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CHARACTERIZATION OF THE MANDIBLE AND MANDIBULAR GLANDS IN DIFFERENT CASTES OF THE LEAF-CUTTING ANT *Atta laevigata* (F.SMITH) (HYMENOPTERA: FORMICIDAE) USING SCANNING ELECTRON MICROSCOPY.

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ABSTRACT

The morphology and ultrastructure of the mandibles and mandibular glands of different castes of the leaf-cutting ant *Atta laevigata* (F. Smith) were characterized. The mandibles in the different castes of workers do not show differences in external morphology, only a difference in size; the mandibles are arched with teeth of different sizes. In all castes, an opening was observed over the trulleum that possibly corresponds to the exit hole of the mandibular gland secretion. The glands in the different castes (queen and workers) are of different sizes. The site of the secretory portion shows an alveolar arrangement and was found at the distal part of the gland. In the glands of the queen the alveolus are larger and more densely packed than those of the workers.

Key words: *Atta laevigata*, mandible, mandibular gland, castes.

RESUMEN

Se caracterizan las mandíbulas y glándulas mandibulares de diferentes castas de *Atta laevigata* (F. Smith) a nivel de ultraesructura. Para ello se utilizó un microscopio electrónico de barrido MBE Joel JSM T300. De acuerdo con la casta, las mandíbulas presentan tamaños diferentes. Sin embargo, no se observaron diferencias morfológicas externas. En las obreras las mandíbulas son arqueadas y poseen dientes de tamaño variable. En todas las castas se observó una abertura situada sobre el trulleum, que posiblemente corresponda con el orificio de salida para las secreciones de la glándula mandibular. También se registra la diferencia en el tamaño de las glándulas mandibulares entre las castas estudiadas. La porción secretora siempre se encuentra en la parte distal de la glándula y presenta arreglo alveolar. En la reina la porción secretora presenta alvéolos mayores y más compactos que las obreras.

Pulabras clave: *Atta laevigata*; mandíbula, glándula mandibular, castas.

INTRODUCTION

There is very little known about the morphology of the mandibles in ants. Ettershank (1966) was the first to use and define terms to characterize and describe the morphology of mandibles in the Myrmicinae. Within the Attini mandible morphology has been described in the ants ***Acromyrmex subterraneus*** Forel and ***A. landolti*** Forel, including a characterization of the trulleum (Mayhé and Caetano 1994). The mandibular glands of the Formicidae are a source of

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volatile compounds (Cammaerts *et al.* 1983, Holldobler and Wilson 1990) which together with other glands affect the behavior of the ants (*op. cit.*). The mandibular gland is joined to the basal articulation of the mandible. It is formed by glandular cells and contains a reservoir in the form of a sac, the latter connected to the mandible by a secretory channel (duct) which may be short or long, (Toledo 1967, Gama 1985, Cruz-Landim 1990, Mayhé and Caetano 1994). Bellas and Holldobler (1985) described the mandibular glands (variable in size) in different castes of the ant ***Polyrhachis*** sp. Athula and Morgan (1984) pointed out that the mandibular gland has a similar anatomy in all ant species. Gama (*op.cit.*) did not find differences in the organization of the mandibular glands of ***Camponotus rufipes*** (Fab.), except that the size of the glands varied with ant size. Within the ***Atta***, Toledo (1967) described the mandibular glands of ***Atta sexdens rubropilosa*** Forel. These are formed by a pair of voluminous structures that occupy the anterior zone of the head. The reservoir sac is formed by a thin membrane that shows secretory cell islands of varying sizes. The secretory cells are spherical with a large and elliptic nucleus and each cell shows a canalicule. Toledo (1967) also observed that the mandibular glands showed differences in size in the different castes, the workers having larger glands than the males and queen. Blum *et al.* (1968), pointed out that the exit ducts are apparently always connected to the mesal side of the mandibles and open near to the anterior edge of the preoral cavity. The mechanism by which the mandibular gland secretion is released is a controversial subject (Hermann *et al.* 1971). Simpson (1960) believed that depressing the floor of the hypopharynx causes the entrance of the gland to open and release the secretion. Kratky (1931) suggested that the ducts open automatically when the mandibles are abducted. Longitudinal mandibular grooves have been suspected as channels through which mandibular secretions flow (Buren *et al.* 1970). Simpson (1960) pointed out, however, that the groove does not extend as far as the gland hole. Furthermore, Hermann *et al.* (1971) suggested that since the mandibular gland always appears to be on the opposite side of the mandible to the exit hole of is, it seems unlikely that the two are related.

