Description of the Immature and Adult Stages of *Ectatomma vizottoi* (Formicidae: Ectatomminae)

by

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ABSTRACT

We estimated the number of larval instars of the ant *Ectatomma vizottoi* (Ectatomminae), by measuring the maximum width of the head capsules of 208 larvae and the morphology of the immature stages (eggs, larvae and pupae) and adults. There are three larval instars during the post-embryonic development. The reproductive eggs are dark brown. Hairs are present beginning with the first instar, are uniformly distributed over the larval body, and do not vary in length in the three instars. Pupae are protected by a light-brown silk cocoon. Adults of the worker and queen castes can be differentiated by size.

Keywords: ants, cephalic capsule, Dyar's rule, larval instars.

INTRODUCTION

The exoskeleton of insects made possible their evolutionary success in the terrestrial environment. Among many important physical characteristics of the exoskeleton is its rigidity and impermeability. The presence of the exoskeleton determines a different form of growth from vertebrates. The principal growth mechanism of insects is marked by a series of molts or ecdyses, which are preceded by a period of intense growth and subsequently by a period where the insect rarely increases its body size (Wigglesworth 1972). According to Dyar's rule (Dyar 1890), the cephalic capsule of larvae and caterpillars grow

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arithmetically, increasing in width at each change of instar, at a constant and specific rate in the interval from 1.1 to 1.9 mm, with a mean of 1.4 mm. In the insects, in general, the number of larval instars can vary from three to 40, and in Hymenoptera can range from three to six (Sehnal 1985; Chapman 1998). In the ants, the number of instars ranges from three to six (Masuko 1990), most often with four instars (Hölldobler & Wilson 1990), and, rarely, six instars (Masuko 1990).

The distinction and description of the larval instars are often prerequisites for ecological investigations of social insects, such as studies of colony development for analysis of age distribution (Masuko 1990). Many studies of the number of larval instars of ants have been conducted on species belonging to two more-derived subfamilies, the Myrmicinae and the Formicinae (Masuko 1990). For the poneromorphs, studies have concentrated on the following species: *Amblyopone silvestri*, an Amblyoponinae (Masuko 1990), *Ectatomma planidens*, mistakenly identified as *E. edentatum*, an Ectatomminae (Antonialli-Junior & Giannotti 2000), and in the Ponerinae, *Pachycondyla* (= *Brachyponera*) *chinensis* studied by Masuko (1990), *P. villosa* by Zara & Caetano (2001) and *Odontomachus haematodus* (=*haematodes*) by Colombel (1978).

In lateral view, the larva of poneromorphs shows the thorax and part of the abdomen elongated and a "chest" folded ventrally, with the rest of the ventral profile straight and dorsally convex, and rounded in the caudal region. The profile of the larva varies little among species of the same genus, and the pupae are generally covered by a cocoon made of silk produced by the larva itself (Wheeler & Wheeler 1979).

There are only two published studies, one with *E. opaciventre* (Antonialli-Junior & Giannotti 1997) and the other with *E. planidens*, mistakenly identified as *E. edentatum* (Antonialli-Junior & Giannotti 2001), that describe the morphological differentiation between workers and queens; the workers are significantly larger. In this context, the objective of the present study was to describe the immature stages and the morphometric differentiation between the worker and queen castes, as well as the males of *Ectatomma vizottoi* Almeida (1987), a species of ant belonging to the subfamily Ectatomminae, a group of the poneromorph subfamilies which occurs throughout the Neotropical region (Bolton 2003).

MATERIAL AND METHODS

Adult and immature individuals from eight colonies of *E. vizottoi* were collected during the period from November 2004 through August 2006, on the campus of the State University of Mato Grosso do Sul (UEMS), Dourados, MS (22°13'16"S; 54°4820"W). The subterranean nests were excavated according to the method described by Antonialli-Júnior & Giannotti (1997).

Immature stages

With the aid of a stereomicroscope, the length and diameter of 44 eggs (1 ocular unit equal to 0.20 mm) and 50 pupae (1 ocular unit equal to 1.0 mm) were measured. To determine the number of larval instars, the width of the cephalic capsule of 208 larvae was measured (1 ocular unit equal to 0.20 mm), and Dyar's rule was applied (Dyar 1890). The means of the different larval groups were analyzed by Tukey test (Parra & Haddad 1989), considering each group as one instar.

