Surface Morphology of the Spermatheca of Dolycoris baccarum (Linnaeus, 1758) (Heteroptera: Pentatomidae)

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SURFACE MORPHOLOGY OF THE SPERMATHECA OF *DOLYCORIS BACCARUM* (LINNAEUS, 1758) (HETEROPTERA: PENTATOMIDAE)[1]

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ABSTRACT: The morphology of the spermatheca of *Dolycoris baccarum* (Linnaeus, 1758) (Heteroptera: Pentatomidae) was examined using both light microscopy and scanning electron microscopy (SEM). The spermatheca of *D. baccarum* is characterized by the presence of a spherical spermathecal bulb that appears sclerotized and is covered with multiple pores. The spermathecal duct, pumping region with distal and proximal flanges and dilation of spermathecal duct are illustrated. The pumping region contains both distal and proximal flanges. The spermathecal dilation is striated and the walls are muscular. The proximal area of the spermathecal duct is fairly long relative to the distal area and is close to the opening of the vagina. Two alternately placed V-shaped sclerites and two ring sclerites occur in the genital chamber.

KEY WORDS: Heteroptera; Pentatomidae; *Dolycoris baccarum*; spermatheca; scanning electron microscopy

The spermatheca is an ectodermal organ, opening into the anterior tract of the common oviduct of most female insects. During mating, it is filled with spermatozoa which can be stored there for a long time or until fertilization occurs (Davey, 1965). The spermatheca has prominent glands which provide nourishment to the spermatozoa. In Heteroptera, the structure of the spermatheca, often highly complex, shows a great diversity and has been found to exhibit many important characters useful for classification, taxonomy and phylogeny (Pendergrast, 1957). Conversely, in some Heteroptera the spermatheca has been completely lost, while in others the spermatheca has lost its primary function of storing sperm (Dupuis, 1970; Schuh and Slater, 1995). The spermatheca is present in all Pentatomoidea (Pentatomomorpha), and usually consists of a spermathecal duct leading from the vagina to a dilated spermathecal bulb (seminal receptacle or distal bulb), and is characterized by a well marked pumping region (intermediate part) with proximal and distal flanges (Pendergrast, 1957, McDonald, 1966, Pluot-Sigwalt and Lis 2008).

The first examination of the spermatheca in Heteroptera was carried out by Dufour (1833), who erroneously regarded this organ as a sebaceous gland. Subsequently, Von Siebold (1837) published the first correct description of the organ as a spermatheca (as receptaculum seminis) while examining a member of the Pentatomomorpha. However, interest thereafter in internal Heteropteran morphology lay dormant until the middle of the 20th century when several investigators produced papers on this structure (Dupuis, 1955; Pendergrast, 1957;

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Scudder, 1959; Kumar, 1962; McDonald, 1966). Servadei (1964) provided a detailed description of spermathecae of Acanthosomatidae, Pentatomidae and Scutelleridae, and included an original key to subfamilies and genera. The spermatheca of Dinidoridae was studied by Durai (1987) and descriptions of those eleven species belonging to seven genera of Korean Podopinae and Asopinae (Pentatomidae) were subsequently provided by Kim and Lee (1994). Kocorek and Danielczok (2002) compared the morphology of the spermatheca of eleven genera of the family Dinidoridae. The spermathecae of 25 central European species of Coreidae were studied by Vavrinova (1988). The spermathecae of 12 species representing 9 genera and 2 subfamilies of Korean Coreidae were studied by Lee et al. (1989). A microscopic examination of the spermatheca of *Podisus maculiventris* (Pentatomidae) was done by Legaspi et al. (1994). Four new species of the Afrotropical Cydnidae were described and their spermathecae were illustrated by Czaja and Liss (2002). Pluot-Sigwalt and Lis (2008) commented on the significance of the spermatheca for Cydnid classification and phylogeny. As a result of all these studies, it is safe to state that the structure of the spermatheca in the Heteroptera is complex and diverse, being the source of valuable systematic characters. The studies reported above were mainly carried out using light microscopy at low resolution and did not include detailed examination using scanning electron microscopy (SEM). Only Candan et al. (2007) and Candan (2008) have studied spermatheca morphology of Pentatomoidea by utilizing both light and scanning electron microscopy [*Odontotarsus purpureolineatus* (Scutelleridae) and *Enoplops disciger* (Coreidae)].

