Received: September 16, 2008
Accepted: October 6, 2008
Abstract published online: October 31, 2008
Full paper published online: February 28, 2009

J Venom Anim Toxins incl Trop Dis.
V.15, n.1, p. 146-156, 2009.
Short communication.
ISSN 1678-9199.

MORPHOLOGICAL CHARACTERIZATION OF THE VENOM APPARATUS IN THE WOLF SPIDER *Lycosa singoriensis* (LAXMANN, 1770)

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ABSTRACT: The wolf spider *Lycosa singoriensis* (Laxmann, 1770) (Lycosidae: Araneae) is distributed throughout central and eastern Europe, including Russia, Kazakhistan and Turkey. This study describes the venom apparatus morphology of *L. singoriensis* through scanning electron microscopy (SEM). Its structure follows the general architecture observed in other spiders. Generally, a venom apparatus is composed by a pair of venom glands and chelicerae. *L. singoriensis* chelicerae are robust and consist of a stout basis and a movable apical segment (fang). The fang rests in a groove on the basal segment that is covered by different types of hair. *L. singoriensis* venom glands present equal size and measure about 4 mm in length. Each gland is enclosed by irregular muscular layers.

KEY WORDS: spider, *Lycosa singoriensis*, chelicerae, venom gland, morphology.

CONFLICTS OF INTEREST: There is no conflict.

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INTRODUCTION

Spiders are known by their bites and are very common even in urban areas. Wolf spiders (Lycosidae) are common throughout the globe and are represented by more than 2,300 species (1). They are quite frequent in many parts of the Palearctic region (1, 2). A total of 63 species grouped in 11 genera have been recorded in Turkey (3). Wolf spiders are real hunters that live in a wide variety of terrestrial habitats and generally present robust legs and chelicerae. They can be easily recognized by a frontally narrow and high prosoma and notable eyes that are arranged in three rows. Although members of *Lycosa* and *Geolycosa* have relatively large bodies, *L. singoriensis* size ranges from very small to larger than 30 mm. Their bites are painful and leave significant marks due to the large size of their fangs (4). However, there is no statistically significant difference between bites of large or small lycosids (5).

In the current study the venom apparatus of *Lycosa singoriensis* was morphologically described by means of scanning electron microscopy. Two females of *L. singoriensis* were collected from a grassland (Figure 1) in Kirikkale (33°, 31'E-39°, 50'N, a city in the Central Anatolia region) in September 2005. The glands were fixed in 3% glutaraldehyde in 0.1 M sodium phosphate buffer (pH 7.2) for 2 hours at 4°C, rinsed for 2 hours in sodium phosphate buffer, and postfixed in 1% osmium tetroxide in the same buffer for one hour. They were then dehydrated in a graded ethanol series. To clean the surfaces of the chelicerae and fangs, they were washed for 10 minutes in a stream of 100% ethanol. The last stages of dehydration were performed with acetone. The venom apparatuses were dried and coated with a thin layer of gold by Polaron SC 500® sputter coater (VG, Microtech, England). The materials were examined under Jeol JSM 5600® (Jeol Ltd., Japan) scanning electron microscope (SEM).

Figure 1. Female *L. singoriensi*s.

L. singoriensis venom apparatus has the same general structure of those from other spiders, it is situated in the anterior part of the prosoma and composed of a pair of venom glands, a pair of chelicerae with apical fangs and a pair of canals (or ducts) that connect the glands through the chelicerae to the tip of the fangs. Like in other ground-living and burrowing spiders, the chelicerae consist of two parts: basal segment (paturon) and a movable articulated apical segment (fang). The basal segments of the chelicerae are very stout and strong, and are covered by hair, similarly to the rest of the body (Figure 2).

