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## LARVA OF *ATRACTOCERUS BRASILIENSIS* (LEPELETIER & AUDINET-SERVILLE, 1825) (LYMEXYLIDAE, ATRACTOCERINAE)

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### ABSTRACT

The larva of *Atractocerus brasiliensis* (Lepeletier & Audinet-Serville, 1825), collected for the first time in *Pinus oocarpa* Schiede ex Schltdl. (Pinaceae) is described and illustrated. Until now, for Lymexylidae, only the larva of *Melittomma* sp. (Melittomminae) was known from the neotropical region (Brazil). Biological notes, a comparison with the description of *A. brevicornis*, the type-species of the genus (recorded from Africa and Madagascar), and history of the known lymexylid larvae are also included.

KEY-WORDS: Coleoptera; Fungus; Immature; Neotropical region; South America.

### INTRODUCTION

The family Lymexylidae includes 12 genera and about 61 species assigned to four subfamilies: Atractocerinae (*Atractocetus* Kurosawa, 1985, *Atractocerus* Palisot de Beauvois, 1801, *Fusicornis* Philippi, 1866, *Hymaloxylon* Kurosawa, 1985, *Raractocetus* Kurosawa, 1985 and *Urtea* Paulus, 2004); Hylecoetinae (*Elateroides* Schaeffer, 1777 [replacement to *Hylecoelus* Latreille, 1806 by Cuccodoro, 2002]); Lymexylinae (*Lymexylon* Fabricius, 1775); and Melittomminae (*Australymexylon* Wheeler 1986, *Melittomma* Murray, 1867, *Melittommopsis* Lane, 1955 and *Protomelittomma* Wheeler, 1986) (Wheeler, 1986; Paulus, 2004).

Thirteen species included in four genera (*Atractocerus*, *Fusicornis*, *Melittomma* and *Melittommopsis*) are recorded from the neotropical region, from which nine species of three genera are recorded from Brazil: *Atractocerus brasiliensis* (Lepeletier & Audinet-Serville, 1825), *A. procerus* Schenkling, 1914, *A. termiticola*

Wasmann, 1902, *Melittomma brasiliense* (Laporte, 1832), *M. marginellum* Schenkling, 1914, *M. pubicolle* Pic, 1944, *Melittommopsis juquiensi* Lane, 1955, *M. nigra* Lane, 1955 and *M. validum* (Schenkling, 1914) (Blackwelder, 1945, Wheeler, 1986).

*Atractocerus brasiliensis* is recorded from North America (Mexico), Central America (Guatemala, Nicaragua, Panama), the Caribbean (Cuba, Dominican Republic, Haiti and Puerto Rico), and South America (Brazil, Argentina and Chile).

The immature forms of Lymexylidae are poorly known. Larvae of about eleven species are described, only one of which is from the neotropical region (Brazil). In the subfamily Atractocerinae, larvae of four species of *Atractocerus* are known: *A. brevicornis* (Linnaeus, 1766) [Wheeler, 1986], *A. emarginatus* Castelnau, 1836 [Gardner, 1926, Fulmek, 1930], *A. quercus* Gardner, 1935 [Gardner, 1935] and *A. reversus* Walker, 1858 [Gardner, 1944 (1945)]. The larva of *A. brasiliensis*, described herein, is the first larva of

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this genus known from the neotropical region. In the subfamily Melittomminae, larvae of three species are described: *Australymexylon australe* (Erichson, 1842) [Wheeler, 1986], *Melittomma* sp. [Costa *et al.*, 1988] and *Protomelittomma insulare* (Fairmaire, 1893) [Wheeler, 1986]. Up to now, the only larva of Lymexylidae described from Brazil was *Melittomma* sp. The remainder species belong to *Elateroides* [described as *Hylecoetus*] (Hylecoetinae) and *Lymexylon* (Lymexylinae): *Elateroides dermestoides* (Linnaeus, 1761) [Grandi, 1962; Egger, 1974; Klausnitzer, 1996], *E. flavicornis* (Schneider, 1791) [Klausnitzer, 1996], *E. lugubris* (Say, 1835) [Peterson, 1962; Böving & Craighead, 1953] and *Lymexylon navale* (Linnaeus, 1758) [Burakowski & Kilian 2005].

