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Genitalic structure and copulation in *Paralabella dorsalis* (Dermaptera: Labbidae)

R.D. Briceño
Escuela de Biología, Universidad de Costa Rica, Costa Rica, América Central.

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Abstract: The genitalia of 30 females and 30 males in *Paralabella dorsalis* were dissected and drawn using a camera lucida. Between 10 and 20 min from the initiation of copulation 20 pairs were frozen with ethylchloride, and the females were then dissected immediately to determine the location of male genitalic parts. The male genitalia consist of a subcylindrical penis with a single medial distal lobe, ornamented areas with sclerotized spines in the mid section. The cloacal opening of the female is simple with spines surrounding the gonopore. The spermatheca is a thin, coiled tube. During copulation part of the male genitalic teeth reach the sclerotized female spines. The tip of the virga reaches the opening of the spermatheca, where sperm deposition occurs.

Key words: Dermaptera, *Paralabella dorsalis*, genitalia, function, anatomy, copulation.

One of the characters most used in the classification and taxonomy of the order Dermaptera are the male genitalia (Burr 1915, Ramamurthi 1958, 1959, Giles 1960, Hincks and Pophman 1970). However, none of these studies treated the everted morphology of the male genitalia during copulation and their possible function in this process. The external genitalia of male Dermaptera are simple and comparatively uniform in structure throughout the order (Hincks and Pophman 1970). The female reproductive organs are known for only few species and comparative studies are necessary (Hincks and Pophman 1970).

The present work describes the internal genitalia of the males of *Paralabella dorsalis* and explains the probable functions of its structures during copulation. The morphological terminology utilized corresponds to that used by Hincks and Popham (1970).

MATERIALS AND METHODS

The dermapterans were collected in fallen stalks of plantain (*Musa* sp.) in advanced stages of decomposition in San Antonio de Escazú (1400 m), San José, Costa Rica.

The genitalia of 30 females and 30 males were dissected and drawn using a camera lucida. In the females, in addition to drawing the spermatheca, its length was estimated using a map measurer. Between 10 and 20 min from the initiation of copulation (which normally lasts on the order of 89.6 ± 32.4 min, n=15) 20 pairs were frozen with ethylchloride, and the females were then dissected immediately to determine the location of the different parts of the male genitalia inside her.