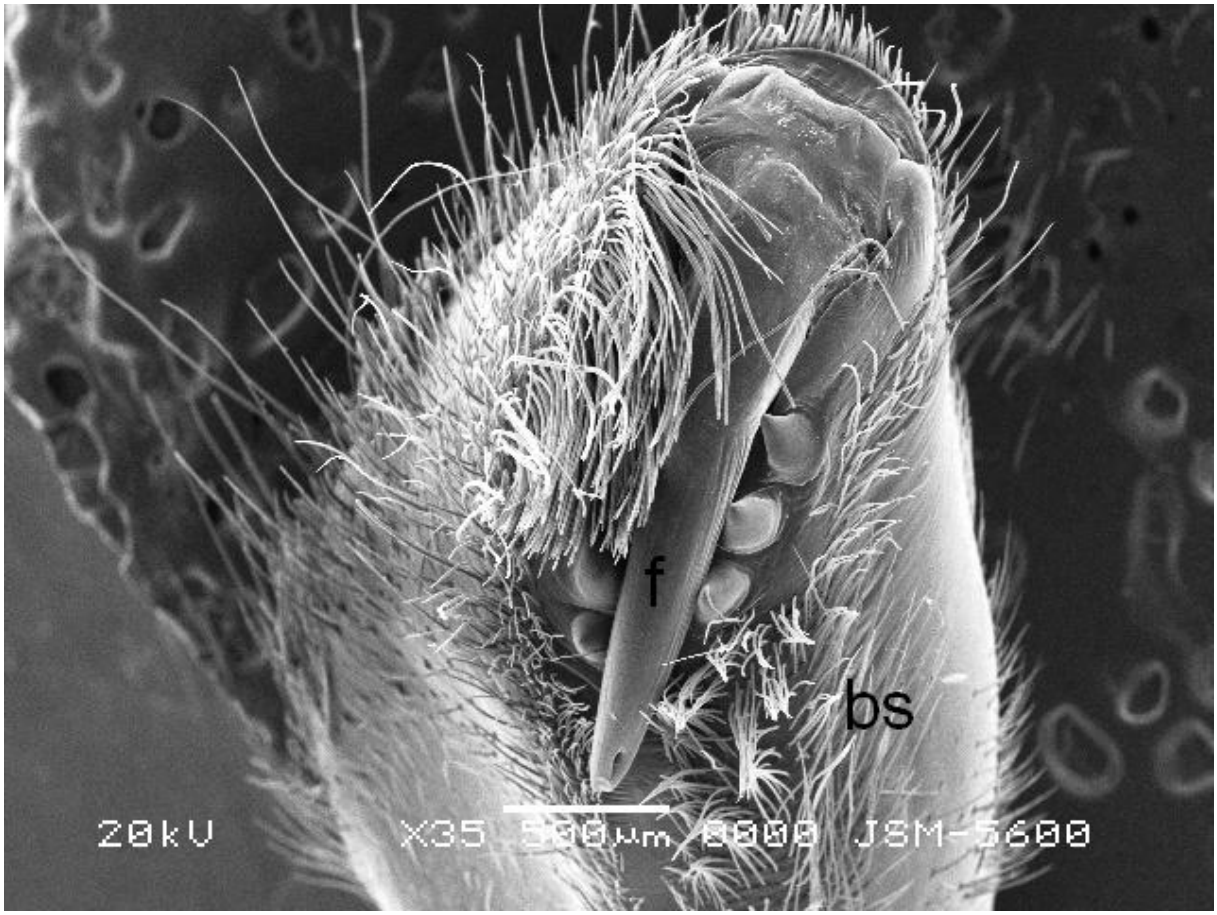

Figure 2. Chelicera of *L. singoriensi*s, the fang (f) and basal segment (bs). The basal segment is covered by dense hair.

The movable fang rests in a groove of the chelicera basal segment, it looks like an injection needle and presents the same function (Figures 2 and 3). From the base up to its apical region, the fang becomes narrower, ending in a quite sharp tip. The pore is situated on the fang subterminal part, from which the venom is ejected. Parallel fine grooves, observed running longitudinally on the fang surface, in higher magnifications appear to form a ridge that constitutes a blade-like structure. In addition, both sides of cheliceral grooves are equipped with three or four cuticular marginal cone-shaped teeth (Figure 4 – **a** and **b**).

