



## Article

### Description of immature stages of *Phelypera schuppeli* (Boheman, 1834) with comments on natural history (Coleoptera: Curculionidae: Hyperinae)

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#### Abstract

Immatures of the *Phelypera schuppeli* (Boheman, 1834) (Curculionidae; Hyperinae; Cepurini) are described, illustrated and compared with available descriptions of larvae and pupae of Hyperini. Immatures and adults from midwest (Dourados, Mato Grosso do Sul; Pirenópolis, Goiás) and southeast Brazil (Bauru, São Paulo) were found on leaves of the host plant, *Pachira aquatica* Aubl. (Malvaceae, formerly Bombacaceae), a tree used as an ornamental plant in many Brazilian frost-free cities. Larvae of *P. schuppeli* are exophytic, brightly colored, eruciform and possess abdominal ambulatory ampullae, resembling larvae of Lepidoptera. Mature larvae can spin globular lattice-like cocoons where pupation takes place. Data in the field and under laboratory conditions confirmed previously published biological observations on *P. schuppeli*. Additional information about defensive behaviors, process of cocoon construction and natural enemies, such as the larval predator *Supputius cinticeps* (Stål, 1860) (Hemiptera: Pentatomidae) and the prepupal and pupal parasitoid *Jaliscoa nudipennis* Bouček, 1993 (Hymenoptera: Pteromalidae), are reported.

**Key words:** *Phelypera schuppeli*, larva, pupa, morphology, chaetotaxy, Cepurini, *Dysdercus*, *Jaliscoa*, Neotropical Region, *Pachira*, *Supputius*, weevil

#### Introduction

Unlike most other groups of Curculionidae (except some Cyclominae (e.g. *Gonipterus* Schoenherr, 1833 and *Listroderes* Schoenherr, 1826), Ceutorynchinae (e.g. *Pelenomus* C. G. Thompson, 1859) and Curculioninae (*Cionus* Clairville, 1798) (May 1994; Marvaldi *et al.* 2002; Skuhrovec 2008)), the larvae of Hyperinae do not live inside plant tissue, but instead are exophytic and spend all development time on or under the surface of their host plant leaves (Capiomont 1868; Lima 1956). The known larvae of species of the *Phelypera* are exophytic and ectophagous, brightly colored, eruciform, and possess abdominal ambulatory ampullae, thus resembling larvae of Lepidoptera. Mature larvae spin globular wide-laced cocoons where pupation occurs (Lima 1920, 1956; Bondar 1943).

*Phelypera* Jekel, 1865 presently includes 15 Neotropical species distributed from Mexico south to Uruguay and is represented in Brazil by 10 species. The last revision of the genus was published by Capiomont (1868), who recognized eight species, all of them currently valid (O'Brien & Wibmer 1982; Wibmer & O'Brien 1986). The knowledge of taxonomy and natural history of the Cepurini, the tribe to which the genus *Phelypera* is assigned, is scanty. *Phelypera* species are associated with species of the plant families Arecaceae, Malvaceae (formerly Bombacaceae), Fabaceae and Sterculariaceae (Silva *et al.* 1968; Janzen 1979). According to Silva *et al.* (1968) two species of *Phelypera* which occur in Brazil, *P. griseofasciata* (Capiomont, 1867) and *P. schuppeli* (Boheman, 1834), are associated with Malvaceae, the former with *Pachira aquatica* Aubl. ("manguba", "mongubeira", "mungubeira", "castanheira do Maranhão" or "Malabar Chestnut") and the latter with *Pachira insignis* Savigny ("Guiana Chest-

nut"). Lima (1920) recorded *P. schuppeli* in the state of Ceará, feeding on young leaves of *Bombax monguba* Mart., a junior synonym of *Pachira aquatica* Aubl., and described the cocoon constructed by the last instar larva. Bondar (1943) published detailed morphological and biological data on *P. griseofasciata* (misidentified as *P. pachirae* Marshall, 1929 in that paper, but subsequently corrected by the same author (Bondar 1945)). Bondar (*l.c.*) reported adults of *P. griseofasciata* feeding on the young leaves of *Pachira insignis* Savigny, in Bonfim, Bahia and noted that the weevil larvae were overlooked, at first glance, because of their very striking resemblance to caterpillars. Two more papers were published reporting biological aspects of *P. schuppeli* and in both of them the specimens were said to be collected on *Pachira aquatica* Aubl. Ferreira & Camargo (1989) studied the life cycle of *P. schuppeli* under laboratory conditions, while Diniz & Morais (1996) described parasitoidism by a pteromalid wasp and reported a marked polymorphism among the wasp populations.

*Phelypera distigma* (Boheman, 1842) is the most northerly species of the genus and ranges from Mexico through Central America south to northern South America, but it does not occur in Brazil (O'Brien & Wibmer 1982). Its host-plant is *Guazuma ulmifolia* Lam. (Sterculiaceae). The natural history of *P. distigma* was reported by Janzen (1979) in Costa Rica, and the peculiar behavior was extensively studied in Costa Rica and Mexico by Costa *et al.* (2004) and Fitzgerald *et al.* (2004). Fitzgerald *et al.* (2004) reported the trail marking, cycloalectic formation and processionary behavior of the larvae. Costa *et al.* (2004) used observational and experimental approaches to investigate the basis of the processionary and head-vibration behaviors.

As immatures of *Phelypera* are poorly described, we decided to provide a detailed morphological description of the last instar larva and pupa of *P. schuppeli* and give additional field and laboratory information on defensive behavior, the process of cocoon construction, and natural enemies that contribute to the natural regulation of the weevil populations.