Herein we present a detailed examination of the spermatheca of *Dolycoris baccarum* (L.) (Heteroptera: Pentatomidae: Asopinae) using both light and SEM and a comparison of the results with those of other researchers who have described similar structures in Heteroptera.

METHODS

The ten specimens of *Dolycoris baccarum* which were examined were selected from among dried museum material collected at Orhaniye village, Kazan, Ankara, Turkey, on 18 June 2007. The spermatheca was prepared by first softening the abdomen in 10% KOH for 5-10 minutes. Thereafter, tissues were carefully removed and the spermathecae were placed in glycerin. Observations were made initially using a stereomicroscope (Olympus SZX12 photomicroscope at 40X). For SEM examinations, rinsed and dried spermathecae were mounted with double-sided tape on SEM stubs, coated with gold using a Polaron SC 502 Sputter Coater, and examined with a Jeol JSM 6060 SEM operated at 15 kV.

Nomenclature follows that of Pendergrast (1957), Scudder (1959), and Mc Donalds (1966). The following morphological characters of the spermatheca were examined: shape of spermathecal bulb (apical receptacle), shape of the spermathecal pump (intermediate part), size of the flanges of the pump (located between spermathecal pump and spermathecal duct), shape and size of the distal part of the spermathecal duct, shape and size of the dilation of the spermathecal

duct, shape and size of the distal and proximal parts of the spermathecal duct, shape of the sclerites and ring sclerites and shape of the ring sclerites (genital chamber).

RESULTS

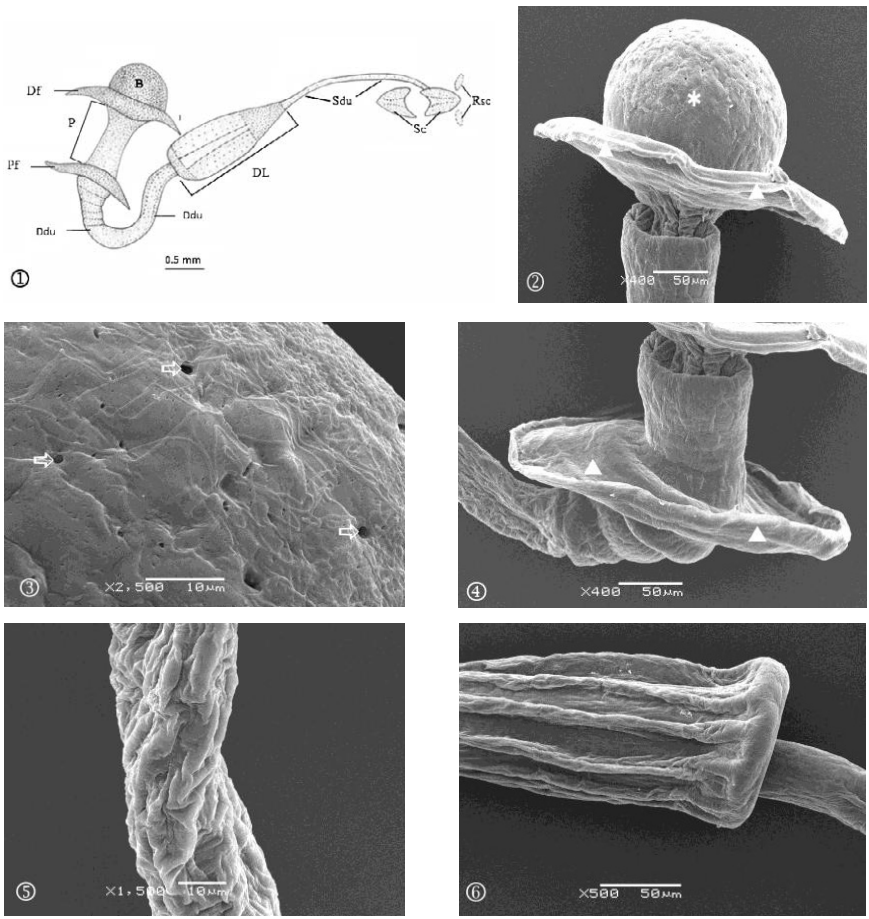
The spermatheca of *D. baccarum* consists of the spermathecal bulb, spermathecal pump, flanges of the pump, spermathecal ducts, dilation of the spermathecal duct, and the genital chamber. The heavily sclerotized spermathecal bulb (B) is brown and spherical (Figs. 1,2). The surface of the bulb is covered with multiple pores (Figs. 2,3). The diameter of the bulb is 168-174 μm (Figs. 1,2). The pumping region contains both sclerotized distal (Df) and proximal flanges (Pf) which are approximately the same diameter 278-298 μm (Figs. 2,4). The distal part of the spermathecal duct (Ddu) is twisted, somewhat convoluted and is a muscular structure (227-231 μm) (Figs. 1,4,5). The spermathecal dilation (Dl) is striated and has muscular walls (327-334 μm) (Fig. 6). The proximal area of the spermathecal duct (Sdu) is fairly long relative to the distal duct (Ddu) (549-560 μm) (Fig. 1) and is strongly chitinized (Fig. 7). The proximal area of the spermathecal duct is close to the opening of the vagina (Fig. 8). Two alternately placed V-shaped sclerites (Figs. 1,9) (Sc) and two ring sclerites (Rsc) (Fig. 10) occur within the genital chamber.

