

The Thoracic Crop in *Solenopsis invicta* Buren (Hymenoptera: Formicidae)^{1, 2}

by

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ABSTRACT

After dealation mated and virgin queens of *Solenopsis invicta* Buren histolyze their flight muscles, and the esophagus (which is normally a highly pleated tube-like structure) enlarges to occupy the entire thoracic cavity and becomes filled with a clear yellowish oily fluid, composed mainly of triglycerides. The fluid is similar to that found in the gastral crop and probably represents a redistribution of the contents of the gastral crop. The fluid is utilized by mated queens during the production of their first clutches of brood and minor workers. Both crops are empty five to eight weeks after dealation occurs. The fate of the fluid in virgin queens is not known.

The phenomenon of flight muscle histolysis following mating flights in queen ants is well known. The accepted belief is that since the muscles are no longer necessary, the products of histolysis are used for egg production and brood rearing and self maintenance (Janet 1906, 1907; Wilson, 1971). Tooms et al. (1976, a, b, c) showed that in the red imported fire ant, *Solenopsis invicta* Buren, protein, glycogen and lipid concentrations from wing muscle histolysis were important in colony founding. Jones (1978) postulated an endocrine or neural mechanism for the histolysis in opposition to Toom's lysosome mechanism.

Histolysis of the wing muscles is followed by another interesting physiological phenomenon, the enlargement and filling of the esophagus with fluid. Janet (1907) reported that the esophagus of *Lasius niger* (L.) queens could be distended considerably to accommodate liquid. Petersen-Braun and Buschinger (1975) reported that in ants of five genera of two subfamilies the esophagus of the queens differentiated to become a "thoracic crop." We report here our observations on the development of a thoracic crop in mated and unmated queens of *S. invicta*.

¹Hymenoptera: Formicidae.

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MATERIALS AND METHODS

Newly-mated queens were captured immediately after they landed from nuptial flights in May and June 1977 and were transported to our laboratory for examination. Alate queens were obtained either from field colonies or from laboratory-reared colonies in the SEA/AR, USDA Imported Fire Ant Laboratory in Gulfport, MS. All queens were held individually in 1-dr shell vials.

Dissection consisted of securing a queen with a small strip of clay onto a bed of modeling clay, flooding her with Ringers solution, and removing the pronotum with a fine needle. A Wild M-5 dissecting microscope with a camera attachment was used to observe the esophagus, which underlies the pronotum.

Dealated queens were obtained by placing them in a freezer for about 1 minute and then removing the wings with a pair of fine forceps under a dissecting microscope. The dealated virgin queens were held for fourteen days to ensure histolysis of the wing muscles. All queens used in the experiments were held at 27°C with irregular illumination.

RESULTS

In our first study, we used newly-mated queens from a nuptial flight in May 1977. We dissected ten queens immediately; the remaining queens were held in individual containers for four weeks. All ten queens examined initially were inseminated, had intact flight muscles, and had crops filled with clear yellowish fluid. The queens held for four weeks were divided into two categories: those that had founded colonies and had minim workers present and those that had not. All of the latter group were inseminated, had histolyzed flight muscles, and had crops and esophagi filled to distension. All the queens that had founded colonies were inseminated and had histolyzed flight muscles, but only two had both their esophagi and crops filled to distension. Two queens had empty crops and esophagi, and six either had filled crops or filled esophagi.

A second study was conducted to investigate the relationship between the numbers of days after natural dealation to both histolysis of flight muscles and development of the thoracic crop. We used newly-mated queens from a nuptial flight in June 1977. We observed the development of the thoracic crop by dissecting ten queens at weekly intervals for seven weeks. Newly-mated queens that were recently dealated had flight muscles that filled the thoracic cavity and appeared as strands of pink muscle fibers in large bundles that exhibited great elasticity. The esophagi appeared as narrow,