## Material and methods

**Material examined.** The immatures and adults were collected on leaves of *Pachira aquatilis* Aubl. by D. de C. Bená in Dourados (Mato Grosso do Sul) and Bauru (São Paulo), and by F. F. Albertoni in Pirenópolis (Goiás). Field observations and laboratory rearing were conducted by D. de C. Bená and F. F. Albertoni. Larvae, some pre-pupae, pupae and reared adults were preserved in 70% ethanol. Adults collected in the field were dry pinned. Some cocoons with parasitized pre-pupae or pupae were glued on cardboards and also pinned. The following data are presented: state (bold), county (italic), host plant, date and collectors. Sergio A. Vanin determined the weevil species using literature and by comparison with identified specimens of the entomological collection in the Museu de Zoologia, Universidade de São Paulo (MZSP). All specimens are deposited in MZSP.

**Methods.** Terminology and abbreviations used in the larval and pupal description follow Burke (1968), May (1994), Marvaldi (1988) and Gosik & Skuhrovec (2011). Last instar larvae were dissected in water, under a Wild M5A stereomicroscope. Temporary slides were prepared using 100% glycerin. Drawings were done with the aid of a camera lucida, adapted to the stereomicroscope or a Leitz Microscope SM-Lux and processed using Adobe Photoshop CS3. Measurements were made with an eyepiece micrometer.

**Material examined.** BRAZIL. **Mato Grosso do Sul**, *Dourados*, on *Pachira aquatica* Aubl., 05.x.2010, D. C. Bená col., 76 cocoons with pre-pupae (4 dissected), 4 pupae, 6 adults (MZSP). **São Paulo**, *Bauru*, on *Pachira aquatica* Aubl., 28.xii.2010, D. C. Bená & J. Fuhrmann col., 2 larvae (1 dissected), 54 cocoons with pre-pupae, 1 pupa (MZSP); **Goiás**, *Pirenópolis*, in *Pachira aquatica* Aubl., 01.i.2011, F. F. Albertoni col., 10 larvae (3 dissected), 3 pupae (2 reared to adults) (MZSP).

## Results

### *Phelypera schuppeli* (Boheman, 1834)

(Figs 1–32)

**Mature larva description** (Figs 1–3). Length: 13.0–16.0 mm; head width: 1.4–1.5 mm. Body elongate and sub-cylindrical, slightly flattened dorsoventrally, lateral lobes prominent, abdominal segments I to V or VI widest, lateral margins of thoracic and posterior abdominal segments feebly convergent. Ventral side modified and adapted to

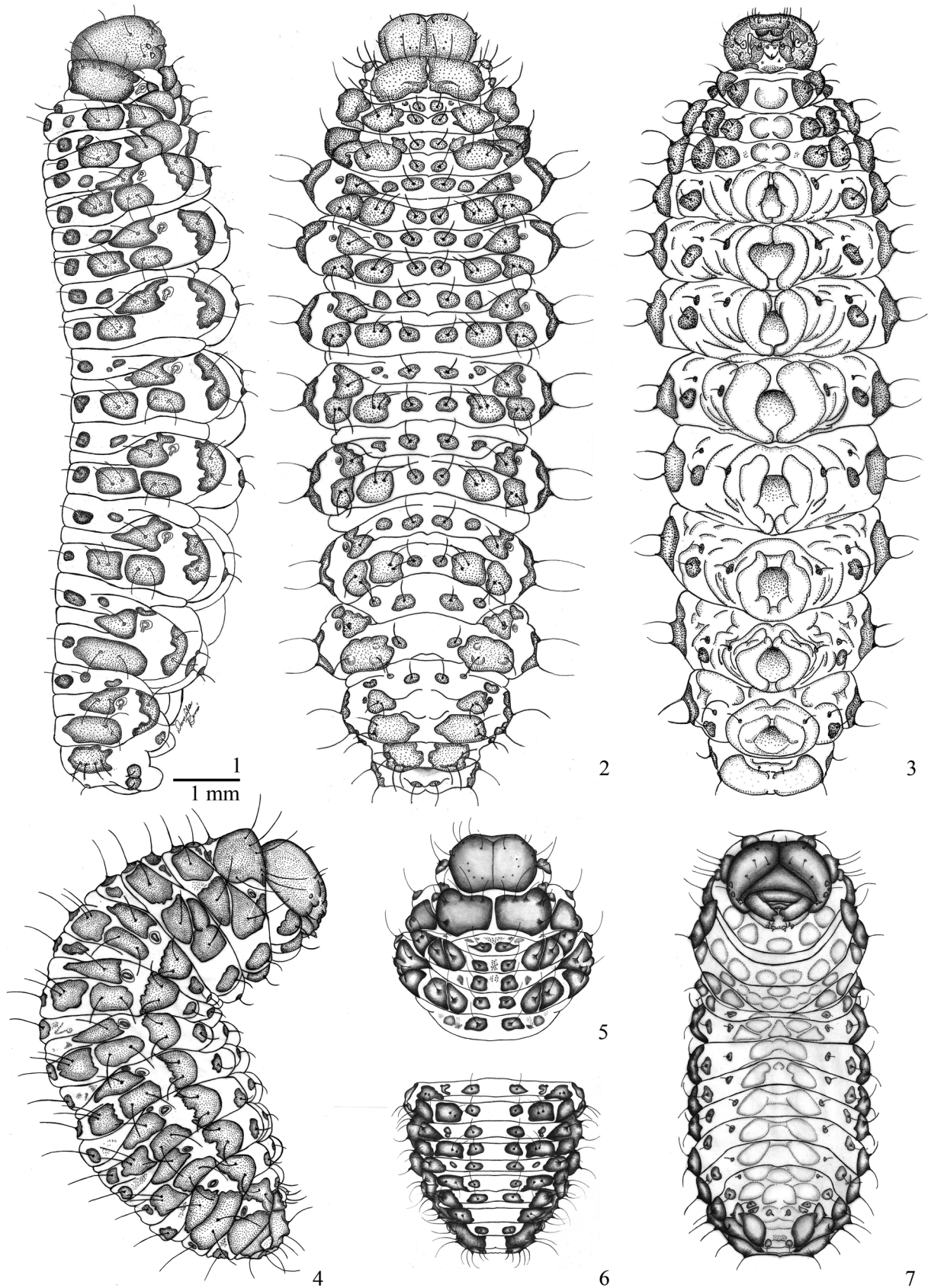
crawling. Median region of abdominal segments I–VIII with a pair of semi-circular protuberances which form eight ambulatory ampullae. Coloration: head capsule, mandibles, maxillae, pronotal shield and body sclerites dark brown to black, labrum and clypeus dark brown with two rounded lateral whitish patches, remaining of body bright yellow to greenish yellow with dorsal and lateral sclerotized spots dark brown to black. Dark spots with dark, curved and elongate hair-like setae.