Böving & Craighead (1953) characterized the larvae of Lymexylidae as having: "labrum elongate, conical, fitting into a groove on dorsal side of mandibles; molar structure of mandible present but rather indistinct; maxillary articulating area well-developed; maxillary palpus three-jointed, palpiger excluded; cardo bipartite; ligula large and broad; prothorax hood-shaped, somewhat swollen dorsally and ventrally; ninth abdominal segment terminal and heavily sclerotized; spiracles bilabiate". They presented a key to two subfamilies, Lymexylinae (*Melittomma*, *Atractocerus*) and Hylecoetinae (*Hylecoetus*). Lymexylinae was characterized as having the ninth abdominal segment cylindrical, obliquely truncate posteriorly, armed with a raised rim and with rugosities or tubercles on the disk inside the rim; abdominal epipleural lobes with a hard, tubercled or shagreened surface.

According to Wheeler (1991) the larvae of this family is distinguished from other Coleoptera especially by a large hood-like pronotum, elongate body with lateral folds and highly modified ninth abdominal segment. He defined three major structural configurations of the ninth abdominal segment: 1) a long, heavily sclerotized, serrate swordlike form; 2) a large bulbous, membranous to slightly sclerotized form; and 3) a truncated, cylindrical, heavily sclerotized (at least apically) and often toothed form. Besides, some lymexylids (*Hylecoetus*, *Atractocerus*) have plurisetose tarsunguli and late-instar larvae lack stemmata. According to him, all larvae of Lymexylidae are wood-boring and believed to be symbiotic associates of fungi and microbes. He observed that a first instar larva differs from later instars, aside from body size, by presence of stemmata, and by pupation occurring in wood.

According to Lawrence (2009), eggs are deposited in bark crevices or under bark scales by means of

a long ovipositor and first instar larvae bore straight into the wood, only occasionally making surface galleries in the cambium. The larvae remove frass from their tunnels by pushing it with the apex of tergum IX, which may also serve to block the tunnel from potential predators or parasites.