Morphological differentiation of castes

The maximum length of the head; length of the antennal scape, length of the anterior end from the pronotum to the posterior part of the propodeus (*i.e.*, the mesosome) and the maximum width of the second gastral tergite of 96 adult individuals (9 queens, 57 workers and 30 males) were measured. The measurements were made with the aid of a stereomicroscope fitted with an ocular reticule (1 ocular unit equal to 0.1 mm). The data were analyzed by means of Student's *t* test for unequal samples, with a significance level of $p<0.05$, between the means of the measurements of the queens and the workers. Later, the immature and adult specimens were drawn, in order to illustrate the morphological differences between them.

RESULTS

Immature stages: eggs

The eggs of this species are elongated and ellipsoid in form (Fig. 1a). The coloration of the reproductive eggs varies from very dark brown to nearly black. The mean length is approximately 1.361 ± 0.004 mm, and the median diameter is 0.768 ± 0.003 mm.

Immature stages: larvae

The larvae of *E. vizottoi* show the typical pogonomyrmecoid profile (Figs. 1 b-d), white-colored and with numerous hairs or tubercules, as well as strongly sclerotized brown mandibles, and one pair of teeth beginning with

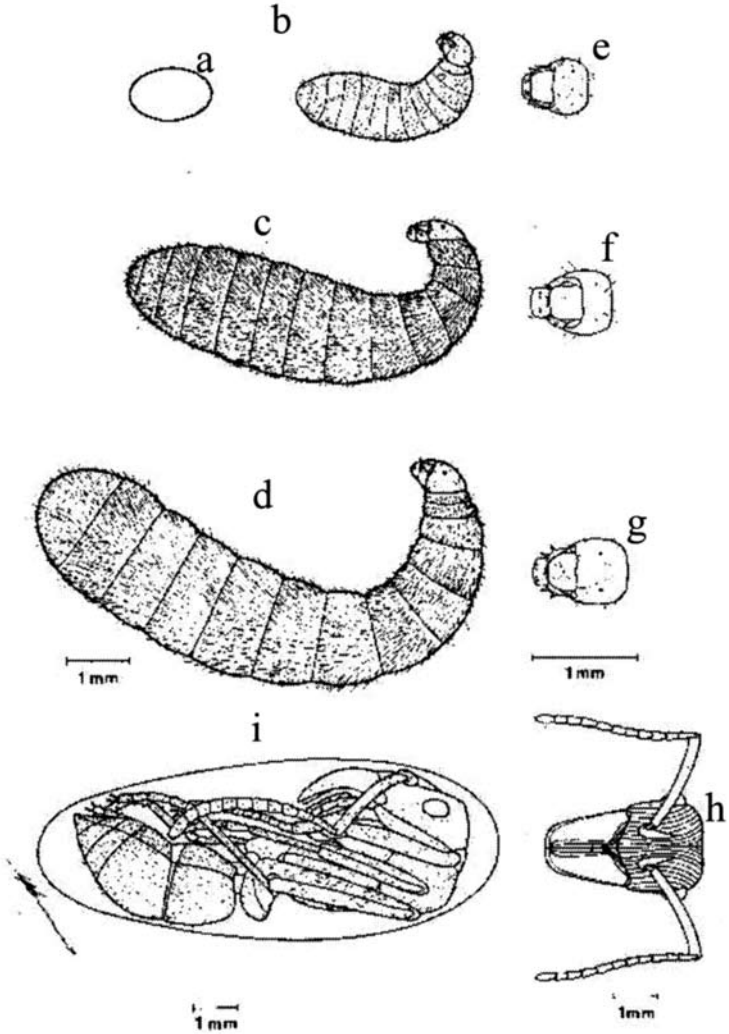

Fig. 1. Immature stages of *Ectatomma vizottoi*. a, Egg (same scale as lateral view of larvae); b, c, d, lateral view of 1st, 2nd and 3rd larval instar, respectively; e, f, g, frontal view of head of 1st, 2nd and 3rd larval instar, respectively; h, frontal view of head of a pupa; i, lateral view of a pupa. Drawings by Jaime R. Somera.

the first instar, with no evidence of morphological changes during the entire development (Fig. 1e-g).

The mean width of the cephalic capsule was 0.20 ± 0.028 mm for the first instar, 0.28 ± 0.057 mm for the second, and 0.38 ± 0.071 mm for the third (Table I). The slopes of the frequency-distribution curve for cephalic capsule width indicate the existence of three distinct peaks (Fig. 2). This suggests the occurrence of three possible larval instars. The estimated growth rate varied from 1.3 to 1.4 mm in the width of the cephalic capsule of the larvae from instar to instar (Table 1).