Head (Figs 8–10) hypognathous, sclerotized, free, head capsule rounded in shape, about 1.4 times as wide as long. Epicranial suture distinct, approximately 0.45 times as long as head capsule. Frontal suture distinct, complete, weakly arcuate, V-shaped. Median endocarina absent. Postoccipital condyles absent. Hypopharyngeal bracon (*hyb*) present, clear (Fig. 9). One pair of convex stemmata present on each lateral side. Antennae exposed (Fig. 11), one-segmented, with conical accessory appendage elongate, about two times as long as basal width and with five minute processes. Head capsule with four pairs of dorsal epicranial setae (*des 1–4*), *des1* and *des3* positioned along frontal suture, *des2* and *des4* placed more laterally; four pairs of frontal setae (*fs*), *fs2* missing, *fs5* longer than *fs4*; two pairs of lateral epicranial setae (*les*), *les1* located between stemmata, *les2* placed near anterior angle of head capsule; four pairs of ventral epicranial setae (*ves*), *ves 4* placed on a prominent tubercle (*vt*) (Fig. 10). Epistoma and frontoclypeal sutures slightly arcuate. Clypeus (Fig. 12) transverse, with two pairs of clypeal setae (*cls 1–2*), anterior margin concave. Labrum (Fig. 12) transverse, with three pairs of labral setae (*lrms1–3*), anterior margin emarginate (sinuate), lateral margins rounded, posterior margin with median pigmented projection. Epipharynx (Fig. 13) with two pairs of anteromedian setae (*ams 1–2*), three pairs of anterolateral setae (*als 1–3*), 3 pairs of median setae (*mes1–3*) between dark, thick, elongate, convergent labral rods. Mandibles (Figs 14–16) symmetrical, stout, apically bidentate, inner margin with a small accessory teeth (Fig. 15), lateral margin with two long setae (*mds*). Maxillae (Figs 17 and 18) with cardo transverse, sub-rectangular; stipes elongate, with one stipal (*stps*) and two palpferral setae (*pfs1–2*) all equal length; mala rounded, with: two malar basiventral setae (*mbs*), five marginal dorsal short spatulate setae (*dms*) and five smaller ventral setae (*vms*) more or less aligned along outer margin; palpifer membranous; maxillary palpus two-segmented, proximal palpomere slightly larger than distal one, with a seta and two sensilla on ventral side. Labium (Figs 17 and 18): prementum with three pairs of setae, posterior pair very long, two anterior pairs very short; premental sclerite V-shaped, with an anterior median extension; labial palpi two-segmented, proximal palpomere transverse, much wider than distal palpomere, conical, slightly longer than wide; ligula with a V-shaped area bearing asperities; postlabium with lateral pairs of postlabial setae (*plbs*) much closer together than median pair.

Thorax (Figs 1–3, 24, 27 and 30). Pro-, meso- and metathorax transverse, width increasing backwards. Prothorax: pronotum with two transverse, large, contiguous sclerites, each one with six pronotal setae (*prns 1–6*); pedal area with one sclerite and two pedal setae (*pdas 1–2*); ventropleural lobe with an asetose sclerite; mediosternal fold with a sclerite and two mediosternal setae (*msts 1–2*); ambulatory ampulla lobate, asetose. Meso- and metathorax: prodorsum of meso- and metathorax with two pairs of dark sclerites, inner pair with one prodorsal seta (*prs*), outer pair of sclerites asetose. Postdorsum of meso- and metathorax with one pair of dark sclerites, each one with a postdorsal seta (*pds*). Alar area of meso- and metathorax with a rounded sclerite, with two alar setae (*as 1–2*); dorsopleural lobe of meso- and metathorax with a large irregular-shaped sclerite, each one with a dorsopleural lobe seta (*dpls*); ventropleural lobe, pedal area and mediosternal fold with one bisetose sclerite each (*vpls 1–2*, *pdas 1–2*, *msts 1–2*); ambulatory ampullae bilobate. Prothoracic spiracle (Fig. 19) bicameral, peritreme circular, air tubes with nine annuli, directed upwards.