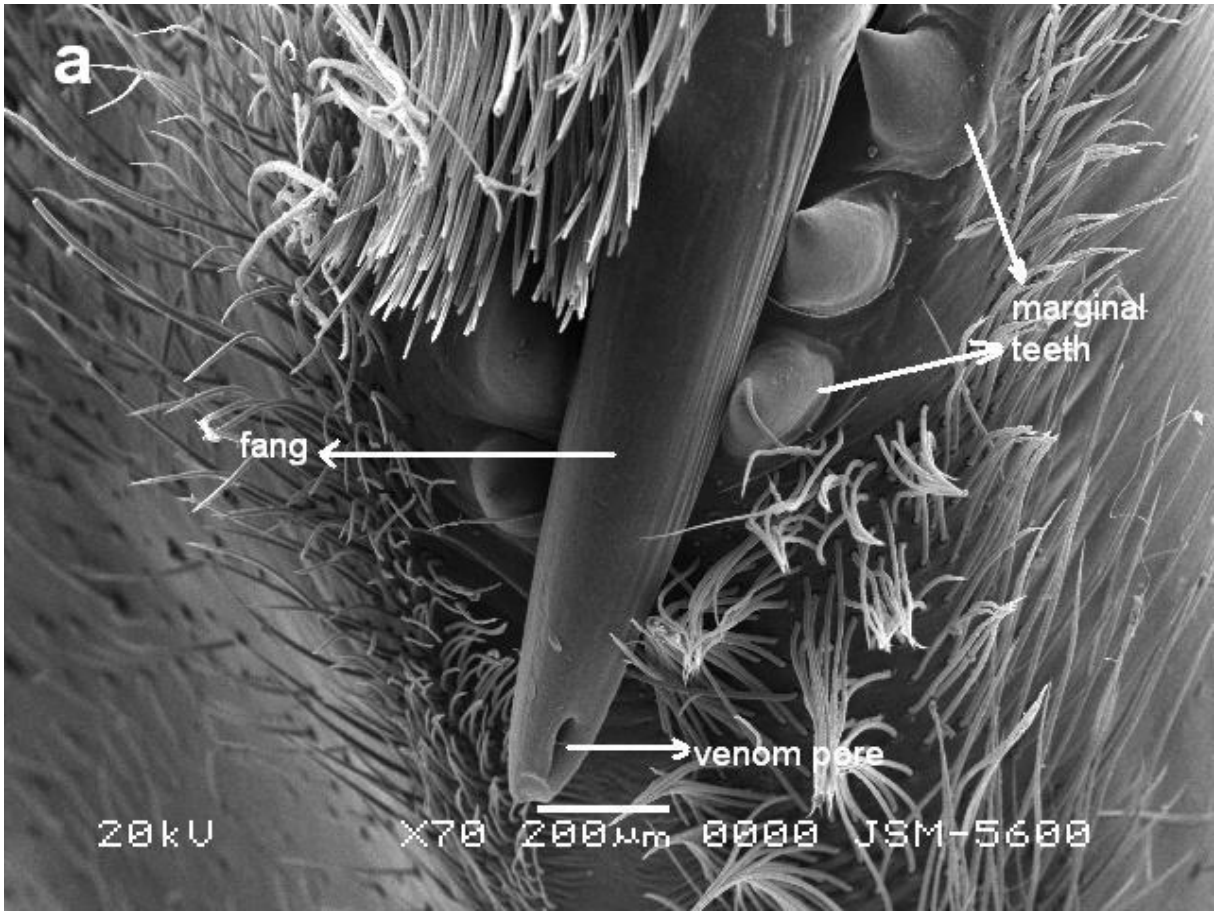

Figure 3. Detail of the fang.