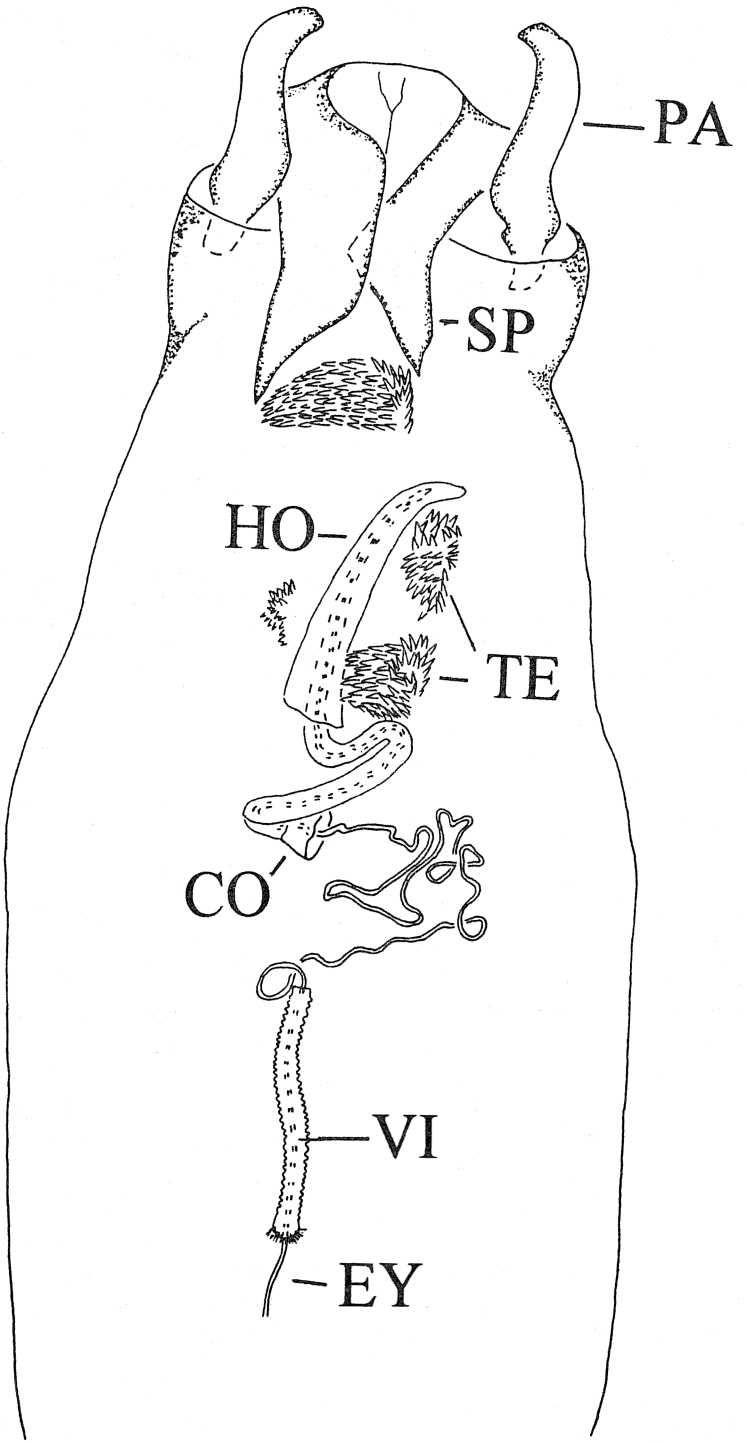

Fig. 1. Uneverted male genitalia. parameres (PA), sclerotized plates (SP), horns (HO), toothed plate (TE), cup (CO), virga (VI), and ejaculatory duct (EY).

RESULTS

Male Genitalia: The male genitialia of *Paralabella dorsalis* shows a subcylindrical penis with a single median lobe. Associated with the lobe are areas covered with sclerotized spines. On each side of the distal lobe are two parameres and between them two sclerotized plates in the form of spoons (Fig. 1).

In the non-everted genital organ the membrane is strongly sclerotized in the anterior part, with a band around the border called the lateral posterior sclerite. Basally, the membrane is not sclerotized and shows two bands of muscles with fibers, situated transverse to the longitudinal plane of the penis. The fibers extend from the anterior part of the organ to the base, where the diameter of the muscle is greater. A few elongate tracheae penetrate the penis through an orifice in the base. Penetrating this same orifice is the ejaculatory duct which connects the penis with the testicles. The duct enters the virga and is observed as a short sclerotized tube free within the lumen. When the duct of the virga leaves this, it coils back on itself before entering a cup-like entrance. This tube is in turn inserted inside a strongly sclerotized, horn-like structure. The portion of the virga within the horn narrows, eventually taking the form of a thin flagellum (Fig. 2).