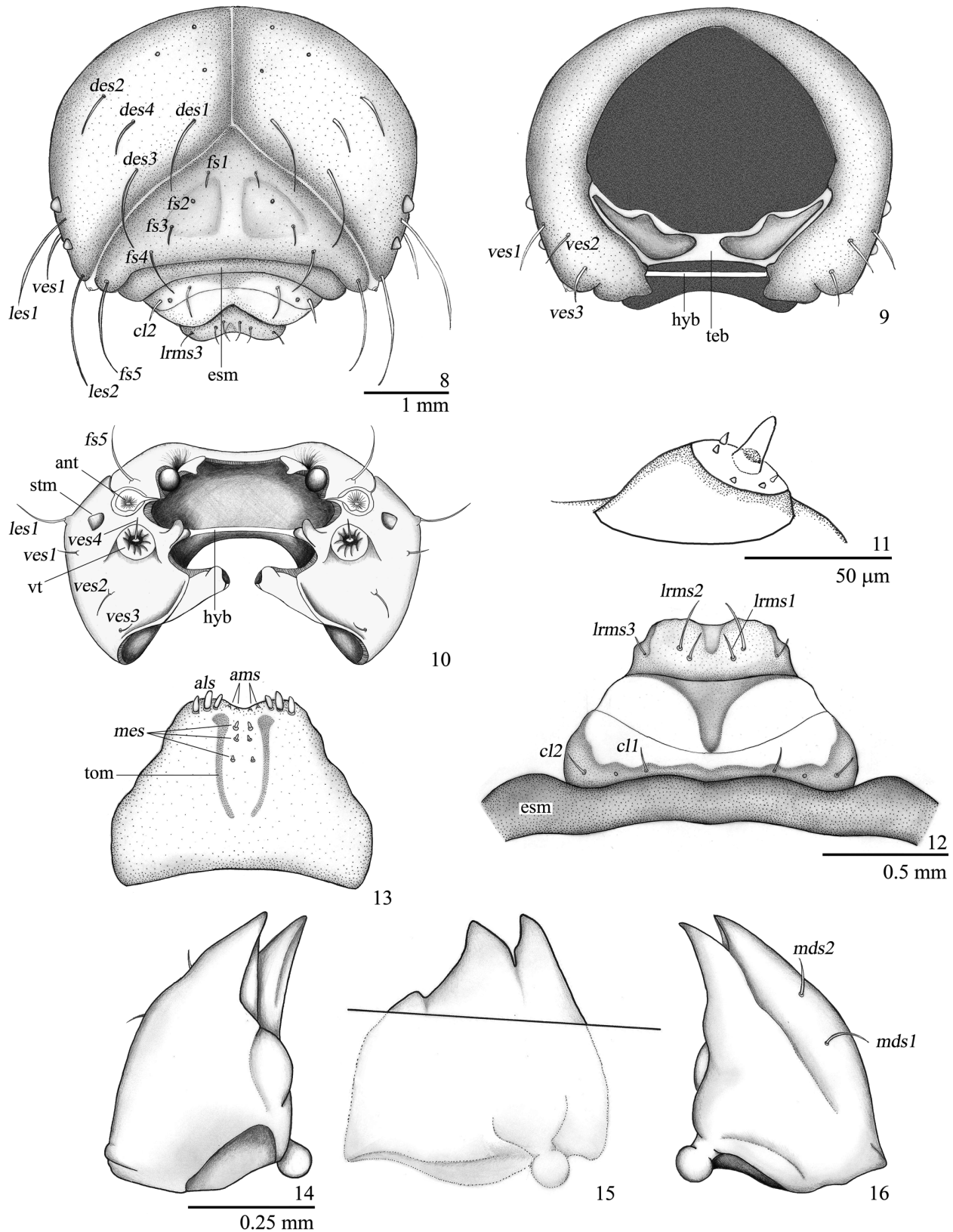
Abdomen (Figs 1–3, 25, 26, 28, 29, 31 and 32) with 8 pairs of lateral spiracles (Figs 20 and 21), bicameral, peritreme circular, air tubes with nine annuli, obliquely caudad; spiracles of abdominal segments I–VII similar, spiracles of segment VIII smaller, with air tubes directed backwards. Abdominal segments I–VIII each one with three folds, fold indistinct in segment IX. Dark sclerites and setation similar on segments I–VI (Figs 25, 28 and 31): prodorsum with one pair of sclerites, inner sclerite with a prodorsal seta (*prs*), outer sclerite asetose; sclerite of spiracular area triangular and unisetose (*ss*); postdorsal fold with one unisetose sclerite (*pds*); dorsolateral area with two bisetose sclerites (*dls 1–4*); dorsopleural lobe with a bisetose sclerite (*dpls 1–2*); ventropleural lobe, laterosternal lobe and mediosternal fold with a unisetose sclerite each (*vpls*, *lsts*, *msts*); ambulatory ampulla circular. Lobes and chaetotaxy of segment VII similar to I–VI (Figs 26, 29 and 32), but dorsolateral area with a single bisetose sclerite (*dls 1–2*). Lobes and chaetotaxy of segment VIII (Figs 26, 29 and 32) similar to segments I–VII, but spiracular area with two sclerites, the larger bisetose (*ss 1–2*); segment IX: dorsolateral area (Figs 26, 29 and 32) with a large sclerite with four dorsal setae (*ds 1–4*); pleural lobe (Fig. 32) with two contiguous sclerites, similarly sized

and unisetose (*ps* 1–2); ambulatory ampullae transversal. Segment X reduced, placed dorsally to segment IX (Fig. 26), with a pair of small, dark, unisetose sclerites; anus opening dorsally.