Table 1. Mean cephalic capsule width (mm) of *Ectatomma vizottoi* larvae and the growth rate of the larval instars.

Instar	Amplitude (mm)	Frequency	Mean width (mm)	SD (mm)	Growth rate	Mean growth rate
1st	0.180-0.220	28	0.200	0.028	-	-
2nd	0.240-0.320	106	0.280	0.057	1.400	1.387
3rd	0.340-0.440	74	0.385	0.071	1.375	-

Table 2. Tukey's test applied to the mean values for the three instars detected in *Ectatomma vizottoi*. *P value significant

Larval instar	Mean (1)	Mean (2)	Mean (3)
	0.200	0.280	0.385
1	-	0.0464*	0.0004*
2	0.0464*	-	0.0051*
3	0.0004*	0.0051*	-

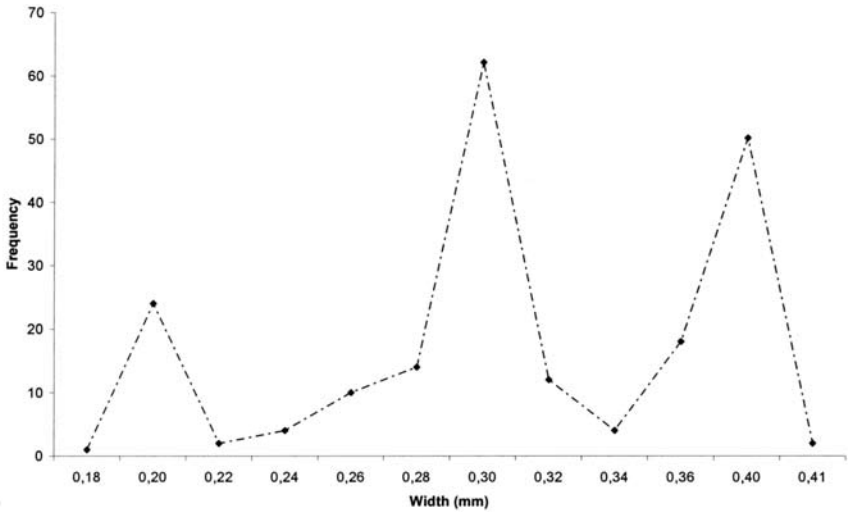

Fig. 2. Frequency distribution of the cephalic capsule widths (mm) of *Ectatomma vizottoi* larvae.

The growth rate of the cephalic capsule was 1.4 mm from the first to the second instar, and 1.375 mm from the second to the third; the mean growth rate of the species was 1.387 mm (Table 1). Tukey's test indicated significant

