Notes on the Male Reproductive System in Ants (Hymenoptera: Formicidae)[1]

A. C. F. HUNG AND S. B. VINSON
DEPARTMENT OF ENTOMOLOGY, TEXAS A&M UNIVERSITY, COLLEGE STATION, TEXAS 77843

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Abstract: The gross morphology of the male reproductive system of *Pachycondyla harpax* (Fabr.), *Eciton hamatum* (Fabr.), *Neivamyrmex* sp., *Pogonomyrmex barbatus* (F. Smith), *Crematogaster laeviuscula* Mayr, *Solenopsis invicta* Buren, *Atta texana* (Buckley), *Iridomyrmex pruinosum* (Roger), *Conomyrma insana* (Buckley), *Formica canadensis* Santschi, *F. subintegra* Emery and *Polyergus breviceps* Emery was studied. As the ants matured the spermatozoa descended into the vas deferens and were retained there while the testes progressively decreased in size. The dilated vasa deferentia where mature spermatozoa are retained should be called "seminal vesicles" and what was formerly called "seminal vesicle" should be referred to as "accessory gland." Two types of accessory glands were found in ants. In the first type which is found so far only in the Ecitonini, the glands are long, coiled and both enclosed in a single capsule. In the second type the glands consist of two distinct bodies and are either ball-shaped, bean-shaped, or elongated.

There have been very few studies on the male reproductive system in ants. Janet (1902) in his study of the anatomy of the gaster of *Myrmica rubra* L. depicted the male reproductive organs. This classic illustration has been reproduced in such famous myrmecological monographs as "Ants" by Wheeler (1910), "British Ants" by Donisthorpe (1915), and "Le monde social des fourmis" by Forel (1921–1923). Forbes (1954) gave a comprehensive review on this subject. Trakimas (1968) reinvestigated the anatomy and histology of *M. rubra*. Unfortunately, only the abstract of her work was published.

According to Janet (1902), the male reproductive system of ants consists of the testes, the vasa deferentia, the seminal vesicles, the ejaculatory duct and the external genitalia. An aedeagal bladder was later found in *Camponotus* and *Formica* (Forbes 1954), *Eciton* (Forbes 1958), *Rhytidoponera* (Hagopian 1963), *Neivamyrmex* (Forbes and Do-Van-Quy 1965), *Solenopsis* (Tice 1967), and *Myrmica* (Trakimas 1968). Although a pair of accessory glands was found in *Dorylus labiatus* Schuck (Mukerjee 1926), *Eciton hamatum* (Fabr.) (Forbes 1953), and *Neivamyrmex harrisi* (Haldeman) (Forbes and Do-Van-Quy 1965), no mention of accessory glands has been made in other ants (Janet 1902,