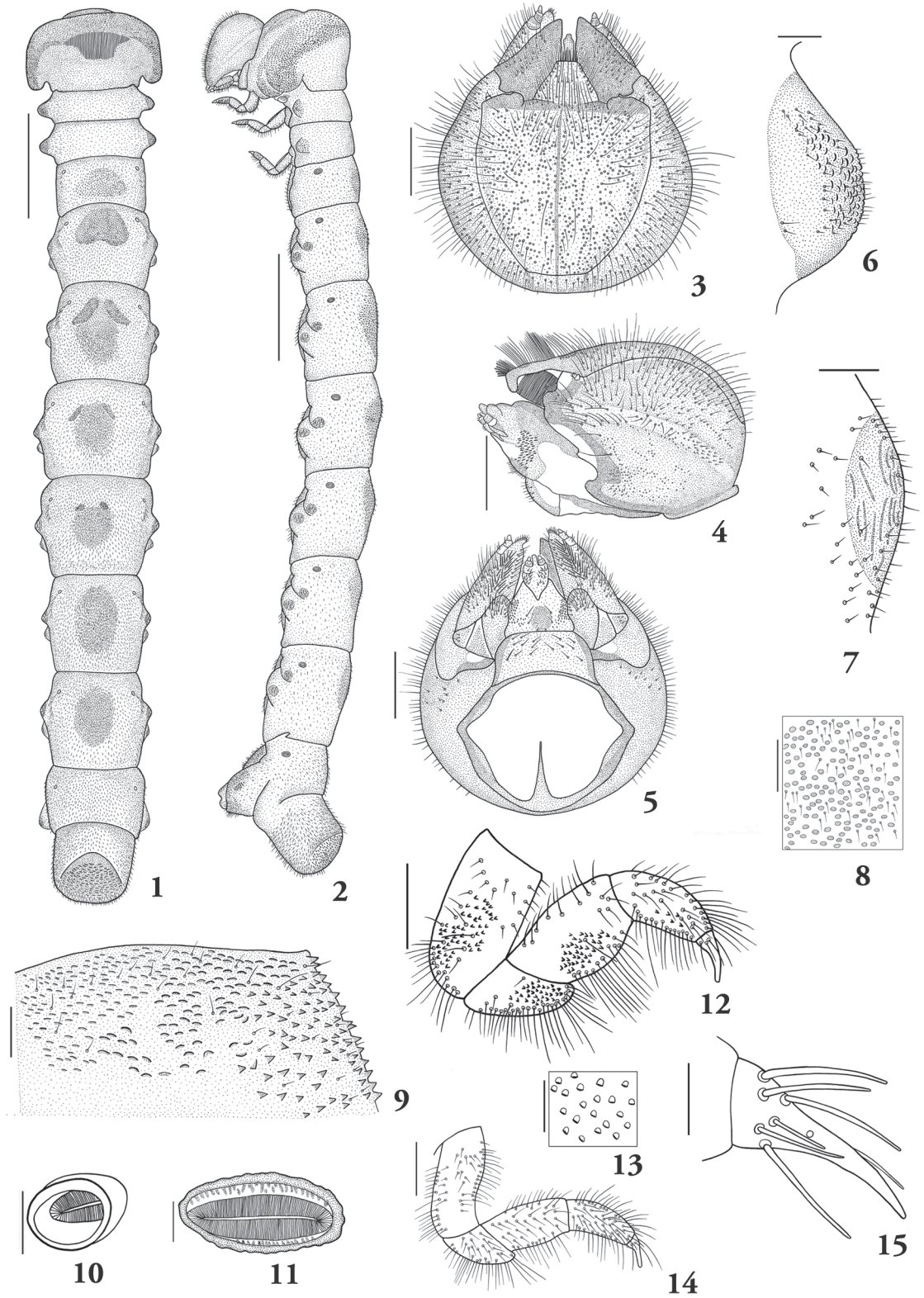
## MATERIAL AND METHODS

Mature larvae of different sizes were collected inside the trunk of a stressed tree of *Pinus oocarpa* Schiede ex Schltdl. (Pinaceae), on 07.III.2008, by E.P. Teixeira, in two different areas of Ribeirão Branco (Fazenda São Miguel – Companhia Florestal Guapiara) (24°10'04.9"S; 48°38'46.5"W, 901 m and 24°10'16.0"S; 48°38'11.2"W, 907 m), state of São Paulo, Brazil. The stand of *P. oocarpa* chosen for experimentation was selected in an area near a fragment of Atlantic forest. The selected trees were stressed with herbicide Thordon (10%) with the purpose of detecting the woodwasp *Sirex noctilio* (Hymenoptera, Sirexidae). This species, native of Eurasia and North Africa, is a serious pest of coniferous forest and was collected in Brazil in 1988 attacking *Pinus taeda* in State of Rio Grande do Sul. During the collecting in the trunks, besides the larvae of *Sirex* woodwasp, also were found larvae of Lymexylidae along with some adults and larvae of Scolytidae and adults of Platypodidae.

About three months after stressing, the trees were cut and the trunk divided into several logs. Each log was sectioned longitudinally, observing carefully for the presence of woodwasp larvae. During this process, the Lymexylidae larvae were found in a transversal tunnel in the trunk (Fig. 40). Some larvae were removed from the tunnel, photographed (Figs. 41, 42) and sacrificed for studying. The larvae were killed in hot water and preserved in 70% alcohol. Some parts of the trunk were kept in the laboratory, inside a wood cage (50 × 40 × 40 cm) until the adults emerged. The emergence period lasted from 30 to 117 days and adults kept alive from three to four days. The pupa was not observed.