DISCUSSION

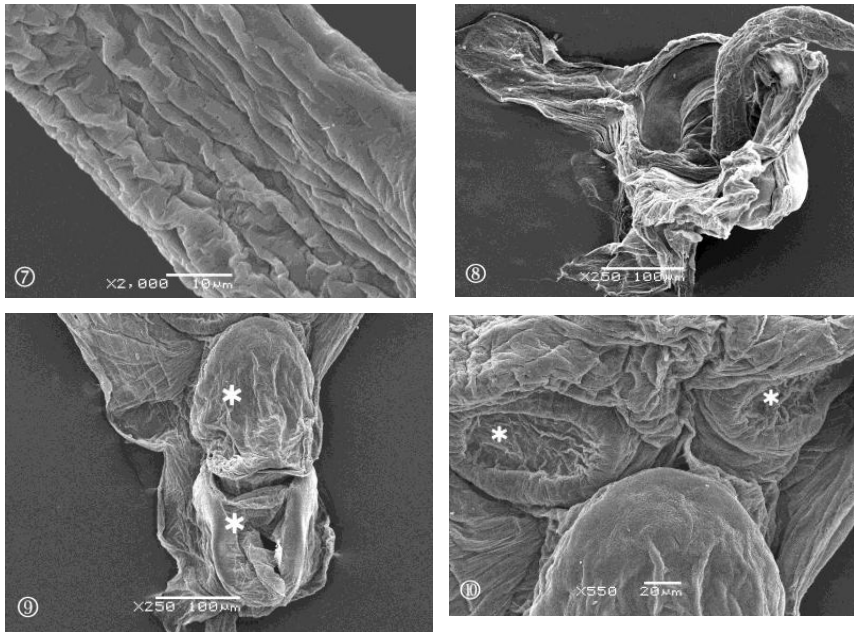
The insect spermatheca, a female reproductive accessory organ, is present in all insect orders except Protura and Collembola (Matsuda, 1976). The spermatheca plays a significant role in many functions such as sperm storage, copulation, fertilization, and oviposition (Gaffour-Bensebbane, 1991, 1994; Gschwenthner and Tadler 2000). The spermatozoa transferred during copulation are stored by the female in the spermatheca where the spermatozoa remain viable for a long time or until they are used to fertilize eggs (Davey, 1965). It is a complex organ and varies greatly in shape and histology between groups (Pendergrast, 1957).

A spermatheca is present in all Heteropteran Pentatomoidea and it usually consists of a spermathecal duct, leading from the vagina to a dilated spermathecal bulb (seminal receptacle or distal bulb). In these insects, the spermatheca is characterized by a well marked pump (pump apparatus) in the intermediate part which contains both proximal and distal flanges (Pendergrast, 1957; Mc Donald, 1966; Pluot-Sigwalt and Lis 2008). However, in some Pentatomoidea the spermatheca morphology is different. For example, in the Podopinae and Asopinae (Pentatomidae) the spermatheca is composed of a spermathecal bulb, a pumping region with two flanges, a median spermathecal dilation containing a sclerotized rod, and one or two sclerites (McDonald, 1966; Adams, 2001; Kumar, 1962). In the Podopinae, the spermathecal bulb may be spherical (*Scotinophara lurida, S. scotti, S. horwathi*), semioblong (*Graphosoma rubrolineatum*) or oblong-ovate (*Dybowskyia reticulata*) and have one to three spermathecal processes. In