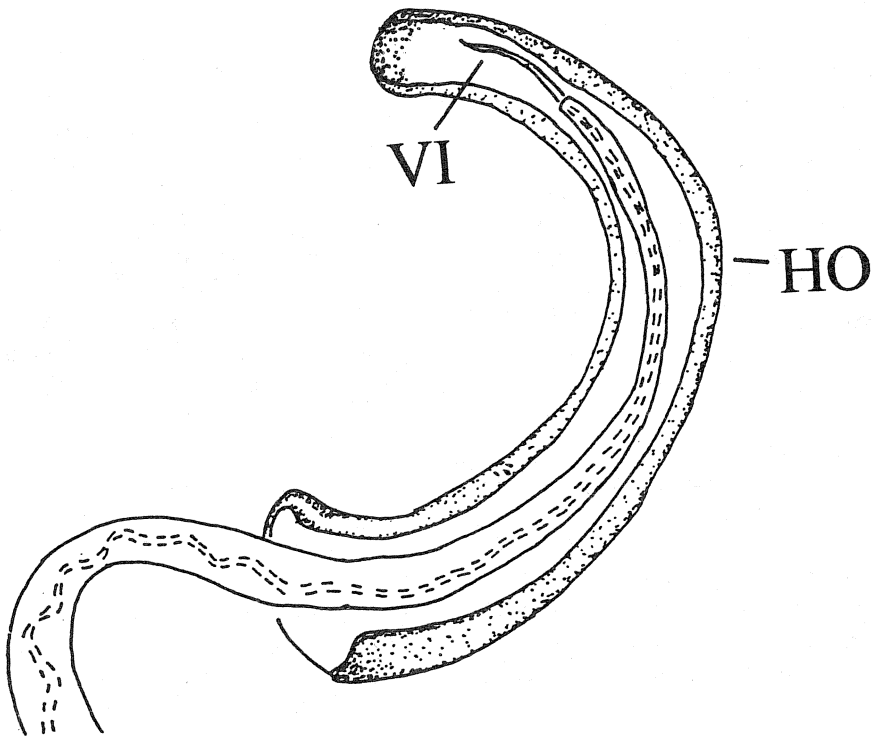

Fig. 2. Detail of the horn in the uneverted male genitalia.

Ornamented areas with sclerotized teeth are observed in the middle part of the penis. The position of these areas varied in different P. Dorsalis individuals.

Female Genitalia: The genital cavity is simple, with spines in the roof of the vagina surrounding the gonopore, which is lightly sclerotized with small spines. The spermatheca is a long narrow tube (average length of the spermatheca was 2.887 ± 1.23 mm, n=10). The only site at which spermatazoa were observed was along the length of the spermatheca. The spermatheca was not fragile: when extended and then released, it immediately recoiled . Permanent extension was achieved only by drying. The spermatheca has a chitinous receptacle in the entrance that receives the apex of the virga of the male. Associated with the female genitalia is an elongate, sclerotized pygidium with small protuberances along its border (Fig. 3).

Copulation Behavior: During courtship the male orients his cerci toward the female and moves backward with the cerci directed slightly downward. Once the male establishes contact with the female, he moves backward and forward maintaining his cerci downward in such manner that the cerci softly push her head or legs. In order to copulate the male attempts to align himself with the female, cerci to cerci, and maintain the tips of his cerci downward so that his abdomen is bent 90 degrees, thus inducing the female to raise the tip of her abdomen or cerci. If the female raises her abdomen, the male grabs the base of her cercus with his cerci, and then procedes to introduce his genitalia. The internal teeth of the male cerci allow him to grab the cerci of the female (Fig. 4). During the genital erection the two sclerotized plates open upward and backward. The parameres open sideways grasping the pygidium of the female allowing the distal lobe to exit, thereby extending the ejaculatory conduit (Fig. 5). Both sclerotized plates enter through the genital opening of the female. Some of the teeth mesh with the sclerotized spines around the gonopore (Fig. 6) while others contact the lateral wall of the vagina. Upon inflating the lobes, the horn and the virga are oriented in such a manner that the tip of the horn approaches the spermathecal opening, where the spermatozoidea are probably deposited (Fig. 6). In this position the duct between the virga and the cup is nearly completely extended indicating that the tip of the virga probably does not penetrate very far into the spermathecal duct.

During copulation the prepucial sac of the male is everted (probably by an increase in haemolymph pressure) and the virga is placed directly in the spermatheca to deposit spermatazoidia. During copulation the male moves his abdomen gently. The presence of spermatazoidea in the spermatheca of the female was detected 20 minutes after the initiation of copulation (n=10).

In addition, the male's parameres allow fastening to the female pygidium and the protuberances of the latter reduce the chance of slipping, thus constituting a double hold. Apparently this is the only female structure that fastens to the male genitalia, since the rest of the genitalia are invariably expelled once the dead animal thaws out. At the base of each protuberance in the female´s pygidium a hair with an apparent sensory function is observed.

DISCUSSION

The most primitive type of external male genitalia is to be found in *Parasopsalis spryi* Burr. which has two backwardly directed pennis lobes, each of which is posterior hollowed by the preputial sac. On the wall of the sac is a small toothed plate bearing numerous fine cuticular processes, which grip the wall of the vagina of the female during copulation (Hincks and Popham 1970), as observed in *Paralabella dorsalis*. In Labbidae the left pennis is completely absent (both paramers have been retained), and during