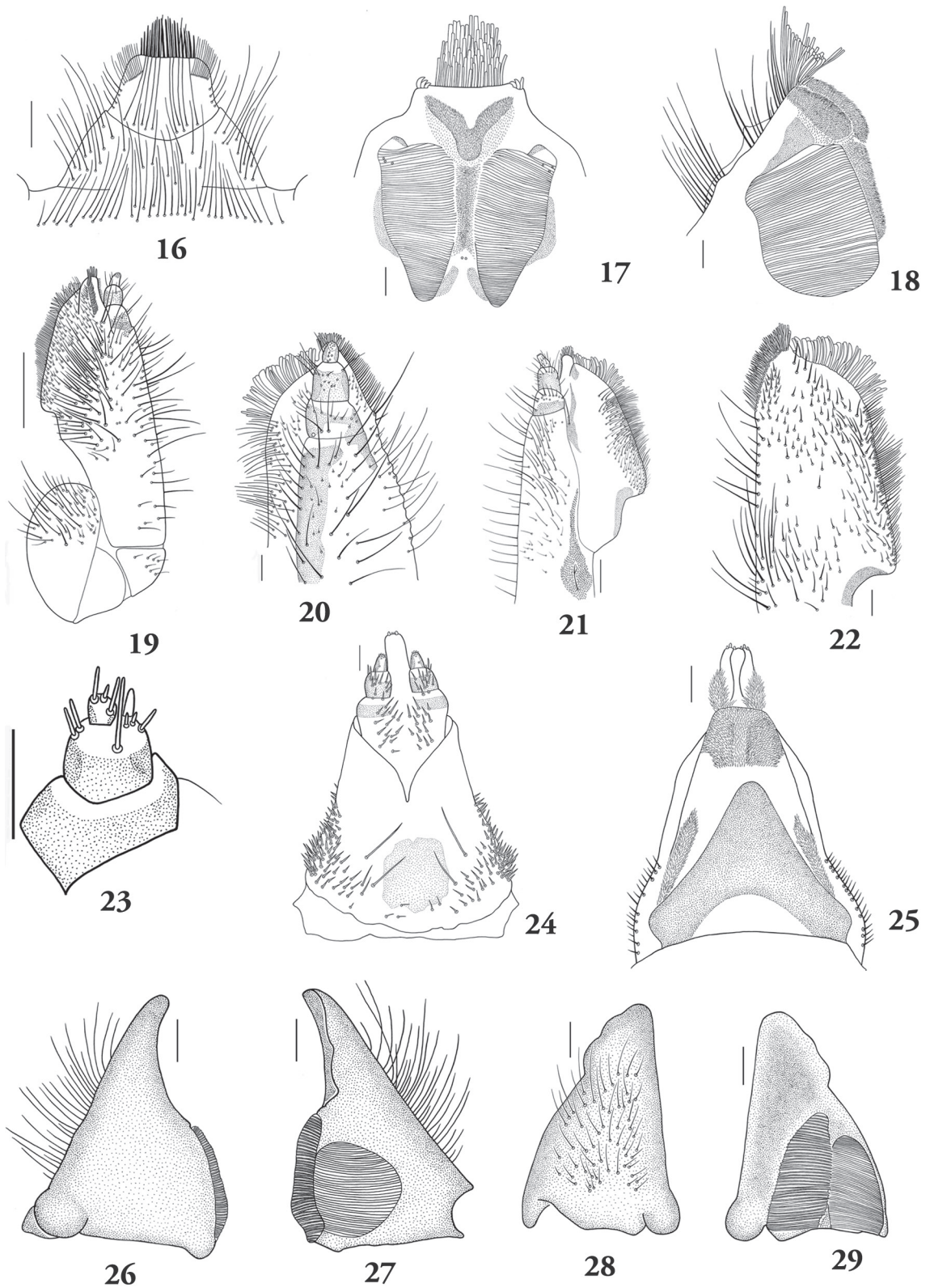
Thirteen larvae (one dissected) and two adults are housed at the "Museu de Zoologia da Universidade de São Paulo, São Paulo" (MZUSP), and 10 adults are housed at the "Instituto Agrônomo de Campinas, Campinas, São Paulo" (IACC), labeled with number 8072.

Included in the illustrations are three techniques: line drawings (Figs. 1-29), electron micrographs (Figs. 30-36), and digital photographs (Figs. 37-44).



FIGURAS 1-15: *Atractocerus brasiliensis* (Lepelletier & Audinet-Serville, 1825), larva: 1, 2, dorsal, lateral; 3-5, head (dorsal, lateral [mandibles removed], ventral); 6, lateral lobe of mesothorax; 7, lateral lobe of abdomen; 8, detail of median region of 2nd abdominal tergite; 9, spiculi of pronotum; 10, 11, spiracles (abdominal, thoracic); 12, 14, legs (anterior, posterior); 13, microtrichia of anterior leg; 15, tarsungulus of anterior leg. Bars = 2 mm, except Figs. 1, 2, 13, 15 = 1 mm; 3-5 = 10 mm; 12, 14 = 5 mm.