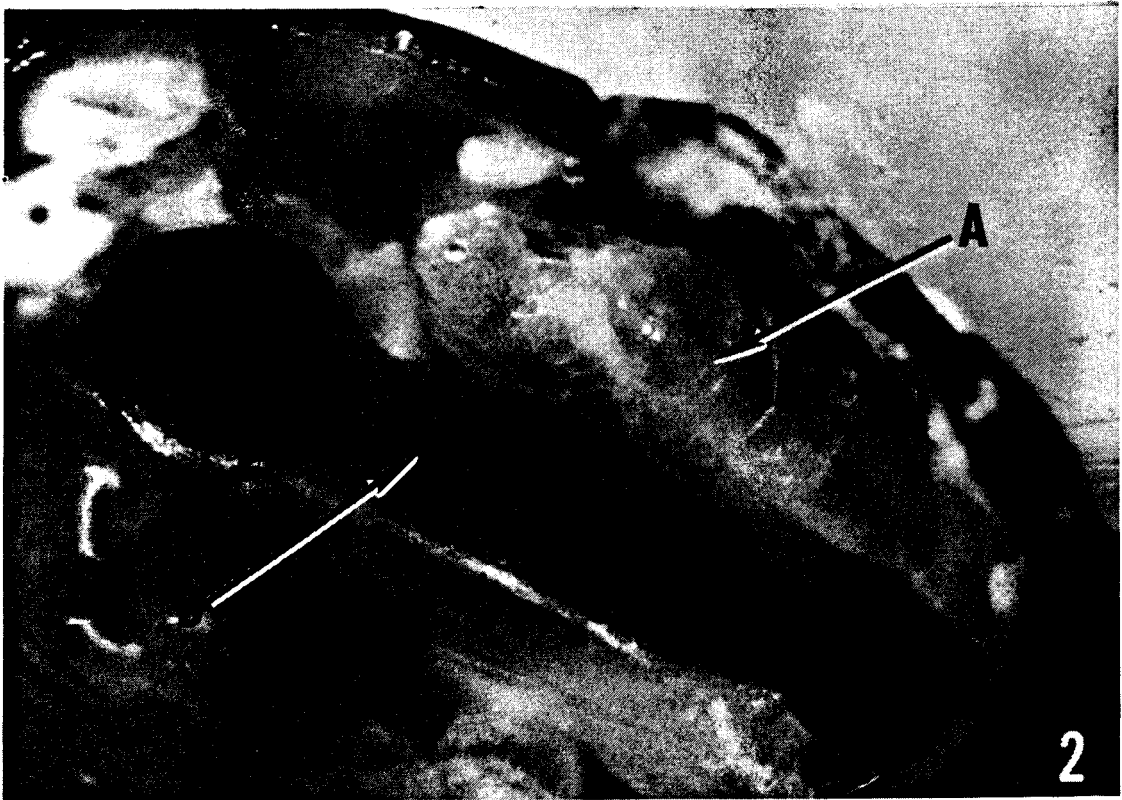
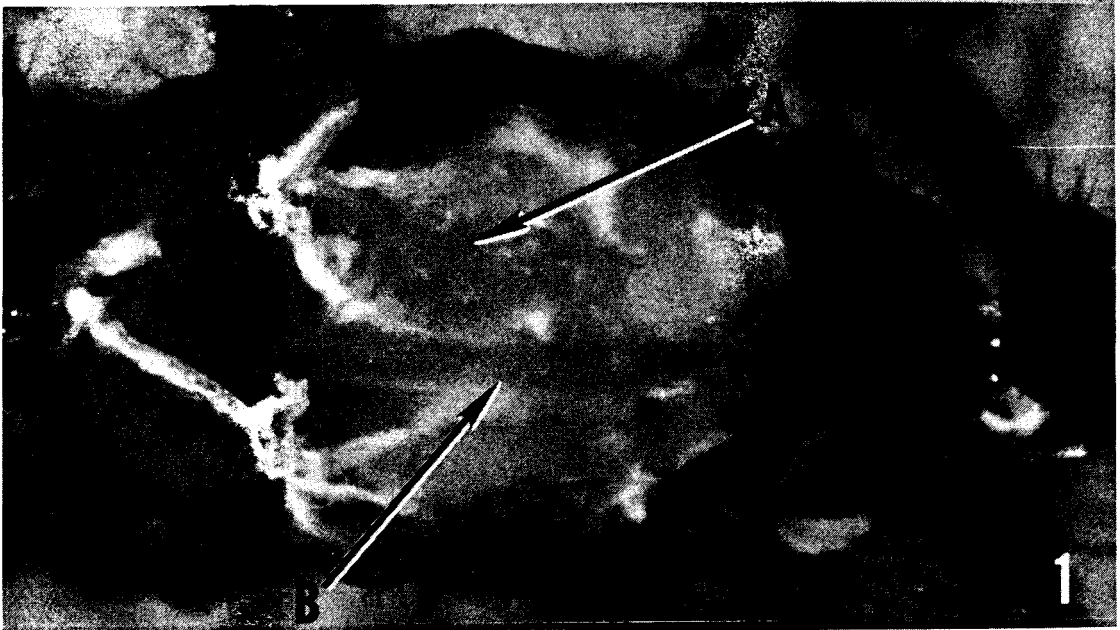