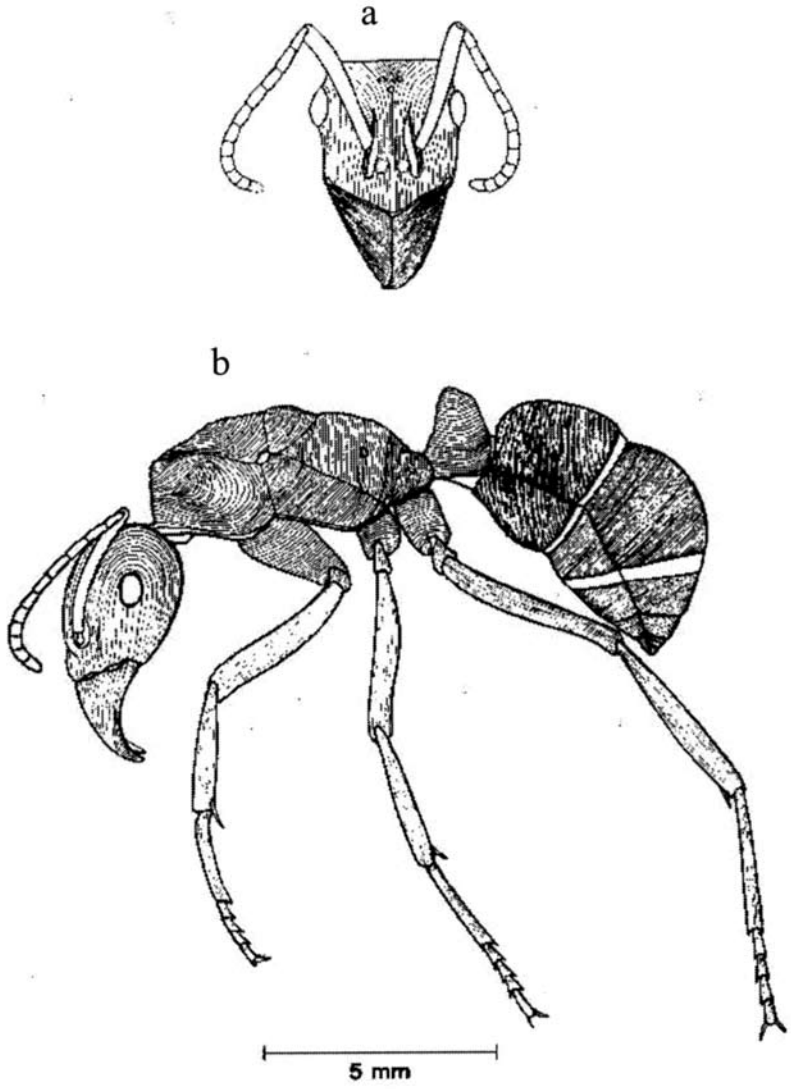

Fig. 3. Queen of *Ectatomma vizottoi*. a, Frontal view of head; b, Lateral view of body. Drawn by Jaime R. Somera

differences among the means of the three groups (Table 2), thus confirming the existence of three instars during the larval development of this species (Figs. 1b-g).

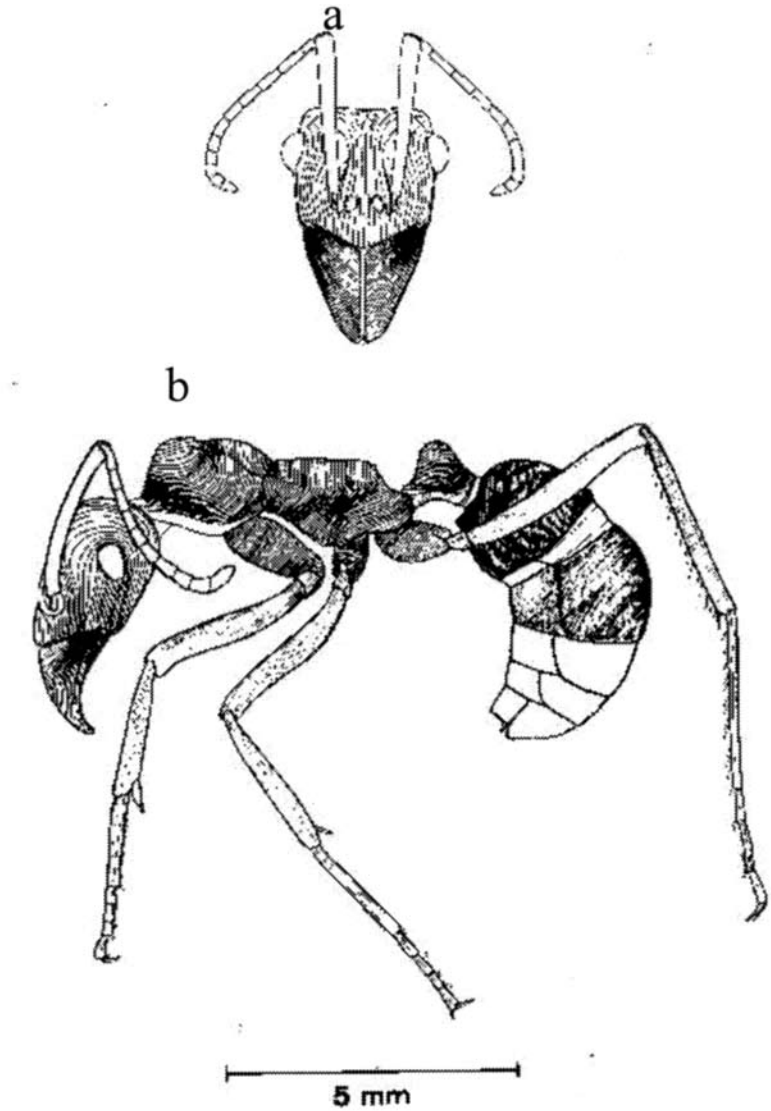

Fig. 4. Worker of *Ectatomma vizottoi*. a, Frontal view of head; b, Lateral view of body. Drawn by Jaime R. Somera

Immature stages: pupae

The pupae (Fig. 1h-i) of *E. vizottoi* were surrounded by a light-brown silk cocoon. Their mean length was 9.450 ± 2.887 mm, and mean diameter 4.13 ± 0.274 mm.