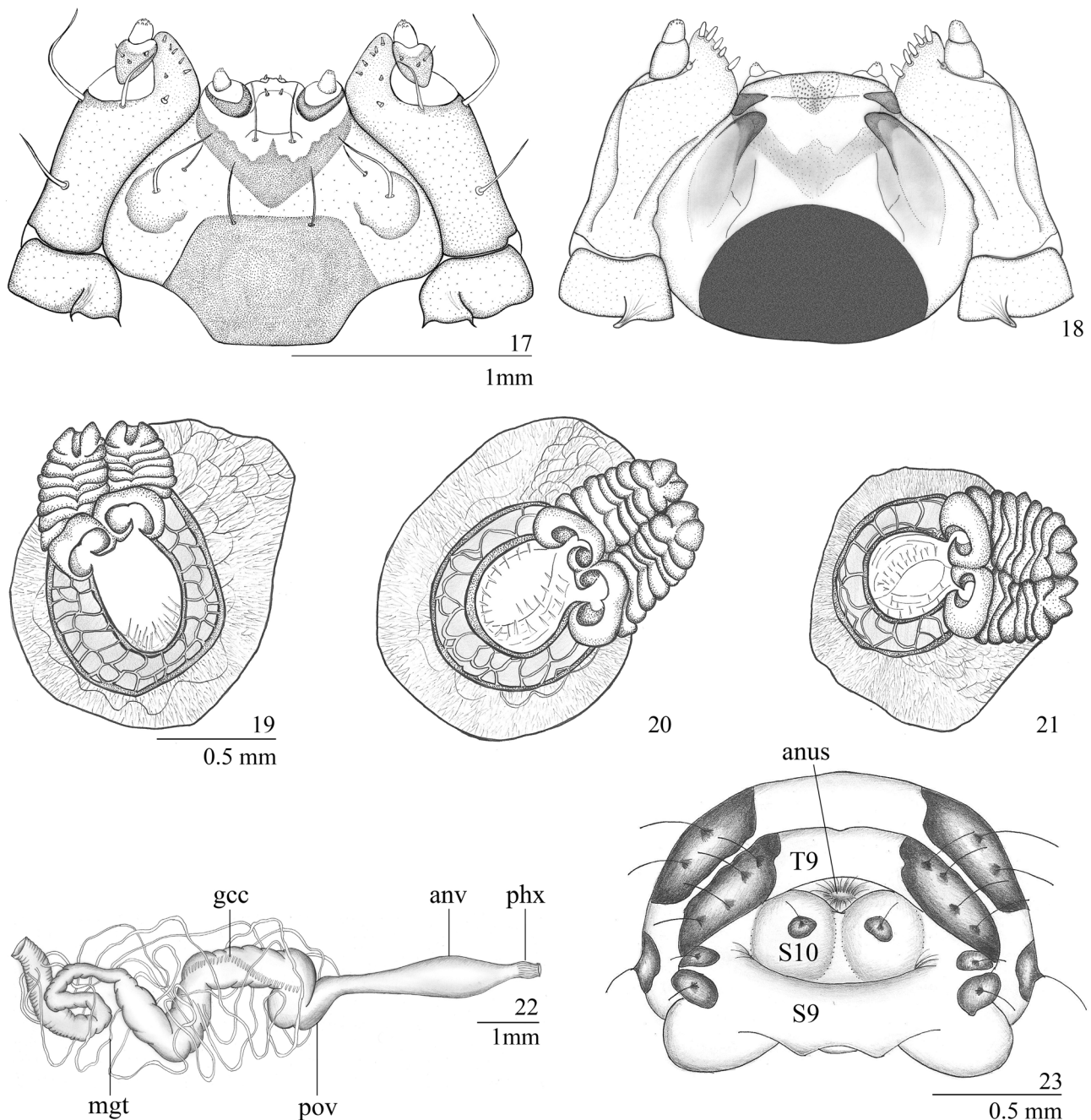


**FIGURES 1–7.** *Phelypera schuppeli* (Boheman, 1834), habitus of fourth instar larva: 1—lateral view, 2—dorsal view, 3—ventral view; habitus of pre-pupa: 4—lateral view, 5—antero-dorsal view, 6—postero-dorsal view, 7—ventral view.





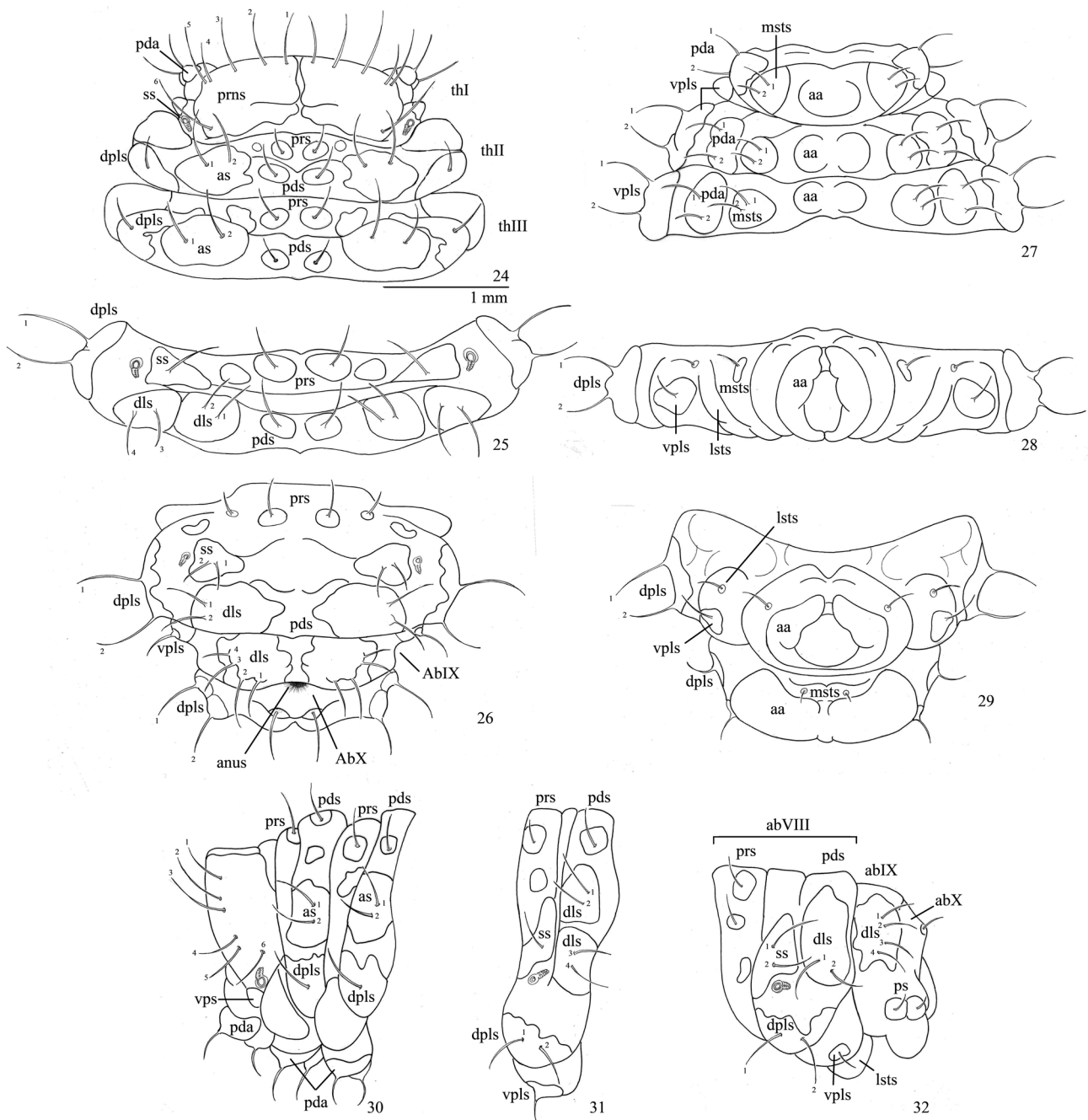
**FIGURES 8–16.** *Phelypera schuppeli* (Boheman, 1834), head and mouthparts of fourth instar larva: 8—head, frontal view, 9—posterior view, 10—ventral view, 11—antenna, 12—labrum, 13—epipharynx, 14—right mandible, dorsal view, 15—mesal, 16—ventral view (*ams*—anteromedian s., *als*—anterolateral s., *ant*—antenna, *cls*—clypeal s., *esm*—epistoma, *des*—dorsal epicranial s., *fs*—frontal s., *hyb*—hypopharyngeal bracon, *les*—lateral epicranial s., *lr*—labral rods, *lrms*—labral s., *mds*—mandibular s., *mes*—median s., *stm*—stemmata, *teb*—tentorial bridge, *ves*—ventral s., *vt*—ventral tubercle).