**FIGURAS 16-29:** *Atractocerus brasiliensis* (Lepelletier & Audinet-Serville, 1825), larva: **16**, clypeus and labrum; **17, 18**, epipharynx (ventral, lateral); **19**, maxilla, **20-22**, apex of maxilla (lateral, dorsal, mesal); **23**, right antenna (dorsal); **24**, labium; **25**, hypopharynx; **26-29**, mandible (ventral, dorsal, lateral, mesal). Bars = 1 mm, except Figs. 16, 21, 26-29 = 2 mm; 19 = 5 mm.

## Biological Notes

In the laboratory, the cages were observed periodically to verify the presence of adults. The first rounded hole (Fig. 37) outside of the trunk, indicating adult emergence, appeared one month later. During the following observations it was verified that some holes were closed with frass (Fig. 39). The frass was removed (Fig. 38) in one day, and it reappeared some days later. This indicated that, as observed by Lawrence (2009), the larva pushes the frass outside of the tunnel with the apex of tergum IX.

In the cage, the adult was observed resting on the ceiling, its long abdomen extended with apex downwardly directed (Fig. 44).

According to Wheeler (1986), it is probable that lymexylids were among the first Coleoptera to evolve fungus-growing habits, despite the process being less sophisticated than those of the more familiar ambrosia beetles (Francker-Grossmann, 1967; Graham, 1967; Schedl, 1958; Wilson, 1971 *apud* Wheeler, 1986). Several authors have described the biology and the fungus association of *Hylecoetus dermestoides* (Buchner, 1928, 1953; Lyngnes, 1958; Francke-Grossmann, 1967; Egger, 1974 *apud* Wheeler, 1986). Oviposition occurs on wood and the first instar larvae have a twisting behavior assuring contacts with siblings and eggs, resulting in the transfer of fungal spores onto integument. Fungi grow on the tunnel walls during larval development, including the host fungus species. Adult females emerge bearing spores in the special vaginal pouches, eventually depositing them in a slimy matrix with eggs. Evidence of symbiosis between *Atractocerus* and fungi include morphological observations of fungus pouches in the vagina. This was noted for *A. reversus* in association with 'mold and sap' and larval tunnels of *A. kreuslerae* with fungi (Clark, 1925; Roonwall, 1972 *apud* Wheeler, 1986).

No symbiont fungus was observed in the galleries of *A. brasiliensis* inside the trunks, despite the observations stated in literature on the existence of an association between Lymexylidae beetles and fungus. Considering the fact that *A. brasiliensis* occurred together with *Sirex noctilio*, which includes the mycosymbiont *Amylosterium areolatum* (Fr.) Boidin (Basidiomycete), we supposed that the association of this lymexylid with wood destroying fungus should have occurred. Besides, the presence of the *Lasiodiplodia* (Fig. 41) was also observed adult of Platypodidae and adults and larvae of Scolytidae.

During the study of the preserved material it was observed that the larvae were very fatty. The

conservative liquid remained with a layer of fat at the surface, especially after dissections.

## Host Plant

*Atractocerus brasiliensis* has been recorded from the wood of *Mangifera indica* ("mango"), *Mora excelsa*, *Prioria copaiifera*, and *Albizzia lebbeck* in Trinidad, Costa Rica and Barbados (Swabey 1935; Simmonds, 1956 *apud* Wheeler, 1986). This is the first record of this species as host of a Pinaceae (*Pinus oocarpa*). The genus *Pinus* was recorded among the arboreal hosts for the genus *Hylecoetus* (Batra & Francke-Grossmann, 1961 and Batra, 1967 *apud* Wheeler, 1986).