Fig. 1. Thoracic cavity of alate virgin female. A - large flight muscle; B - undistended esophagus.

Fig. 2. Virgin female, mechanically dealated, at 4 days. A - flight muscle; B - esophagus partially distended.

undistended tubes, devoid of the yellow oily fluid found in the gastral crop. Each esophagus seemed to be constricted in the region of the pronotum.

Within one day after dealation, the flight muscles had begun to histolyze. Some elasticity was lost, the coloration changed to pale pink, and the muscle strands appeared less tightly bound. No distension of the esophagi was apparent.

One week after dealation, most of the flight muscles had histolyzed and were whitish. The esophagi were so distended that they filled the entire thoracic cavity of each queen.

Two weeks after dealation, all the queens we examined showed complete muscle histolysis, with only a few strands of white connective tissue remaining. The esophagi and crops were both filled to distension with the yellow oily fluid. Chemical analysis of this material showed it to consist mostly of triglycerides (Malcom Thompson, pers. comm.). At subsequent time intervals, there was no further change in the structure of the thorax; however, the location of the fluid varied in the ten queens as shown below (Table). The results at five and eight weeks illustrate that the fluid is eventually used up during the production and rearing the first brood.

In a third study, we collected and dealated fifty two-week-old virgin alates, from our laboratory colonies. Each queen was isolated in a vial. We dissected three queens/day and examined the flight muscles and the thoracic crop. Histolysis of flight muscles and development of thoracic crops were the same as with newly mated queens; however, complete histolysis took three days longer. The changes seen in queens from days 1-4 are shown in Fig. 1 and 2. A ring-like structure, much like the one described by Mura (1973) and Petersen-Braun and Buschinger (1975) for *L. niger*, is evident in the esophagus (Fig. 3). Their description was based on mated queens; however, we found the same structure in both newly mated and artificially dealated virgin queens. The folded or pleated dorsal walls, which allow the esophagus to expand, can be seen in Fig. 3. This condition was also found in mated queens of the Pharaoh ant, *Monomorium pharaonis* (L.) (Petersen-Braun and Buschinger, 1975). We found this condition in both newly mated and artificially dealated queens. An artificially dealated virgin queen with a fully distended thoracic crop is shown in Fig. 4. The diameter of the esophagus was about 220 μ , with a calculated increase in volume of 7X that of a normal esophagus.

DISCUSSION

The enlargement of the esophagus for storage of fluid in mated or virgin queens of *S. invicta* was demonstrated. Once the flight muscles are histolyzed, the folds of tissue in the walls of the esophagus allow it to be distended.