This paper reports on our recent examination of the mandibles and mandibular glands of the leaf-cutting ant ***Atta laevigata*** (F. Smith) using scanning electron microscopy in order to verify the differences in the mandibles and mandibular glands between castes and to clarify the discharge mechanism of the mandibular gland.

MATERIALS AND METHODS

A. laevigata nests were collected in Productos Forestales de Oriente C.A. a pine tree plantation managed by PROFORCA at El Merey (Monagas State, Venezuela). The nests were kept at laboratory conditions of 60 % rh and 26^0 C, 12 hours light-darkness, at the Universidad Simón Bolívar (Caracas, Venezuela).

Ant activity was slowed by cooling the ants to -5° C for 15 minutes. The ants were then dissected in a physiological solution of buffer phosphate pH 7.2 360 mOsm/l, using stereoscopic microscopy. The pieces (mandibles and mandibular glands) were fixed in Bouin Solution and left in this solution for 24 hours after which they were stored in 70% ethanol. The

material was then dehydrated by putting it in increasingly dry solutions of acetone, from 50 % to 100 %. It was dried by the critical point method in a Balzer CPD 020 instrument and coated with gold for 3 minute by Balzer sputtering. The pieces were then examined and photographed using scanning electron microscopy (JOEL JSM T300).

RESULTS AND DISCUSSION

The different worker castes do not show differences in the external morphology of their mandibles. The only variation between then is that of size. The queens, however, show differences in both the external morphology and size of the mandibles. The workers have arched mandibles with teeth of variable sizes, the apical tooth more developed than the rest (Fig. 1) as was observed in the ants ***A. landolti*** and ***A. subterraneus*** by Mayhé and Caetano (1994). The queens have mandibles with slightly arched borders and more uniform teeth (Fig. 3). All castes studied have trulleum with the same traits; a triangular shape and characteristic sculpture on the upper side, that probably aids in the dispersion of the mandibular gland secretion by increasing the area for evaporation (Figs. 2 and 4). The shape of the trulleum is completely different in comparison with ***A. landolti*** and ***A. subterraneus*** observed by Mayhé and Caetano (1994).

The results of the study show that the mandibular glands of ***A. laevigata*** have similar characteristics to those of another species of the same genus, ***Atta capiguara*** Gonçalves as described by Gama and Cruz Landim (1982), and to those of the species of the same tribe, ***A. landolti*** and ***A. subterraneus*** as described by Mayhé and Caetano (1994). We found that the different castes have different sized mandibular glands. The queen showing more developed glands, contrary to that described by Toledo (1967) for ***A. sexdens rubropilosa*** in which the worker castes show more developed glands than the queen and male. Furthermore, the secretory part of the mandibular gland of the queen has alveolus which are larger and more packed than those of the workers (Fig. 5). In all castes studied the mandibular gland starts in the interior of the mandible with the secretory portion on the distal site of the gland. The glandular duct is very short and poorly defined, giving the impression that the gland opens immediately into the reservory sac (Figs. 6 and 7). This contrasts with the description for ***Acromyrmex*** species by Mayhé and Caetano (1994) where the structure of the mandibular gland has a larger and more clearly defined duct. The mandibular gland discharge orifice is located towards the base of the mandible, in the internal lateral zone exactly above the trulleum (Fig. 8). These structures (trulleum and discharge orifice) are similar to those described for ***Acromyrmex*** species by Mayhé and Caetano (1994) but contradict the descriptions of some of the researchers above mentioned (Simpson 1961, Kraty 1931).

The fact that the mandibular gland opens above the trulleum suggests that the release of the mandibular gland secretion is achieved by opening the mandibles and is enhanced by the pilosity and sculpture of the trulleum. When the mandibles are closed the opening is automatically sealed by the inner wall of the clypeus.