the Asopinae, the spermathecal bulb may be spherical (*Arma chinensis, Picromerus bidens, P. lewisi*), semioblong (*Pinthaeus sanguinipes*) or semioval (*Zicrona caerulea*); however, all species of the Asopinae lack spermathecal processes. The function of these processes is not clear, but the presence of spermathecal processes is important as a taxonomical character below the generic level (Kim and Lee, 1994; Legaspi et al., 1994). The spermathecal bulb is covered by secretory cells located outside the epithelium of the spermatheca. Sperm is stored there (Kocorek and Danielczok, 2002; Candan et al., 2007). The spermatheca of *D. baccarum* is characterized by a spherical spermathecal bulb which has many pores, but lacks spermathecal processes.



Figs. 1-6. Drawing and SEM micrographs of the spermatheca of *Dolycoris baccarum*. 1- Illustration of the gross morphology of the spermatheca; 2- Spermathecal bulb and distal flange of pump(✱); 3- Pores on the spermathecal bulb (⇨); 4- Pomping region and proximal flange (△). 5- Distal part with muscles of spermathecal duct. 6- Dilation of spermathecal duct.



Figs. 7-10. SEM micrographs of the spermatheca of *Dolycoris baccarum*. 7- proximal part with muscles of spermathecal duct; 8- opening of proximal duct and back surface of genital chamber. 9- V- shaped two sclerites (✱) in genital chamber. 10- Two ring sclerites (✱).

In some Pentatomoidea, including Pentatomidae, the pumping region is well developed and connected to the spermathecal dilation by a short duct which has one or two flanges (McDonald, 1966; Kim and Lee, 1994; Kocorek and Danielczok, 2002). In some Dinidoridae species, such as *Cyclopelta obscura* and *Coridius putoni,* flanges are well developed but in others they are not distinctly marked (Kocorek and Danielczok-Demska 2002). Pentatomidae also have a pumping region with two flanges (distal and proximal). Their size and shape can be similar or different. The two flanges of the *Graphosoma rubrolineatum* and *Dybowskyia reticulata* are of the same diameter, but the distal flange of *Scotinophara lurida* is wider than the proximal one (Kim and Lee 1994). In some Scutelleridae, as in *Pachycoris torridus,* proximal and distal flanges are well developed, but the distal flange is reduced in *Acantholomidea porosa* and the proximal flange is reduced in *Chelysomidea guttata* (McDonald 1966). *Odontotarsus purpureolineatus* has a distinct distal flange (Candan et al., 2007). In *D. baccarum*, however, distal and proximal flanges have approximately the same diameter.

Apart from the Plataspidae (Pluot-Sigwalt and Lis, 2008), a simple spermathecal duct (without differentiation) is known in only three other pentatomoid fam-

ilies: Acanthosomatidae (Pendergrast, 1957; Servadei, 1964), Lestoniidae (Mc Donald, 1970; Fischer, 2000) and Urostylididae (Pendergrast, 1957; Kumar, 1971; Agarwal and Baijal, 1982); it may also occur sporadically in Scutelleridae (McDonald, 1966; Gaffour-Bensebbane, 1991).

The spermathecal duct in the Pentatomidae varies from short to long. The length of the distal spermathecal duct in the Asopinae (*Arma custos, Picromerus bidens, Zicrona caerulea*) is much shorter than that of Podopinae (*Graphosoma rubrolineatum, Dybowskyia reticulata, Scotinophara lurida*), as is also seen in *D. baccarum*. This is a common feature of pentatomids (Pendergrast, 1957; Mc Donald, 1966; Ramamurty, 1969; Kim and Lee 1994). The spermathecal duct where it attaches to the bulb is modified into a pump, the cuticular lining of which is slightly sclerotized and flexible (Lee and Pendergrast, 1983).

The number of hardened sclerites which open into the spermathecal duct varies from one in the Asopinae to two in the Podopinae. Double ring sclerites within the genital chamber are similar in all species of Pentatomidae previously studied (Kim and Lee 1994). In *D. baccarum*, the structure is slightly different from that of other Pentatomidae, but the basic gross morphology of the spermatheca is similar.

Morphological characters of the spermathecae are important in classification above the generic level in Heteroptera. However more studies utilizing SEM are needed to establish clear trends within this taxonomic group.

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