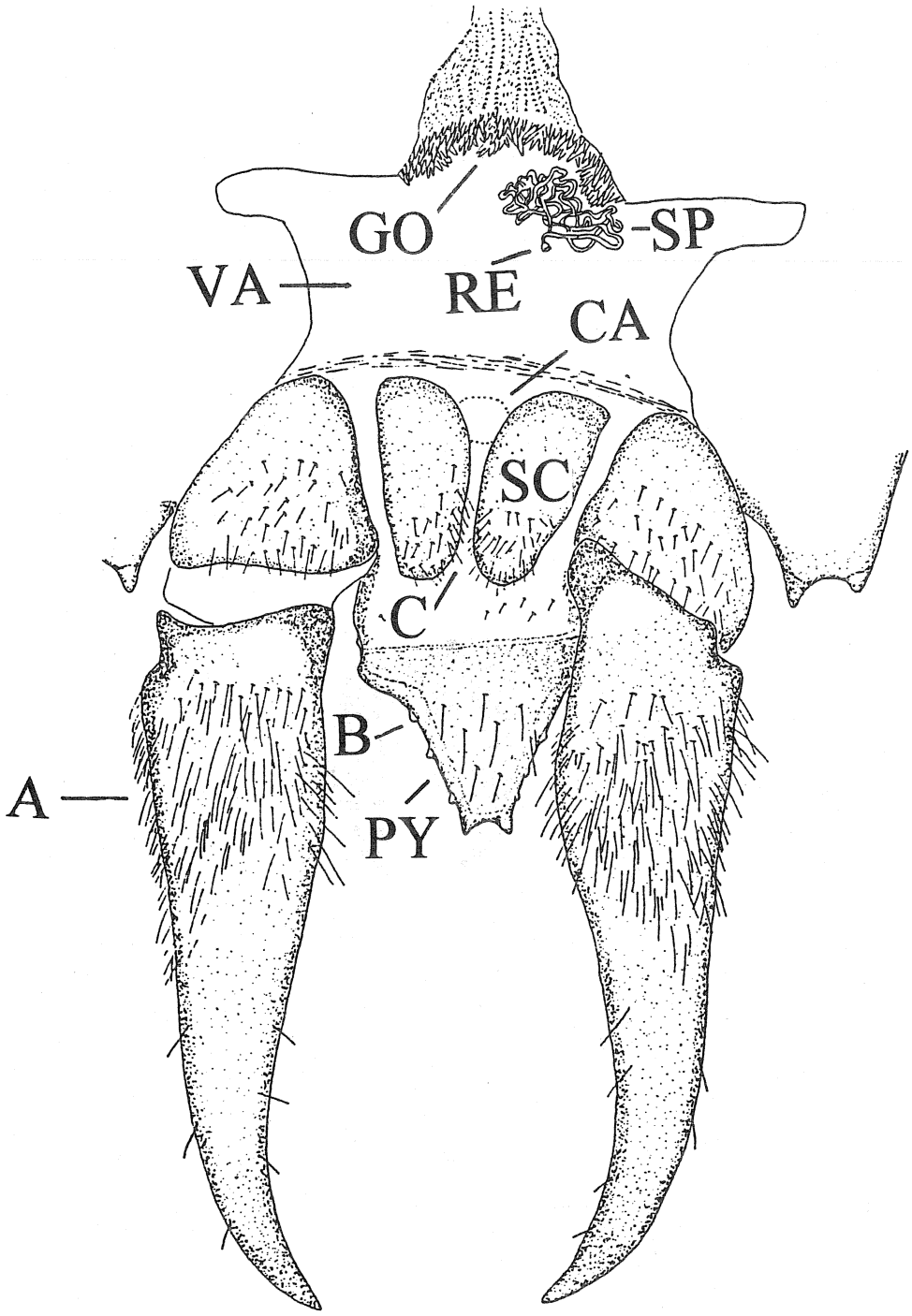

Fig. 3. Female genitalia. spermatheca (SP), gonopore (GO), receptacle (RE), cloacal aperture (CA), pygidium (PY) and vagina (VA). Letters A, B and C indicate the areas were the cerci (A) and the paramers (B) meet the females´s body before intromission. Letter C indicate the hairs between sclerites that need to yield as the aedeagus passes towards the female genital opening.