## RESULTS

### *Atractocerus brasiliensis* (Lepeletier & Audinet-Serville, 1825) (Figs. 1-44)

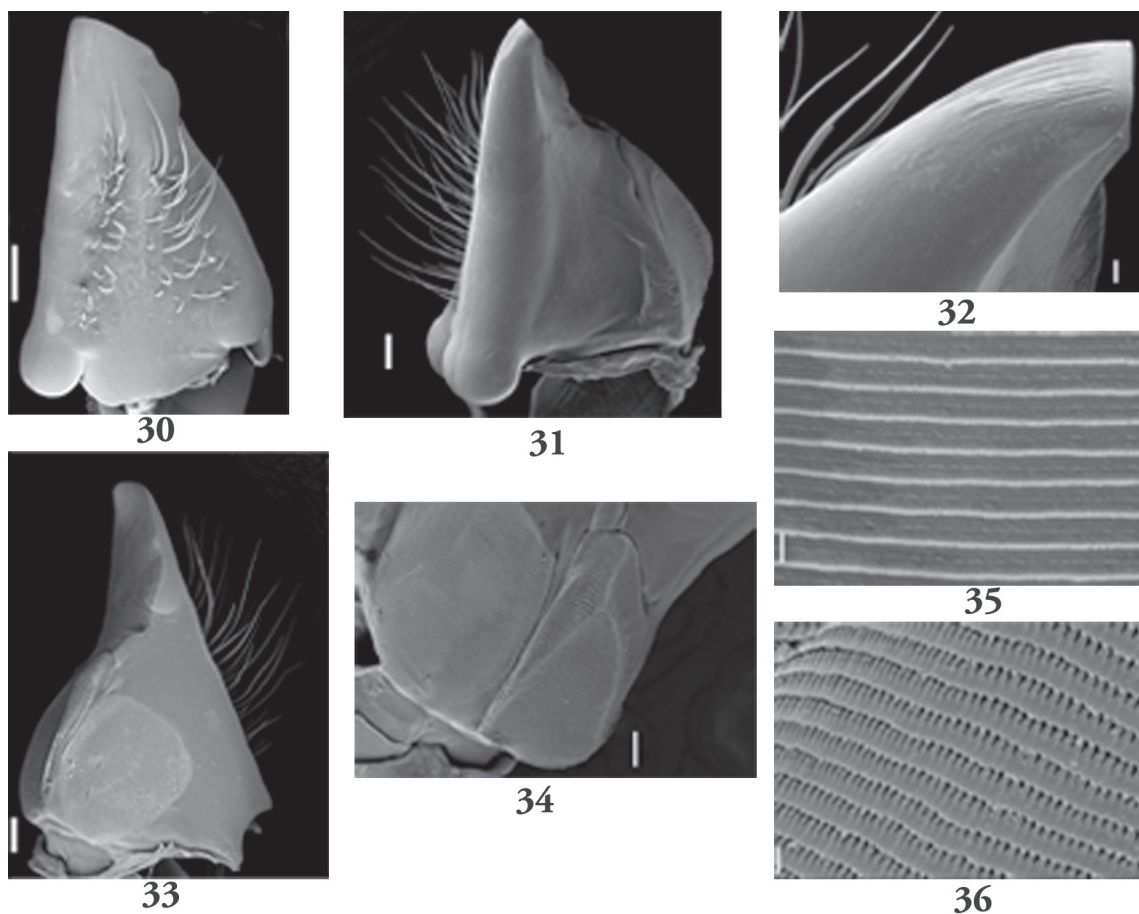
*Mature larva:* Length: 14-48 mm.

Body (Figs. 1, 2) elongate, cylindrical, orthosomatic, apparently softy, slightly dorsoventrally compressed, with small lateral folds forming partially sclerotized tubercles. General coloration (Figs. 41, 42) cream with anterior and lateral region of prothorax, legs (partially), spiracles, apex of lateral tubercles and apex of abdomen, yellow; head partially brownish. In preserved specimens, general coloration whitish with yellow pronotum, legs (except meso- and metafemora, whitish), apex of lateral tubercles, spiracles, apex of segment IX and segment X; brownish head (except clypeus, labrum and mandibles, black). General pubescence very short (except head and legs) and ferruginous; with spicules and asperites on integument.