**FIGURES 17–23.** *Phelypera schuppeli* (Boheman, 1834), fourth instar larva, maxillo-labial complex: 17—ventral view, 18—dorsal view, 19—prothoracic spiracle, 20—spiracle of abdominal segment I, 21—spiracle of abdominal segment VIII, 22—alimentary canal, 23—abdominal segments VIII–X, posterior view. (*anv*—anterior ventriculus, *dms*—dorsally malar s., *gcc*—gastric caeca, *mbs*—malar basiventral s., *mgt*—Malpighian tubules, *pfs*—palpiferal s., *phx*—pharynx, *pov*—posterior ventriculus, *SIX*—sternite IX, *stps*—stipal setae, *SX*—sternite X, *TIX*—tergite IX, *vms*—ventrally malar s.).

Alimentary canal (Fig. 22) lacking mycetomes; posterior ventriculus two coiled, with about 36 short rodlike gastric caeca, nearly contiguous, arranged in a sinuous row on each side of lower ventricular coil. Malpighian tubules not thickened.

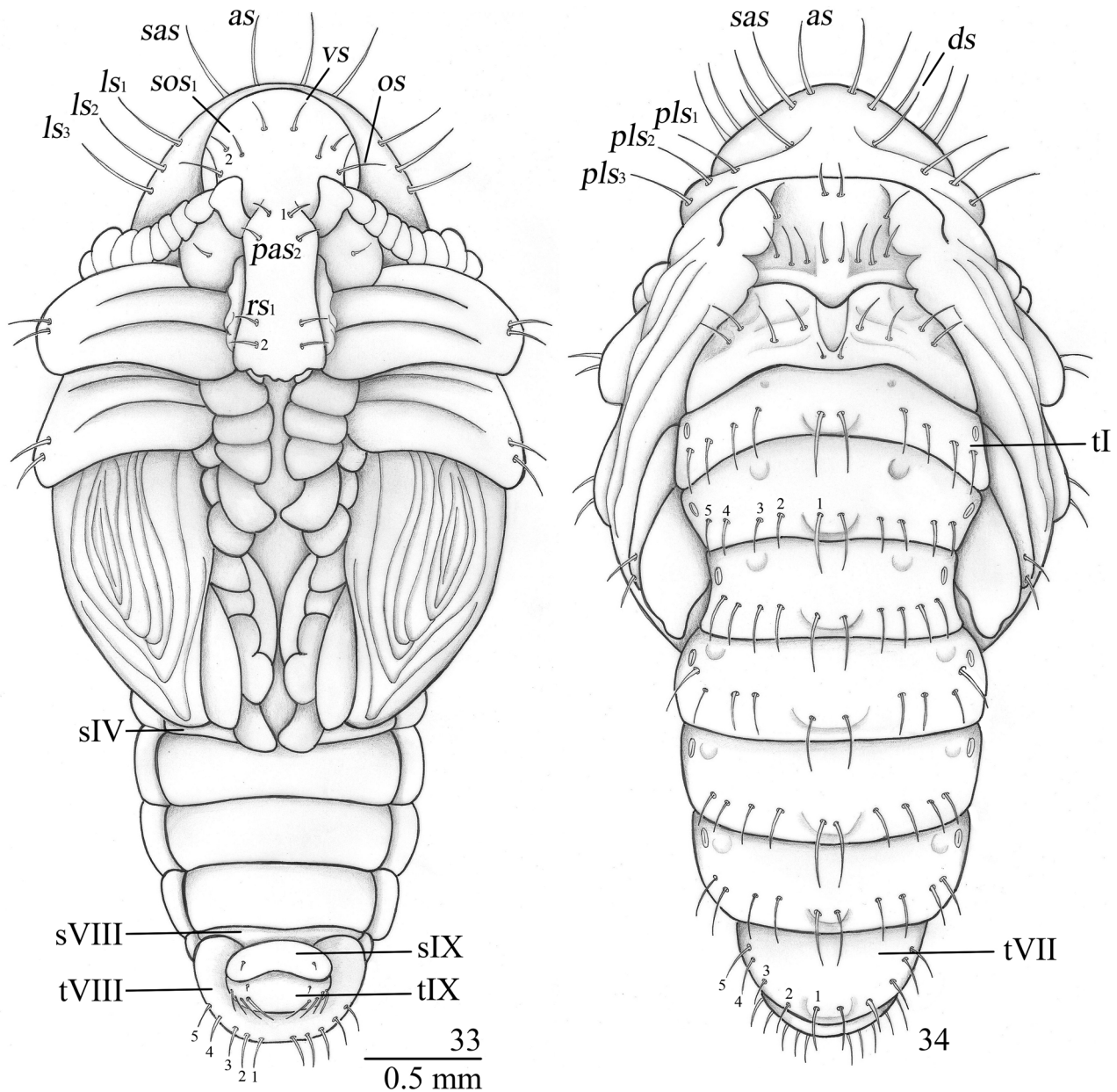
**Pre-pupa description** (Figs 4–7). Body stout, very shortened and curved, C-shaped. Color predominantly orange, not showing greenish shades, dark brown to black sclerites closely grouped and less distinct, last abdominal segments telescoped. Abdominal ambulatory ampullae retracted and almost indistinct.