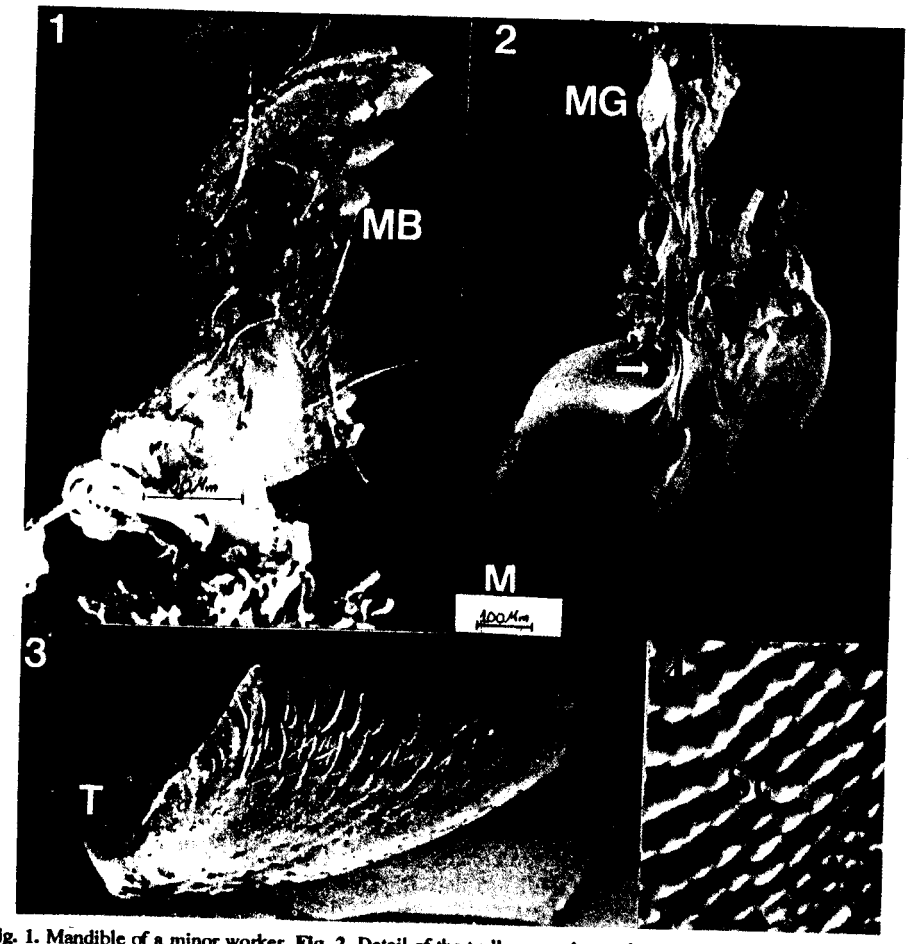

Fig. 1. Mandible of a minor worker, Fig. 2. Detail of the trulleum region and part of the mandibular gland of a soldier, Fig. 3. Mandible of a queen (35X), Fig. 4. Detail of the sculpturation of the trulleum of the queen. MB= masticatory border; M= mandible; MG= mandibular gland; T= trulleum; Sc= sculpture; H= hairs.

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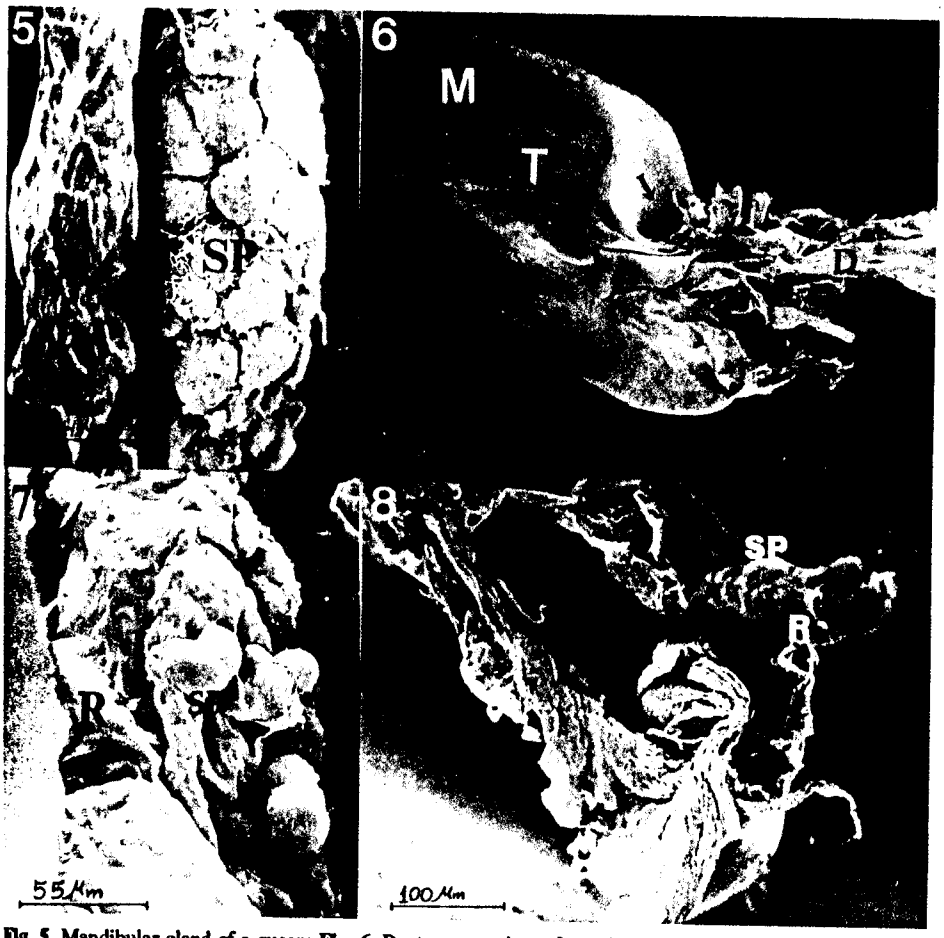