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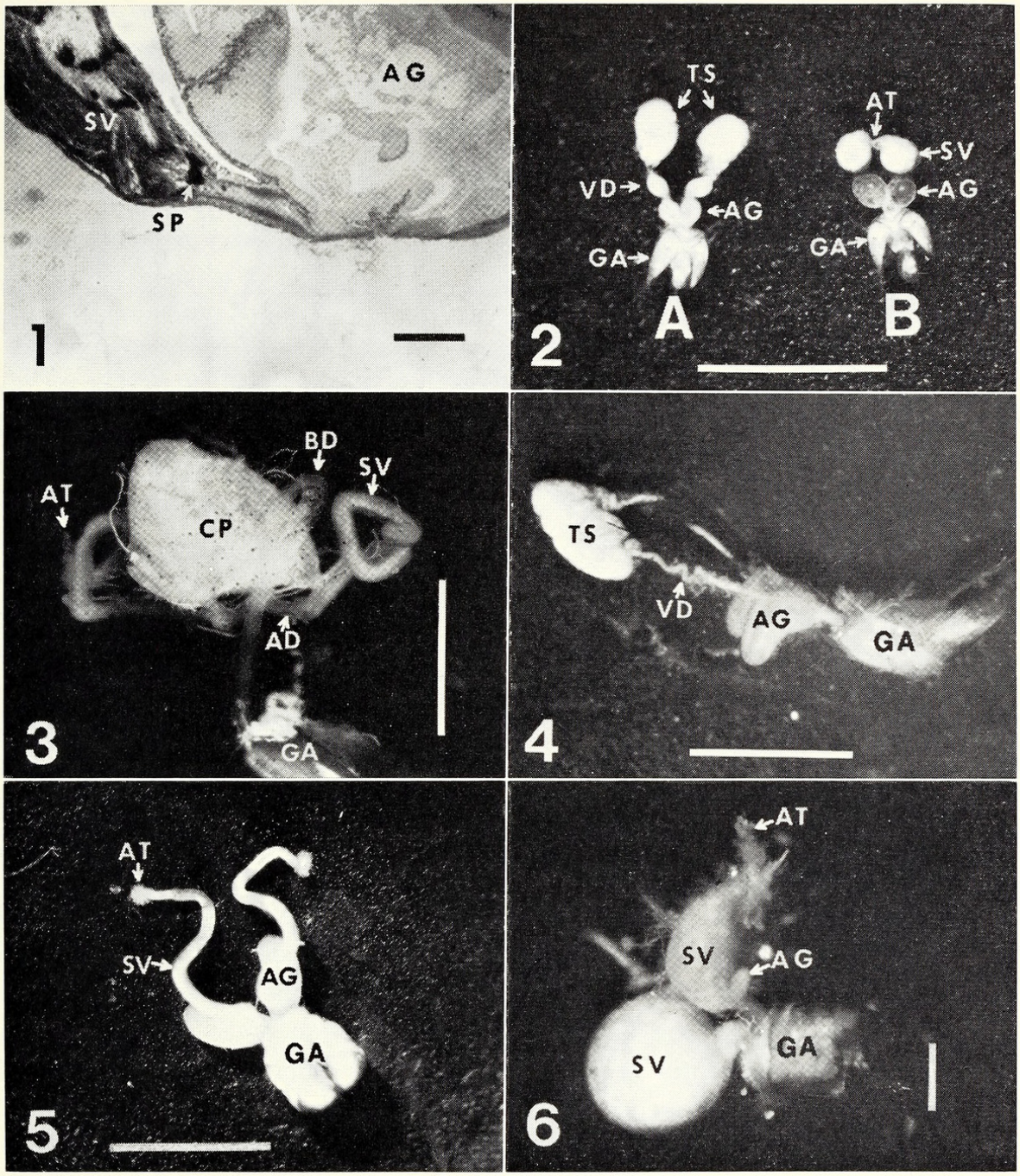

FIG. 1. Longitudinal section of seminal vesicle and accessory gland of *F. subintegra*. (Scale line = 0.1 mm).

FIGS. 2–6. Male reproductive system in ants (scale lines = 1 mm). 2. *I. pruinosum*. A, newly emerged; B, matured. 3. *Neivamyrmex* sp., matured. 4. *Pachycondyla harpax*, newly emerged. 5. *Pogonomyrmex barbatus*, matured. 6. *A. texana*, matured.

Abbreviations: AD, duct of accessory gland; AG, accessory gland; AT, atrophied testis; BD, bound accessory gland ducts; CP, capsule of accessory gland; GA, genitalia; SP, sperm plug; SV, seminal vesicle; TS, testis; VD, vas deferens.

Forbes 1954, Hagopian 1963, Dlussky 1967, Tice 1967, Trakimas 1968). Therefore, according to Forbes (1954) the mature sperm in *Camponotus pennsylvanicus* (DeGeer) are stored in the vasa deferentia and prevented from moving into the seminal vesicles by a granular plug. A similar plug was also found in *Formica subintegra* Emery (Fig. 1).

The above citations suggest that army ants differ from other ants in having accessory glands and further, that ants other than army ants do not store the mature sperm in the seminal vesicles like other insects. We suggest the assumption is false. The discrepancy appears to have been created by the use of incorrect terminology.