**FIGURES 24–32.** *Phelypera schuppeli* (Boheman, 1834), fourth instar larva: 24—dorsal view of thoracic segments, 25—dorsal view of abdominal segment I, 26—dorsal view of abdominal segments VIII–X, 27—ventral view of thoracic segments, 28—ventral view of abdominal segment I, 29—ventral view of abdominal segments VIII–X, 30—lateral view of thoracic segments, 31—lateral view of abdominal segment I, 32—lateral view of abdominal segments VIII–X (*aa*—ambulatory ampullae, *ab*—abdominal segment, *as*—alar s., *dls*—dorsolateral s., *dpls*—dorsopleural s., *ds*—dorsal s., *lsts*—laterosternal s., *msts*—mesosternal s., *pda*—pedal s., *pds*—postdorsal s., *prns*—pronotal s., *prs*—prodorsal s., *ps*—pleural s., *ss*—spiracular s., *sts*—sternal s., *vpls*—ventropleural s., *th*—thoracic segment).

**Pupa description** (Figs 33 and 34). Length: 8.0–9.0 mm. Aedeiticous and exarate. Coloration cream, abdomen pinkish, with weakly curved setae, concentrated mainly on dorsal side. Head completely covered by pronotum when seen from above; on each side with one vertical setae (*vs*), two approximate short super orbital setae (*sos* 1–2) and one orbital setae (*os*) located near eye margin; rostrum with lateral margins arcuate, on each side with two short postantennal setae (*pas* 1–2) and two short rostral setae (*rs* 1–2). Pronotum conical, transverse, with two transverse lateral depressions; discal area with a pair of dorsal setae (*ds*); on each side with two pairs of apical setae (*as* 1–2), three lateral setae (*ls* 1–3), and three posterolateral setae (*pls* 1–3). Mesothorax with two setae located

medially near anterior margin, one pair located anterolaterally and eight setae located posteriorly and forming an irregular transversal row. Metathorax with eight anterior setae of similar length and one pair of shorter setae located posteromedially. Abdomen: segments I to VII with five pairs of setae, the median pair longer and placed over a weak protuberance; segment III strongly constricted, much narrower than segments II or IV; segments I–VI with a latero-dorsal dark pink rounded depression on each side. Each leg with two femoral setae (*fes* 1–2) of similar length. Pterothecae extending up to apex of fourth ventrite. Anterior coxae rounded and prominent, unisetose. Abdomen with six pairs of annular spiracles on segments I–VI, elongate oval, visible in dorsal view. Abdominal segment IX visible only in ventral view, tergal area with a group on four long setae on each side and a pair of micro-setae; sternal area with a pair of micro-setae.



**FIGURES 33, 34.** *Phelypera schuppeli* (Boheman, 1834), habitus of male pupa: 33—ventral view, 34—dorsal view (*as*—apical s., *ds*—discal s., *fs*—femora s., *ls*—lateral s., *os*—orbital s., *pas*—postantennal s., *pls*—posterolateral s., *rs*—rostral s., *sfs*—super lateral s., *sos*—super orbital s., *vs*—vertical s., SIV—sternite IV, SVIII—sternite VIII, SIX—sternite IX, TI—tergite I, TVII—tergite VII, TVIII—tergite VIII, TIX—tergite IX).

**Remarks.** The subfamily is divided into two tribes, the Holarctic Hyperini Marseuil, 1863 and the Ceperini Capiomont, 1867, distributed mainly in the Southern Hemisphere (Alonso-Zarazaga & Lyal 1999). Taxonomy and natural history of the Ceperini, is scanty. Only the ecology and behaviour of adults and immatures of *P. distigma*

are well known. Furthermore, no detailed descriptions of larva and pupa of any Cepurini species have been published thus we present a preliminary comparison with the described larvae of species of two genera of Hyperini: *Hypera* Germar, 1817 and *Donus* Jekel, 1865. Larvae of *P. schuppeli* are similar to that of *H. nigricornis* (Fabr., 1775) and *H. rumicis* (L., 1758) described by Scherf (1964), the latter redescribed by Skuhrovec (2006), larva of *H. punctata* (Fabricius, 1775) described by May (1993), larvae of 19 species of *Hypera* described or redescribed by Skuhrovec (2004 and 2006), and larvae of *Donus* described by Skuhrovec (2007). The known last instar larvae of *Hypera* and *Phelypera* share the frontoclypeal suture arcuate, premental sclerite sclerotized, V-shaped and well distinct. They differ mainly by the labial palpi which are 1-segmented in *Hypera* (May 1993 and Skuhrovec 2004 and 2006) but 2-segmented in *P. schuppeli*, and by the body hairs which can vary from hair-like to scale-like in *Hypera* while only hair-like setae occur in *P. schuppeli*. Larvae of *Phelypera* differ from larvae of species of the genus *Donus* mainly by the following characteristics present in *Donus*, according to Skuhrovec (2007) (characters of *Phelypera* parenthesis): frontoclypeal suture slightly concave medially (frontoclypeal suture arcuate), mandibles with three or four teeth apically (with two apical teeth), premental sclerite indistinct (premental sclerite sclerotized, V-shaped and well distinct). Another difference is the presence, in *Donus*, of club-like, bacilliform and hair-like setae, while in *Phelypera* the setae are hair-like.