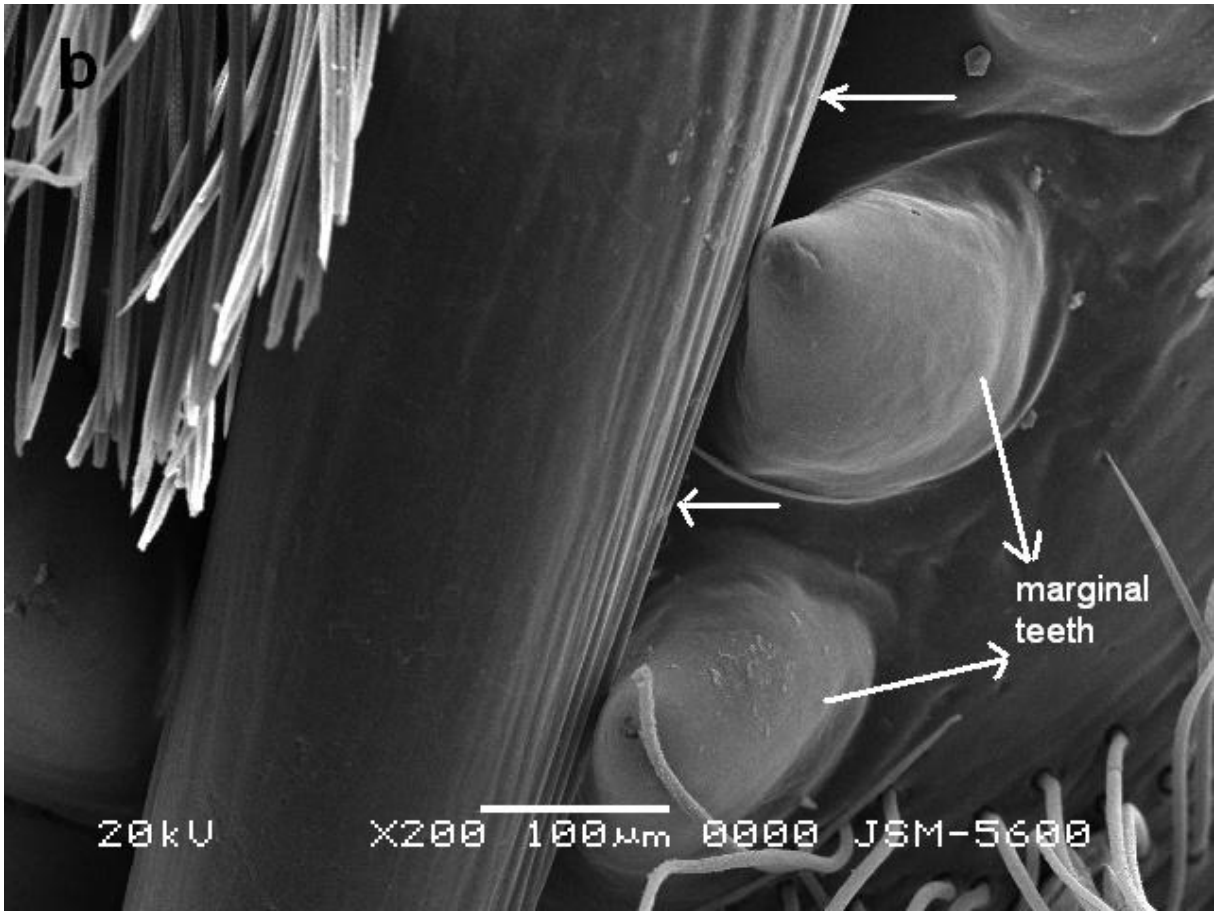

Figure 4. The fang, venom pore and marginal teeth (**a**); blade-like structures (arrows) in higher magnification (**b**).

Venom glands, the main components of the venom apparatus, form a pair that is dorsally located in the prosoma. The glands present similar sizes and have the appearance of long sacs, with approximately 4 mm, extending from the middle prosoma to the chelicera base (Figure 5). The distal portion of the venom gland is wider than the proximal one and there is a large lumen in its center. Furthermore, each gland is enveloped by a thick muscular layer. Dense muscle bundles are irregular and noticeable (Figure 6).