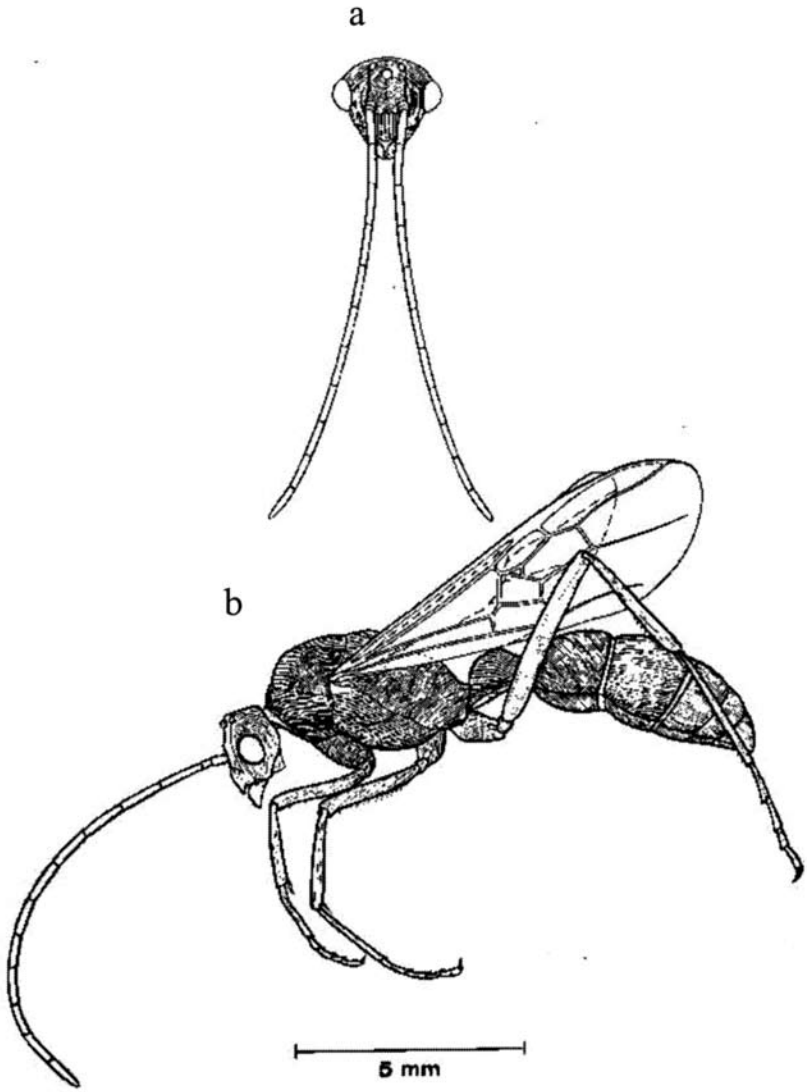

Fig. 5. Male of *Ectatomma vizottoi*. a, Frontal view of head; b, Lateral view of body. Drawn by Jaime R. Somera

Morphological differentiation of castes

The queens are perceptibly larger than the workers (Figs. 3 and 4). They possess wings (which are lost after mating, with only alar scars remaining beneath the tegulae), three ocelli between the compound eyes, and a more developed abdomen compared to the workers (Figs. 3a and b).

All the morphological measurements analyzed showed significant differences between workers and queens. The maximum length of the head showed a mean of 2.20 ± 0.16 mm in workers and 3.09 ± 0.12 mm in queens (t=18.59; p=0.000). The mean length of the antennal scape was 3.18 ± 0.25 mm in workers and 3.51 ± 0.24 mm in queens (t= 3.688; p= 0.002). The mean mesosome length was 5.17 ± 0.25 mm in workers and 7.08 ± 0.40 mm in queens (t= 13.593; p= 0.000). The maximum width of the second gastral tergite was 2.43 ± 0.19 mm in workers and 4.02 ± 0.34 mm in queens, a highly significant difference (t= 13.440; p= 0.000).

In males (Fig. 5a and b), the mean maximum head length was 1.75 ± 0.13 mm, the mean antennal scape length was 0.47 ± 0.06 mm, the mean mesosome length was 5.26 ± 0.23 mm and the maximum width of the second gastral tergite was 2.18 ± 0.09 mm.

