 1982). For example, while there is only 1 tooth at the posterior of the cheliceral groove in the female *Enoplognatha* (Theriididae), there are 6-7 big teeth in the *Tapinopa* (Linyphiidae) members. Four pairs of teeth are present on the chelicera of *Larinioides cornutus.* In *Larinioides cornutus*, many small teeth were also found to be situated in the cheliceral groove, but some spider species (i.e. *Agelena labyrinthica* and *Erasus niger*) do not have any teeth.

Furtermore, in *Tinus* (Pisauridae), the existence of pores was observed among the species (Kaston, 1978). It was determined that the morphological structure of the venom apparatus of *Larinioides cornutus* resembles those of the other related species, but there are some differences in the details.

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