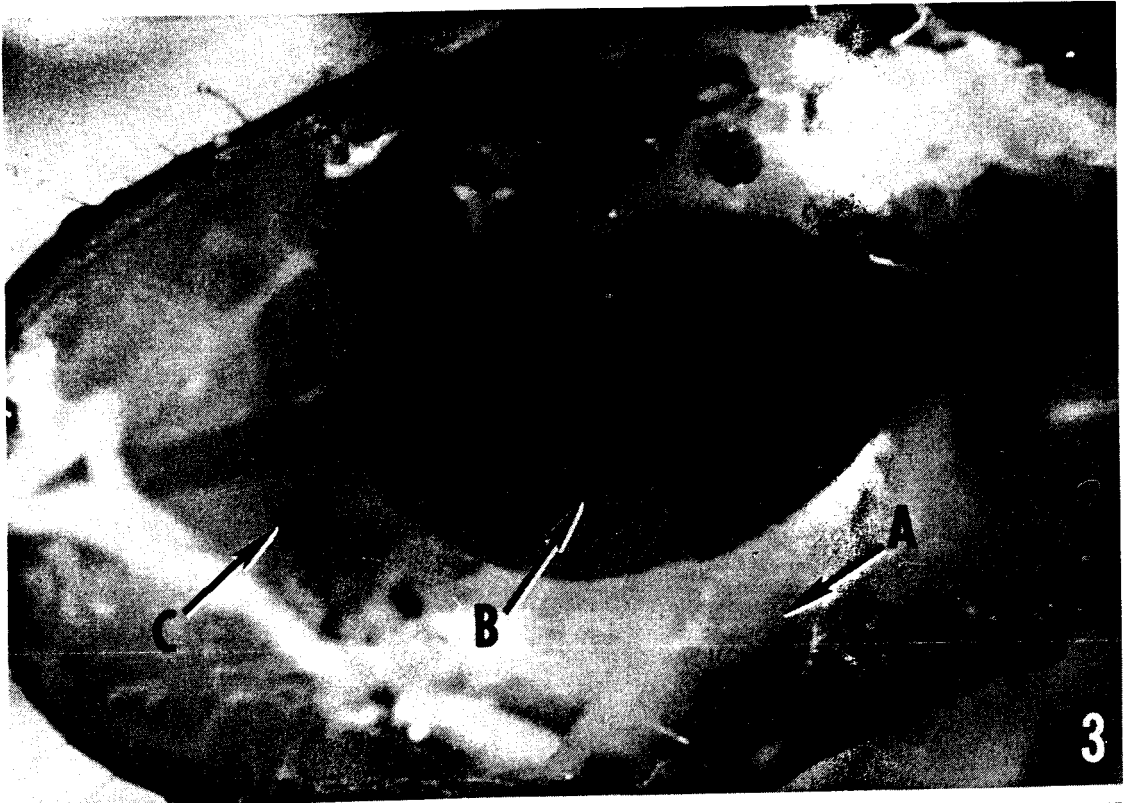


Fig. 3. Virgin female, mechanically dealated, at 7 days. A - remnants of flight muscle; B - distended esophagus; C - constriction (ring muscle) in esophagus.

Fig. 4. Mechanically dealated virgin female showing (B) a fully distended thoracic crop at 10 days.

Storage of fluid in the esophagus routinely follows within seven days after dealation. The ability of unmated queens to distend their esophagi and use it for storage of fluid shows that the process is independent of mating, but is dependent upon loss of wings and histolysis of flight muscles.

The origin of the yellow, oily fluid that fills the thoracic crop is not known; however, large amounts of fluid are found in the gastral crop and post-pharyngeal gland of queens before mating flights. The fluid in the esophagus is probably derived from movement of fluid forward from the gastral crop or

Table. Location of fluid in dissected queens of varying ages.

<u>Oily Food Material was Present in</u>				
<u>Age (wk)</u>	<u>Gastral crop only</u>	<u>Thoracic crop only</u>	<u>Both crops</u>	<u>Neither crop</u>
2	0	0	10	0
3	1	5	4	0
4	0	5	5	0
5	2	1	6	1
8	0	0	1	9

it may, at least partially, be derived from metabolic processes associated with histolysis of flight muscles. Since the queens in our laboratory studies were isolated from workers and no food was provided, the fluid could not have come from an external source.

Petersen-Braun and Buschinger (1975), who described the thoracic crop of *M. pharaonis* thought that the thoracic crop was filled as the ovaries developed and displaced the fluid in the gastral crop. This may also be true with young queens of *S. invicta* since the chemical nature of the fluid in both crops is similar (primarily triglycerides). Since the fluid in both crops of mated queens disappears within five to eight weeks after dealation, the queen probably uses it for her nutrition as well as for that of her first brood and minim workers. Once the minim workers start foraging and tending the queen, the crops may no longer be needed. We have never found older colony queens with large amounts of fluid in either the thoracic or gastral crops. Additional speculation on the function of the thoracic crop must await further research on the source and utilization of its lipoidal contents.

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