According to Snodgrass (1935), the vesicula seminalis is a dilatation of the vas deferens in which spermatozoa may be retained. Therefore, the seminal vesicle could be any portion of the vas deferens. For example, in *Oncopeltus fasciatus* (Dallas) it is located at the upper portion of the vas deferens immediately following the vas efferens (Bonhag and Wick 1953).

We studied the male reproductive system of the following 12 species: *Pachycondyla harpax* (Fabr.) (Ponerinae); *Eciton hamatum* (Fabr.) (Dorylinae); *Neivamyrmex* sp. (Dorylinae); *Pogonomyrmex barbatus* (F. Smith) (Myrmicinae); *Crematogaster laeviuscula* Mayr (Myrmicinae); *Solonopsis invicta* Buren (Myrmicinae); *Atta texana* (Buckley) (Myrmicinae); *Iridomyrmex pruinosum* (Roger) (Dolichoderinae); *Conomyrma insana* (Buckley) (Dolichoderinae); *Formica canadensis* Santschi (Formicinae); *F. subintegra* Emery (Formicinae); and *Polyergus breviceps* Emery (Formicinae).

In *Pogonomyrmex barbatus*, *S. invicta* (Hung et al. 1974), *I. pruinosum*, and *F. subintegra* in which we had freshly killed male pupae and alates of different ages, we found that as the ants matured the spermatozoa descended into the vas deferens and were retained there while the testes progressively decreased in size (Fig. 2). According to the definition of Snodgrass (1935), these dilated vasa deferentia (or portions of the vas deferens) should be called "seminal vesicles." Consequently, what was previously called "seminal vesicle" should be referred to as "accessory gland."

Our studies further revealed that there are 2 types of accessory glands in ants. In the first type the glands are long, tightly coiled and both enclosed in a single capsule (Figs. 3 and 7). This type is found so far only in *Eciton* and *Neivamyrmex*. Although Forbes (1958) and Forbes and Do-Van-Quy (1965) did not mention any capsule enclosing the coiled accessory glands in their preserved material, our dissection of two fresh specimens of *Neivamyrmex* males showed the presence of this capsule (Figs. 3 and 7, CP). In the second type, the glands consist of two distinct bodies. They are ball-shaped in the dolichoderines (Fig. 2), but are elongated in *Dorylus* (Mukerjee 1926) and bean-shaped in ponerines (Fig. 4), myrmicines (Figs. 5–6) and formicines.