Fig. 5. Mandibular gland of a queen; Fig. 6. Duct entrance into of mandible of the a soldier, showing the exit orifice (arrow), Fig. 7. Detail of mandibular gland of a soldier; **Fig. 8.** General view of the mandibular gland of the worker. SP= secretory portion; R= reservoir; T= Trulleun; D= duct; M= mandible.

REFERENCES

ATHULA, B. and E. D. MORGAN. 1984. Chemicals from the glands of ants. Chem. Soc. Rev. 13:245-278.

BELLAS, T. and B. HOLLDOBLER. 1985. Constituents of mandibular and dufour's glands of an Australian ***Polyrhachis*** weaver ant. J. Chem. Ecol. 11: 4, 525-538.

BLUM, M.S., F. PADOVANI, H.R. HERMANN, and P.B. KANNOWSKI. 1968. Chemical Releaser of Social Behavior. XI. Terpenes in the Mandibular glands of ***Lasius umbratus*** (Hymenoptera: Formicidae: Formicinae). Ann. Ent. Soc. Amer. 61: 1354-1359.

BUREN, W.F., H. R.HERMANN, and M. S. BLUM. 1970. The widespread occurrence of mandibular grooves in aculeate. J. Georgia Ent. Soc. 5: 185-196.

CAMMAMERTS, R. P. and E. D. MORGAN. 1983 The volatile components of the mandibular gland secretion of workers of the ants ***Myrmica lobicornis*** and ***Myrmica sulcinodis***. J. Insect. Physiol. 29: 8 659-664.

CRUZ-LANDIM, C. 1990. Cephalic exocrine glands of ants: A morphological view. In: Applied Myrmecology A World Perspective, Edited by Rovert K. Vander Meer, K. Jaffé and A. Cedeño. Westview Studies in Insect Biology, Boulder, San Francisco, & Oxford, 102-118.

ETTERSHANK, G. 1966. A Generic Revision of the World Myrmicinae Related to ***Solenopsis*** and ***Pheidologeton*** (Hymenoptera: Formicidae). Aust. J. Zool. 14: 73-171.

GAMA, V. y C. CRUZ-LANDIM. 1982. Estudo Comparativo das Glandulas do Sistema Salivar de Formigas (Hymenoptera: Formicidae). Naturalia 7: 145-165.

GAMA, V. 1985. O sistema salivar de ***Camponotus (Myrmothrix) rufipes*** (Fabricius,1775), (Hymenoptera: Formicidae) Rev. Bras. Biol. 45:3, 317 - 359.

HERMANN, H.R.; A. N. HUNT and W. F. BUREN. 1971. Mandibular gland and mandibular groove in ***Polistes annularis*** (L.) (Hymenoptera: Vespidae). Int. J. Insect. Morph. Embryol. 1: 43-49.

HOLLDOBLER, B. and E. WILSON. 1990. The Ants. The Belknap Press of Harvard University Press, Cambridge, Masachusetts 732p.

KRATKY, E. 1931. Morphologie und Physiologie der Drusen in Kopf und Thorax der Honigbiene. Z.wiss. Zool. 139: 120-200.

MAYHÉ, A. and F. CAETANO. 1994 Ultramorphology of and Comparison Between the Mandibular Glands and Mandibles of two Species of ***Acromyrmex***. (Hymenoptera, Formicidae). Naturalia 19: 17-27.

SIMPSON, J. 1960. The functions of the salivary glands of ***Apis mellifera***. J. Insect. Physiol. 4: 107-121.

TOLEDO, L.F.A. 1967. Histo-anatomia de Glandulas de ***Atta sexdens rubropilosa*** Forel (Hymenoptera). Arq. Inst. Biol. 34: 321-329.