Head (Figs. 3-5) hypognathous, retracted into large hoodlike pronotum, partially visible dorsally. Oval, heavily sclerotized, with darker transverse area on frons and longitudinal narrow band at border of maxillary insertions; coronal suture long, straight; endocarina long reaching anterior margin of frons; frontal arms U-shaped, ending at antennal base; a pale line starting laterally near mandibular base, reaching posterior margin of head. Head dorsally covered with long, dense and bristle setae; frontal area densely punctate. Stemmata absent. Antennae (Fig. 23) minute, dorsal, posterolateral to mandibles; with two antennomeres; antennifer partially membranous; basal antennomere larger, bearing at apex four stout long setae (dorsal longer), two short and wide setae near one digitiform

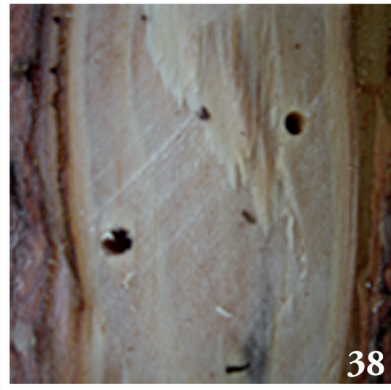
membranous sensorium; distal antennomere very small bearing at apex three stout setae (one ventral shorter). Frontoclypeal suture (Fig. 16) incomplete (absent at middle). Clypeus transverse, subtrapezoidal with distal margin widely notched and rounded, with many very long setae. Labrum (Fig. 16) slightly wider than long; distal margin straight with rounded angles; proximal margin wider, rounded and prominent at middle; an oblique row of long setae near each fore angle and many longer setae in an irregular row near base. Epipharynx (Figs. 17, 18) very prominent longitudinal medially (Fig. 18); distal margin straight with a large bundle of wide setae with truncate apex; each fore angle with three wide unciform setae; longitudinal median region raised and densely microsetous; two distinct, convergent setous areas near distal margin, fused at base forming a V-shaped area; each side of longitudinal median setous area with one large longitudinal striate declivous area (wing-like). Mandibles

(Figs. 26-29, 30, 31, 33) symmetrical, heavily sclerotized, broad, short, with wide apex (Fig. 32); molar area (Figs. 34, 36) well developed, with parallel rows of irregular teeth, perpendicular to longitudinal axis of mandible; apical half dorsally, slightly widened with subapical margin sinuous, forming two weak rounded teeth; well developed rounded striated area (Figs. 33-35) dorsally near mola; prostheca absent; external face (Figs. 28, 30) with many long setae. Maxilla (Fig. 19) elongate, bearing many long setae of varied sizes; cardo subtriangular, bearing several moderately long setae; juxtacardo distinct and glabrous; maxillary articulating area bearing long stout setae on distal half; stipes and mala fused; stipes elongate bearing ventrally and dorsally many long setae, more concentrated near lateroexternal margin; dorsally bearing near middle, elongate patch of microsetae with one long ramified seta near base. Mala (Figs. 20-22) partially divided into lacinia and galea; mesal surface of



**FIGURAS 30-36:** *Atractocerus brasiliensis* (Lepeletier & Audinet-Serville, 1825), larva. Mandible: **30**, lateral; **31**, ventral; **32**, apical region; **33**, dorsal; **34**, mola and sensorial dorsal area; **35**, detail of sensorial dorsal area; **36**, detail of mola. Bars = 200  $\mu$ m, except Fig. 32 = 20  $\mu$ m; 34 = 60  $\mu$ m; 35, 36 = 6  $\mu$ m.





**FIGURAS 37-44:** *Atractocerus brasiliensis* (Lepeletier & Audinet-Serville, 1825). 37, exit hole of adult; 38, holes under bark, indicating tunnel of larva; 39, tunnel of larva closed with frass; 40, larva inside a transversal tunnel; 41, larva removed from tunnel (*Lasiodiplodia* fungus, bluish stain); 42, larva removed from tunnel; 43, 44, adult in laboratory: resting on the bark and at ceiling of wood cage.