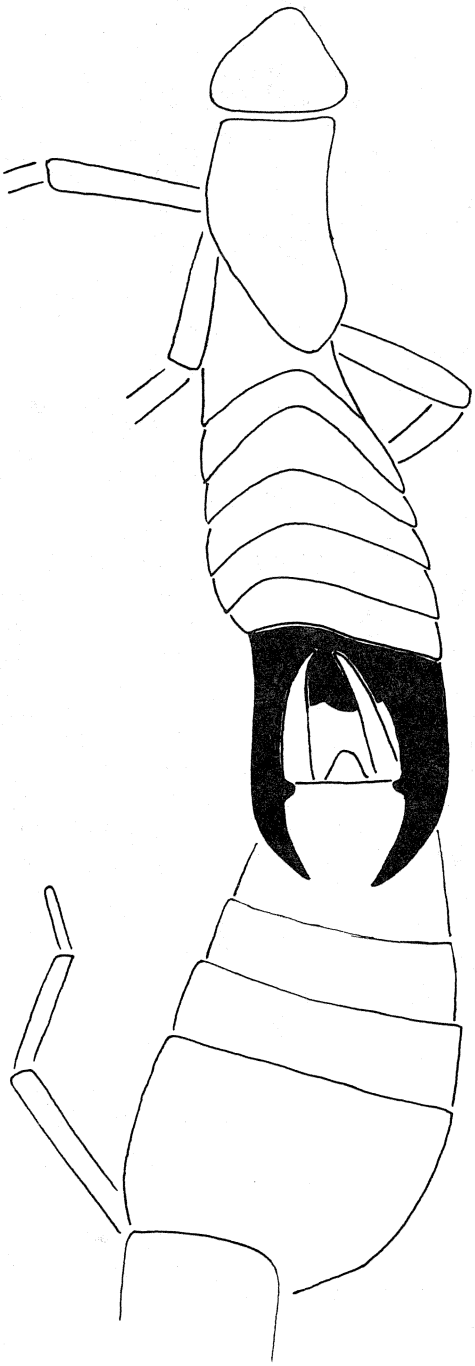

Fig. 4. Male *P. dorsalis* (black) clasped the base of the cerci of a female that had raised her abdomen prior to copulating. The teeth on the inner edges of the male cerci meshed with the female cerci.