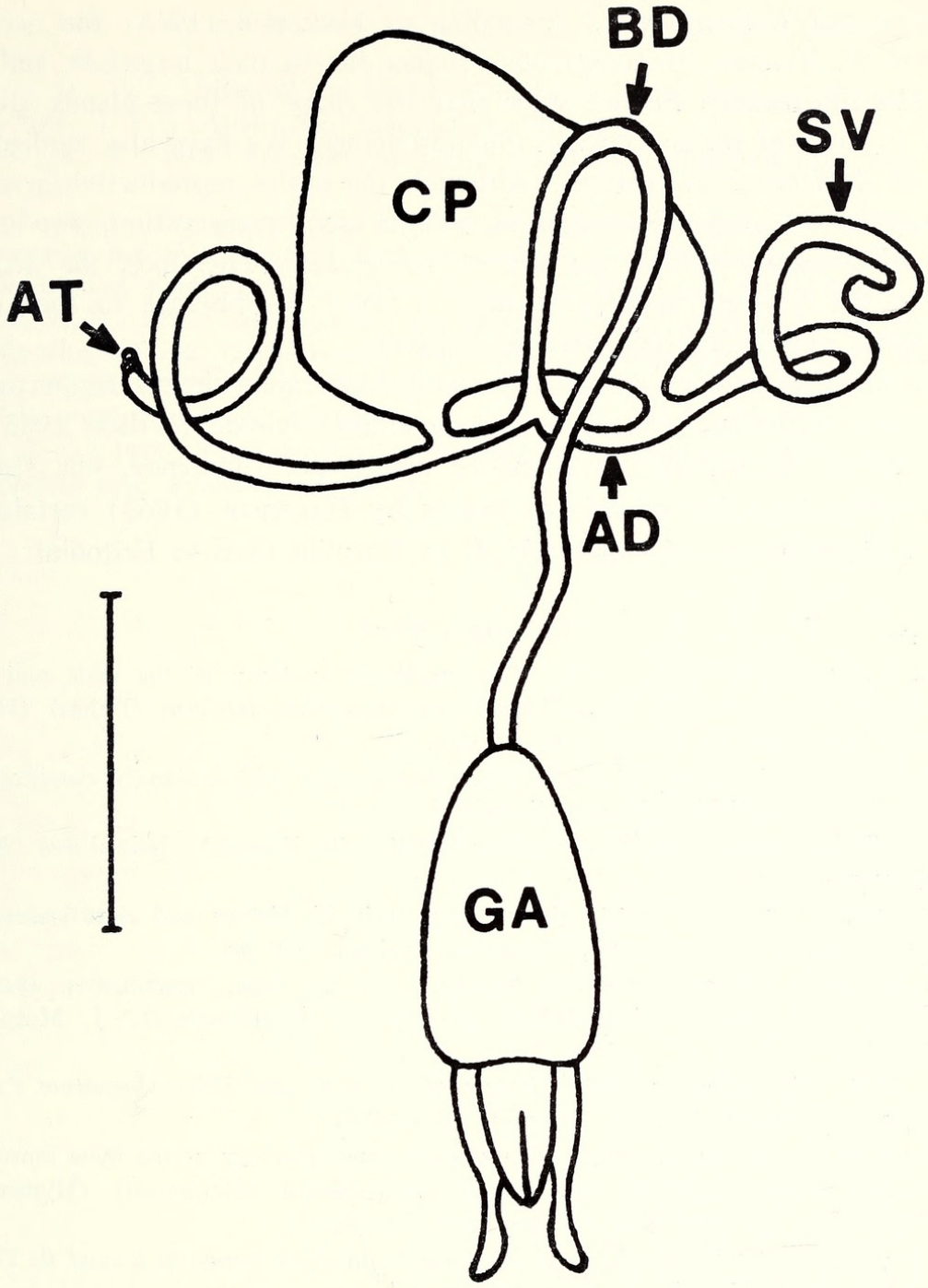

FIG. 7. Diagram of male reproductive system in *Neivamyrmex* sp. (scale line = 1 mm).

In mature males of some ants the glands are sometimes much smaller than the seminal vesicles and are easily overlooked (Fig. 6).

Brown (1954) has suggested that Dorylinae might be diphyletic and Gotwald (1969) goes further to state that the dorylines are tripartite. This preliminary study on the gross morphology of the male reproductive system in ants certainly supports the polypheletic nature of the dorylines. As has previously been pointed out, the coiled, enclosed accessory glands are so far found only

in *Eciton* and *Neivamyrmex*. According to Mukerjee (1926) the accessory glands of *D. labiatus* are conspicuous bodies due to their large size and thick wall. His illustrations further show that the shape of these glands are very similar to those of the myrmicines and formicines. We have also studied male alates of *Aenictus* from Taiwan. Although the entire reproductive system in our material was beyond recognition due to poor preservation, two distinct bodies of accessory glands can still be recognized. Therefore, the accessory gland of the Dorylini appears to have a closer resemblance to that of the Myrmicinae and Formicinae than to Ecitonini.

There have been both anatomical and behavioral evidences supporting the phylogenetic affinities between Ponerinae and Dorylinae (Wilson 1958, Hermann 1969). As far as the accessory glands are concerned, our study of *Pachycondyla* and that of *Rhytidoponera* by Hagopian (1963) certainly indicate that ponerines are closer related to Dorylini than to Ecitonini.

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