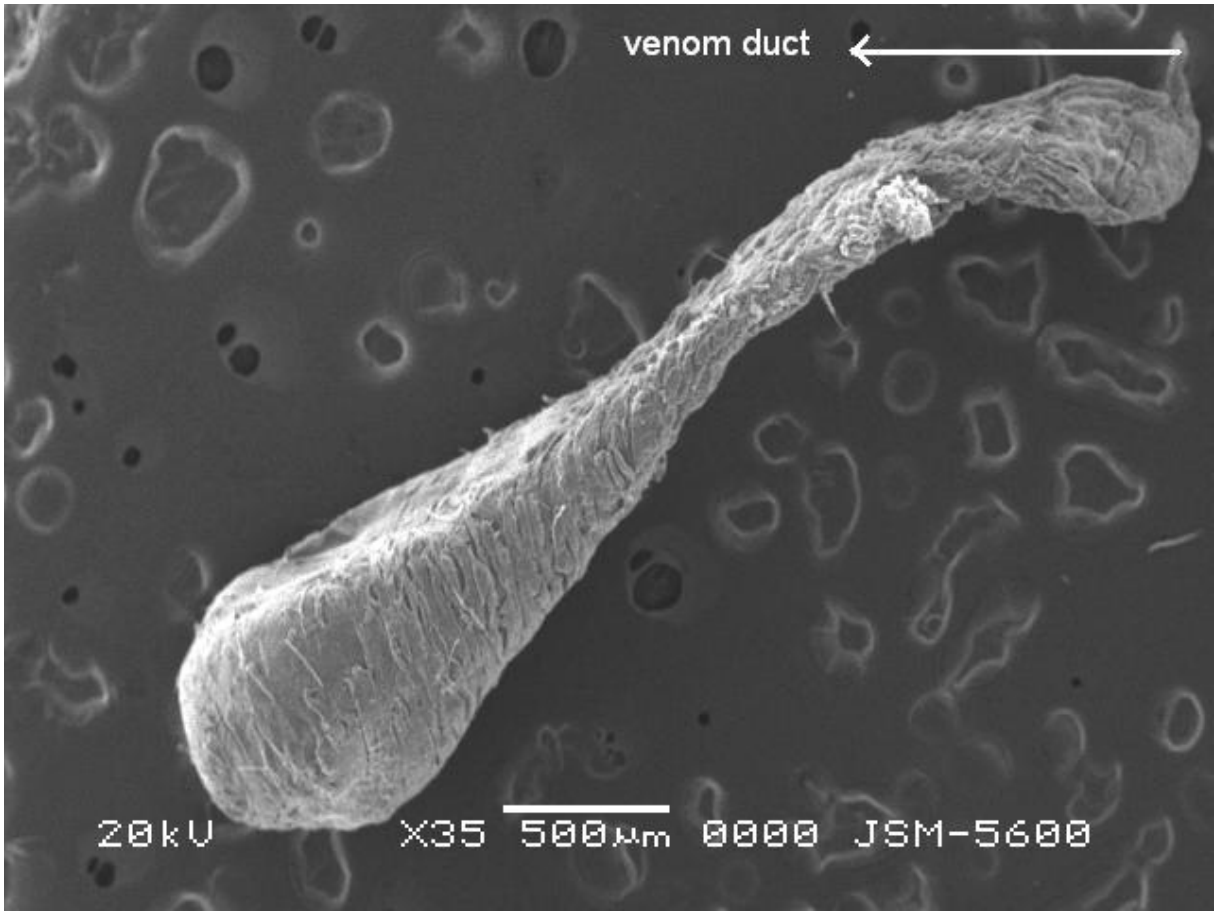

Figure 5. *L. singoriensis* venom gland covered with muscle bundles.