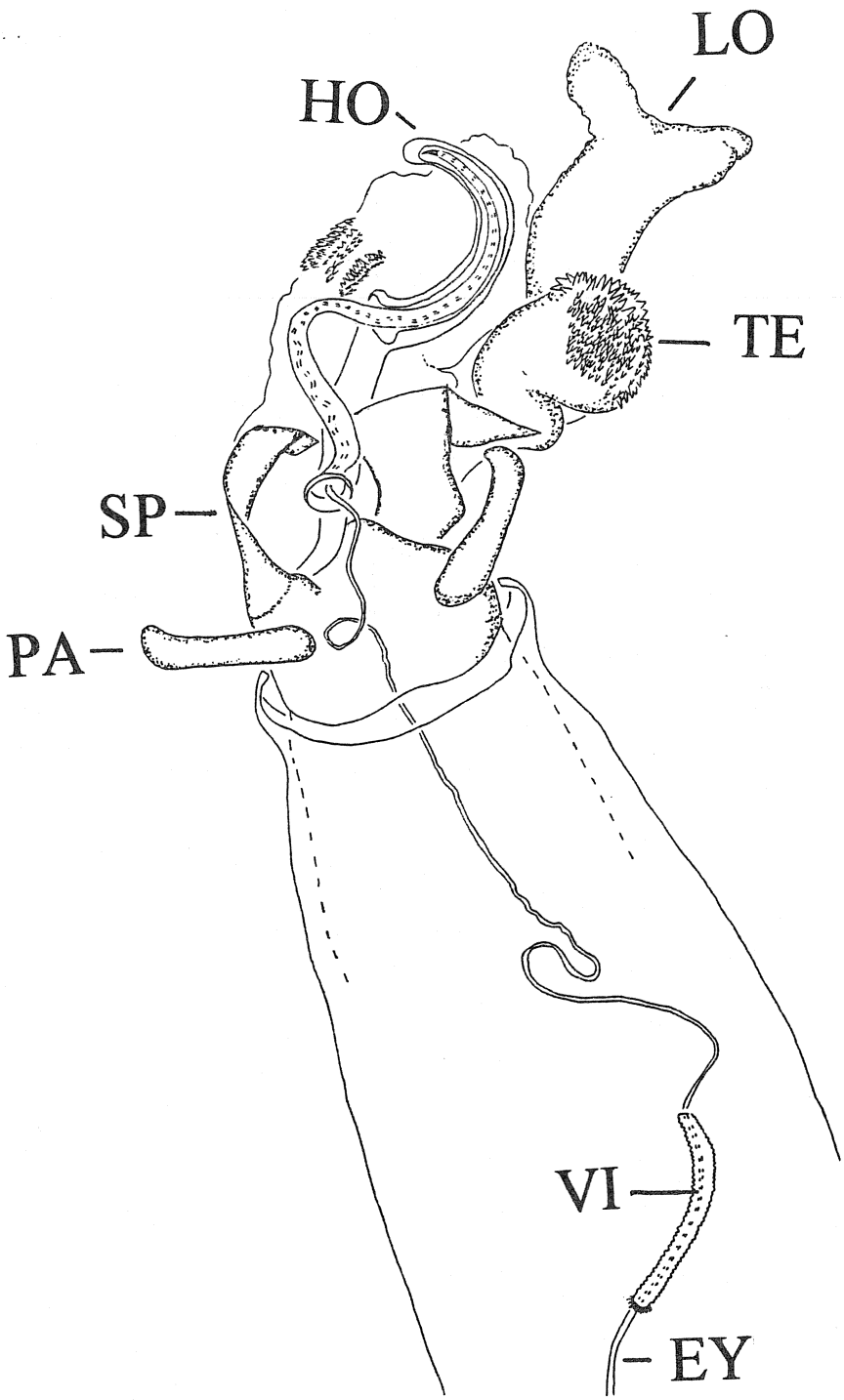

Fig. 5. Everted male genitalia inside the female. parameres (PA), sclerotized plates (SP), horns (HO), toothed plate (TE), lobe (LO), virga (VI) and eyaculatory duct (EY).