galeal lobe compressed laterally near apex; distal margin prominent and slightly rounded; dorsal margin bearing flat and very wide setae on distal third and fringe of long setae of varied sizes until base; ventral margin with dense fringe of wide setae (decreasing in thickness basad) on distal third and long and sparse setae more concentrate basad; internal face bearing spine-like setae, longer near dorsal margin and basad. Maxillary palpi (Figs. 20, 21) with three palpomeres: basal palpomere wider than long with band of long setae near middle; median palpomere slightly longer than wide with row of long setae near apex and shorter setae near margins; distal palpomere elongate, narrower than others, with several setae of varied sizes distributed by whole surface and several peg-like sensilla apically. Labium (Fig. 24): prementum short, transverse, strongly prominent medially at base, making basal half triangular; many stout and moderately long setae near middle; palpi with two palpomeres; basal palpomere slightly wider than long, with many stout moderately long setae and one campaniform sensillum at base, at limit of palpifer; distal palpomere elongate with one campaniform sensillum near lateral margin and some peg-like sensilla at apex; ligula narrow, elongate, longer than palpi, with four wide and short setae at apex (lateral longer); mentum elongate, slightly widened basad; anterior margin strongly notched at middle; median sclerotized area near base; one pair of long setae each side of sclerotized area; many stout moderately long setae concentrated laterally on basal 2/3 and near base each side of sclerotized area. Gular area (Fig. 5) setous on distal half. Hypopharynx (Fig. 25) elongate, widened basad; densely setous near apex; basal half with a large and raised triangular sclerite.

Prothorax longer than meso- or metathorax, hoodlike, partially covering head; expanded laterally forming two lobes each side; bearing dark spicules especially anteriorly; spicules (Fig. 9) more developed near lateral margins, becoming weaker to median direction. Intersegmental area between pro- and mesothorax bearing ventrally one pair of very large elliptical spiracles (Fig. 11). Meso- and metathorax band-like, bearing laterally one well-developed tubercle with asperites (Fig. 6). Legs (Fig. 2) inserted ventrally; coxae separate. Anterior leg (Fig. 12) shorter, more robust and darker; all legs (Figs. 12, 14) densely setous with long setae; anterior leg bearing asperites (Figs. 12, 13) on external side; coxa, femur and tibia elongate; trochanter subtriangular; tarsungulus (Fig. 15) with several long setae.

Dorsal region of abdominal segments I-VII bearing at middle, patch of asperites and setae, decreasing

in size apicad; in some segments patches divided into two parts.

Abdominal segments II-VII bearing lateroventrally two rounded small tubercles with apex sclerotized and bearing small carinae (Fig. 7). Dorsolateral anterior region of segments I-VIII bearing elliptical spiracles (Fig. 10), smaller than thoracics. Segment IX cylindrical, bulbous, upwardly directed with apex slightly sclerotized bearing many carinae. Segment X ventral, pygopod-like projection; each side with one large lobe with spicules at apex; anal region ventrally oriented; anal opening transversal with sclerotized margins.

## DISCUSSION

The larva of *Atractocerus brasiliensis* agrees with the second structural configuration of the ninth abdominal segment and tarsungulus defined by Wheeler (1991).

By comparing the larvae of *A. brasiliensis* with the description of *A. brevicornis*, it was possible to verify that they are very similar in shape. However, *A. brasiliensis* presents dorsal patches of asperites and setae on segments I-VII and two rounded lateroventral small tubercles with apex sclerotized and with small carina at segments II-VII; *A. brevicornis* is apparently smooth dorsally on abdomen. Besides, the epipharyngeal region distally presents three wide short setae on each side in *A. brasiliensis*, and a small area with fine and long setae in *A. brevicornis*. The ligula is very narrow, relatively longer with four short broad sensilla at apex in *A. brasiliensis*, and wide with two short broad sensilla at apex in *A. brevicornis*. In the description, the presence or absence in *A. brevicornis*, of the rounded striated dorsal area at mandibles and the distinct anterior legs is not mentioned.

The larvae of the *Atractocerus brasiliensis* and *Melittomma* sp., both described from Brazil, belong to different subfamilies, and consequently, are morphologically very different especially related to structural configuration of the ninth abdominal segment.

## RESUMO

*A larva de Atractocerus brasiliensis (Lepeletier & Audinet-Serville, 1825), coletada pela primeira vez em Pinus oocarpa Schiede ex Schltdl. (Pinaceae) é descrita e ilustrada. Até o momento, em Lymexylidae, apenas a larva de Melittomma sp. (Melittomminae) era conhecida do Brasil. Notas biológicas, uma comparação com a*



descrição de *A. brevicornis*, a espécie-tipo do gênero (da África e Madagascar) e o histórico das larvas de *limexilideo* conhecidas também estão incluídos.

PALAVRAS-CHAVE: América do Sul; Coleoptera; Fungo; Imaturos; Região neotropical.

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