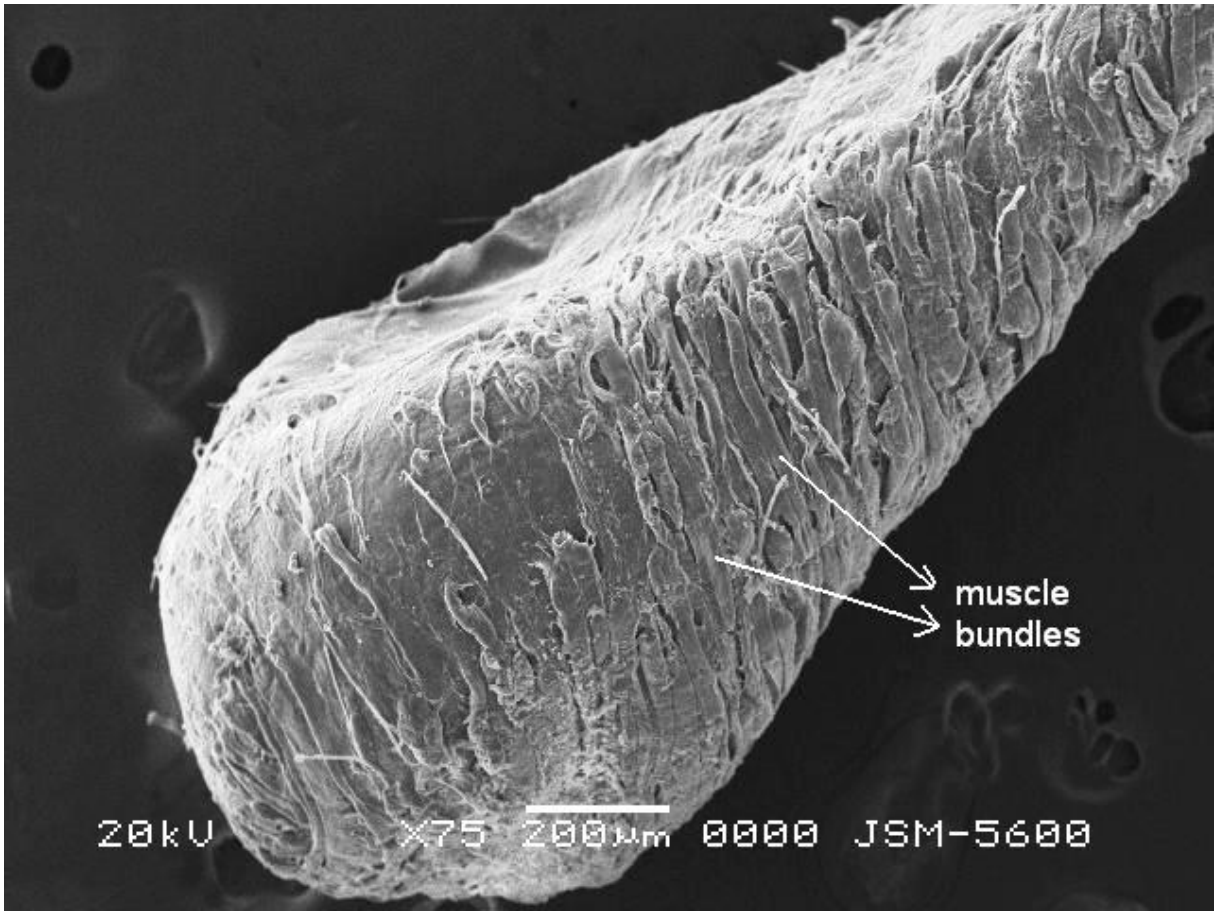

Figure 6. Muscle bundles that cover the venom gland at higher magnification.

Except for the members of Uloboridae and Archaeidae, most spiders have a venom apparatus, which does not mean that all are dangerous to humans (6). Among venomous animals, spiders have proportionally received less attention, since they are relatively small and produce little amount of venom. Thus, they are generally not considered as dangerous as snakes or scorpions.

The chelicerae are important for spiders since they are used for defense, seizing prey, carrying egg cocoons (Lycosidae, Pisauridae), digging soil (Ctenizidae, Theraphosidae, Barychelidae, Eresidae), transporting small preys (Araneidae) and making noise (Ammotrechidae, Solifugae) (7, 8). Lycosids are trapdoor spiders that construct burrows and present large and powerful chelicerae.

In *L. singoriensis*, both sides of the cheliceral grooves are often armed with cuticular teeth that act as buttresses for the movable fang. The number and shape of these marginal teeth are distinct in several species. Spiders whose chelicerae are equipped with such teeth are able to mash their prey into an unrecognizable mass. Spiders without these teeth can only suck on their prey (7). Many victims of lycosid bites

report severe pain (9). Since *L. singoriensis* have three or four marginal teeth on both sides of the cheliceral groove, these structures are probably used to crush skin of victims, leaving perceivable sings and causing pain.

The tip of the fang is usually sharp in almost all spiders. *L. singoriensis* fangs have a venom pore and a blade-like ridge that may facilitate the deep penetration of fangs into the body of the victim. These same features have been observed previously in other studied spiders (10-12).

Venom glands of numerous spiders have been investigated by several authors (5, 6, 10-14). The shape and position of venom glands differ among species. In large tarantulas, venom glands are quite small and lie inside chelicerae (6). In other spiders, venom glands are two voluminous distinct sacs dorsally located that occupy the chelicera basal portion up to the prosoma. In *L. singoriensis*, venom glands are two lengthy sacs dorsally situated in the prosoma. Regarding shape, they can be bulbous in *Loxosceles intermedia* (14); carrot-like in *Pelesiophirctus collinus*; sac-like or cylindrical and bilobed in *Hetropoda venatoria*, *Lycosa indagastrix* (13) and *L. tarantula* (15); and in the form of a long tube in *Agelena gracilens* and *A. labyrinthica* (10, 11).

In *L. singoriensis*, the venom produced by the glands flows through venom ducts that pass throughout the chelicerae, and is finally released by the venom pore on the tip of the fang. The venom discharge process is possible due to the action of a thick layer of striated muscle bundles that surround the glands. These muscle bundles spirally cover the glands and end in the first portion of the venom ducts. In many spiders, including *Larinioides ixobolus, Agelena labyrinthica* and *A. gracilens* (10-12), blocks of muscle bundles spirally encapsulate glands, whereas in other species, like *L. intermedia*, external muscular bundles and cell branches develop a web-like structure (14).

Muscular contractions of the venom glands provide the propulsive force for the venom expulsion. When a spider bites, its fangs penetrate in the victim and the venom is injected. In this way, lycosid and geolycosid spiders leave significant fang marks on human skin.

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