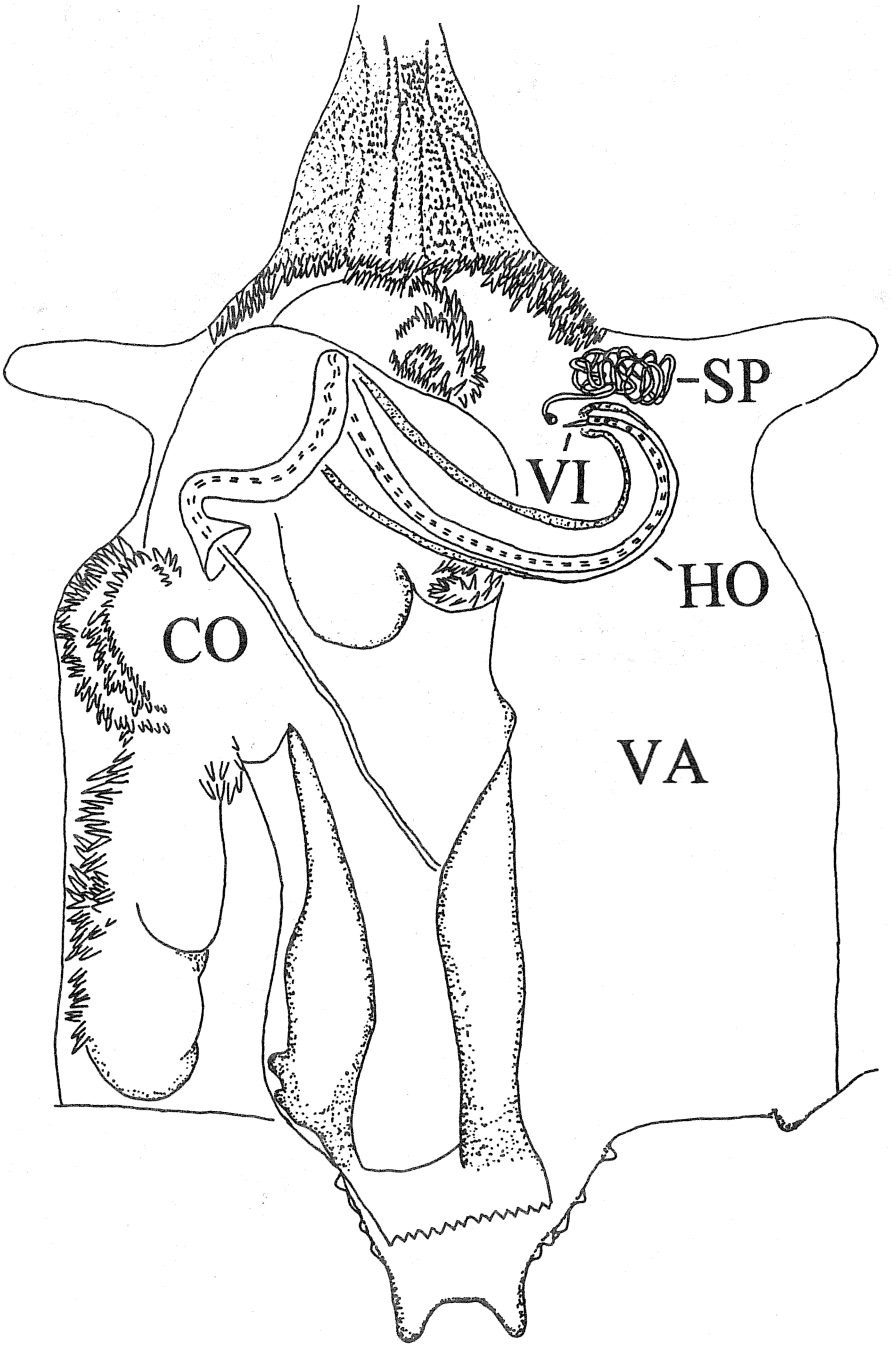

Fig. 6. Female vagina open to show location of the male genitalia inside the female during copulation. The lobes, the horn and the virga are oriented in such a manner that the tip of the horn approaches the spermathecal opening, where the spermatozoidea are probably deposited

copulation haemocoelic fluid pressure everts the preputial sac and the erect virga is directed into the vagina of the female. its is possible too that the sinuous shaped ejaculatory duct help to the movility of the male genitalia. Probably lobes and horn are used to oriented properly the point of the virga into the spermatheca´s receptacle where the spermatozoidea are deposited.

It is known that some of the structures that the male uses to fasten to the female during copulation can be used during courtship (e.g. Robertson and Palerson 1982, Belk 1984, Coyle 1986, Eberhard and Pereira 1994).

In *P. dorsalis* there are areas with numerous setae in the external genitalia of the female, which may have a sensory function and are distributed along the area that fastens to the male during copulation (Fig. 3).

A critical question is whether these structures can stimulate the female during copulation. If such stimulation is the criterium by which the female chooses a male, there should be sensoria (mechanoreceptors) present in the zones of contact of the female (Eberhard 1985). The presence of setae have been mentioned in beetle elytra that are found in contact with the parameres of the male (Eberhard 1992). The two sclerites that give access to the genital opening of the female in *P. dorsalis* show that type of setae that can be bent when making room for the male genitalia. Nonetheless, it is difficult to discern whether these sensoria fuction to stimulate the female or simply orient the male genitalia.

Other than the cerci and parameres of the penis, no other structures function to fasten the male to the female during copulation. A probable explanation of the sclerotized teeth in the male genitalia is that they stimulate and orient the virga toward the spermathecal opening. No receptor was detected in the membranous parts or in the roof of the vagina, but the possible existence of mechanical stimulation in the female can not be rejected.

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RESUMEN

Se analizó los órganos genitales de la tijerilla *Paralabella dorsalis* usando 30 hembras y 30 machos. Entre 10 y 20 min de iniciada la cópula 20 parejas fueron congeladas con etilcloridro, y la hembras fueron disectadas inmediatamente para determinar la localización de las partes del aparato masculino, el cual presenta un pene subcilíndrico con solamente un lóbulo distal ubicado en posición media. En la parte media hay áreas ornamentadas con espinas esclerotizadas. La apertura cloacal femenina se localiza entre dos escleritos. La cavidad genital es simple, con espinas rodeando el gonoporo. La espermateca aparece como un tubo delgado y enrollado. Durante la cópula parte de los dientes del aparato genital masculino empatan con las espinas esclerotizadas en la hembra. Al inflarse los lóbulos menbranosos la virga es orientada en dirección de apertura de la espermateca donde ocurre la deposición de espermatozoos.

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