DISCUSSION

The eggs of *E. planidens* (Antonialli-Junior & Giannotti 2000) have the same form as *E. vizottoi*, but with a different color, light brown. The dark color pattern of the reproductive eggs is similar to the eggs of *E. tuberculatum* studied by Hora *et al.* (2007). However, the same whitish color pattern of the trophic eggs is observed in all three of these species.

The coloration of the larvae is similar to that of the majority of the larvae of Hymenoptera, and the morphology is in accord with the description of Wheeler and Wheeler (1971, 1979). Antonialli-Junior & Giannotti (2000) also described numerous hairs or tubercules and sclerotized mandibles in the larvae of *E. planidens*.

For the larval instars, the estimated growth rate varied from 1.3 to 1.4 mm in the width of the cephalic capsule of the larvae. This accords with Dyar's rule, which proposes a variation from 1.1 to 1.9 mm (Dyar 1890). Antonialli-Junior & Giannotti (2000) found that this rule also applies to the growth rates of larvae of *E. planidens*.

Three larval instars were also found during the larval development of *E. planidens* (Antonialli-Junior & Giannotti 2000). Masuko (1990) observed five larval instars for *A. silvestri,* whereas for *P.* (=*Brachyponera) chinensis* (Masuko 1990)*, O. haematodus* (=*haematodes)* and *P. villosa* (Zara & Caetano 2001), four instars were observed. Therefore, in the poneromorphs, the number of instars during larval development can range from three to five, similar to the Formicinae, and in the Myrmicinae from three to six. However, in the Ecitoninae there appears to be no variation: Masuko (1990) studied three species of this subfamily and observed five larval instars in all of them.

The morphological characteristics of the pupae of this species are similar to those described by Wheeler & Wheeler (1979), who reported that the silk cocoon makes possible the emergence of the adult without the aid of workers. In *E. planidens* (Antonialli-Junior & Giannotti 2000) and *E. vizottoi*, the pupae are also protected by a cocoon, differing, for example, from the Myrmicinae *Solenopsis*, in which the pupae are of the exarate type, or naked (Hölldobler & Wilson 1990).

Significant morphometric differences between queens and workers have been found in other species of the same genus, such as *E. planidens* (Antonialli-Junior & Giannotti 2001) and *E. opaciventre* (Antonialli-Junior & Giannotti 1997). Prominent among these differences are the larger gaster and second gastral tergite of the queens. This may be due to a greater development of the ovaries, which contain a larger number of ovarioles in relation to the workers. In colonies of *E. vizottoi*, workers possess one or two ovarioles and the queens have as many as 12 (Vieira *et al*. 2008). *E. brunneum* also possesses one or two ovarioles per worker, and the queen has up to 15 (Toledo-Mello & Caetano 1980). The dimorphism between queens and workers of *E. vizottoi* is obvious, as also described by Antonialli-Junior & Giannotti (1997) in *E. opaciventre*, by Lachaud *et al*. (1999) in *E. ruidum*, and by Antonialli-Junior & Giannotti (2001) in *E. planidens*. In the case of *E. ruidum,* there is more than one kind of queen, which the authors termed macro- and microgynes (Lachaud *et al*. 1999).

The coloration of the workers and queens accords with the description by Almeida (1987). The females of *E. vizottoi* are predominantly yellow-brown, with a rust-colored gaster. The males are perceptibly smaller than the workers and queens, with a small head and antenna constituted of 13

elongated segments, whereas the antennae of workers and queens possess 12 segments. In addition, the body coloration of the males is darker than that of the females.

In conclusion, *E. vizottoi* has three larval instars, which do not show marked morphological changes during their development. The reproductive eggs are dark, the trophic eggs are whitish, and the pupae are surrounded by a light-brown silk cocoon like the other species of the genus. The queens differ from the workers in size, as well as the presence of wings (or alar thecae, after the loss of the wings), of the tegulae and of the ocelli on the top of the head. The males are quite distinct from the females.

ACKNOWLEDGMENTS

Our thanks to the researcher Jacques Hubert Charles Delabie of the Laboratório de Mirmecologia of the Centro de Pesquisas do Cacau (Ceplac-Ilhéus, BA), for identifying the specimens; to the artist Jaime Roberto Somera, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista (UNESP); to the researcher Riviane R. Hora for revising this manuscript; to FUNDECT for financial support of the project (Process No. 23/200.085/2007) and to Capes for awarding a master's degree fellowship to the first author.

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