The pupa of *P. schuppeli* (Figs 33 and 34) is very similar to that of *H. rumicis* (L. 1758), *H. nigrirostris* (Fabricius, 1775) and *H. postica* Gyllenhal, 1813 (as *H. variabilis* Hbst.) described by Scherf (1964), and *H. arundinis* (Paykull, 1792) described by Gosik (2007). We compare *P. schuppeli* with the latter since the description presented by Gosik (2007) is much more detailed than that presented by Scherf (1964). The main differences are the presence of 2 pairs of orbital setae (*os1* and *os2*) in *H. arundinis*, and one pair (*os1*) in *P. schuppeli*; abdominal segments I–VI with 16 dorsal setae in *H. arundinis* and 10 *ds* in *P. schuppeli*; and presence of 10 ventral setae in *H. rumicis* but *vs* absent in *P. schuppeli*; and the third abdominal segment which is constricted in *P. schuppeli* but not constricted in *H. arundinis*. The sexual dimorphism is similar in pupae of both species, the gonothecae are undivided in males and semicircularly divided in females.

Marvaldi (2003) published a preliminary but very useful key to larvae of the South American families and subfamilies of Curculionoidea, based on external morphological characters. In the Curculionidae, 18 subfamilies were considered, Hyperinae among them. Due to the lack of larval descriptions of South American Cepurini, characters of the larvae of Palaearctic Hyperini were used in the key. The larva of *P. schuppeli* would key out to couplet 20 in Marvaldi's key that leads to Hyperinae, agreeing in "frontal seta 5 (*fs5*) longer than frontal seta 4 (*fs4*); body pigmented, with ambulatory ampullae; ectophytic on leaves", but disagreeing in the following characters (characters of *P. schuppeli* parenthesis): head with maculae (head not maculate, uniformly dark colored); some dorsal setae of body short and expanded at apex (dorsal setae hair-like). More descriptions of Cepurini larvae are required to provide a better knowledge of the morphological character variation within the tribe and to supply a diagnosis for the tribe.

**Host plant.** *Pachira aquatica* Aubl. (Bombacaceae) is a tropical wetland tree which ranges from Mexico, through Central America and into Amazonian South America. It can grow up to 16 m and the seeds are edible (Lorenzi 2000). Due to its dense and spreading canopy, it was introduced as an ornamental shade tree for the urbanization of streets in many Brazilian cities (including Bauru, São Paulo; Dourados, Mato Grosso do Sul and Pirenópolis, Goiás, localities where the studied specimens were collected) located in frost-free areas outside its native range. The plant is cultivated in East Asia (Japan and Taiwan) as an interior decorative green plant and commercially sold on internet web sites under the name "money tree".

**Biological notes on natural history.** According to Ferreira & Camargo (1989) and Diniz & Morais (1996), oviposition can occur day or night. The eggs are laid in galleries constructed by females, with the help of rostrum, inside the central vein of the leaf or in the petiole of young leaves of terminal branches. Up to 80 eggs can be laid by one female inside the gallery. The eggs are elongate oval, measuring about 1 mm in length, and are light yellow. The eggs take three days to hatch and the emergence of the larvae is simultaneous. Larval development has four instars and lasts, on average, six or seven days. First instar larvae are about 1.5 mm in length. Fourth instar larvae collected by us in the field varied from 13 to 16 mm in length. Fourth instar larvae remain grouped on the adaxial leaf surfaces, forming groups of up to 50 individuals (Fig. 37). The larvae begin to eat holes in the leaves (Fig. 35), next they enlarge the feeding area including the lateral margins (Fig. 36) and eventually almost completely consume the leaf surface, leaving only the main veins untouched (Fig. 39). The larvae can partially destroy the apical meristemes and can be important defoliators of the host plant, as was observed for *Phelypera griseofasciata* by

Bondar (1943) and for *P. distigma* by Janzen (1979). Garcia (1999) sampled 1800 ornamental trees in the urban area of Goiânia (GO) and observed that *Pachira aquatica* was the most common, representing 62.7% of the trees, and *Phelypera schuppeli* was one of the five most frequent insects, occurring on 43.4% of the host trees; however, the damages caused by the weevil to its host were considered not as severe as those inflicted by two other beetles, *Steirastoma breve* (Sulzer, 1776) (Cerambycidae) and *Euchroma gigantea* (L., 1758) (Buprestidae).

The larvae are very conspicuous due to their bright black and yellow coloration (Fig. 37). It is likely that the coloration of *Phelypera* larvae is aposematic and directed against vertebrate predators (Janzen 1979, Costa *et al.* 2004), mainly insectivorous birds as suggested by Bondar (1943). The grouping behavior probably increases the warning effect against predators. Furthermore, the dorsum of some larvae observed in the field was covered with feces (Fig. 38), as already observed in *P. griseofasciata* by Bondar (1943) and in *P. schuppeli* by Ferreira & Camargo (1989). Feces are produced by the larvae themselves and held above their bodies with the aid of the long and stiff dorsal and lateral setae. The dorsal opening of the anus (Fig. 23) facilitates placement of the feces. Excremental covering behavior was reported in the Cepurini *Isorhinus undatus* (Champion, 1902) in Panamá by Aiello & Stockwell (1996) and *Haplopodus submarginalis* (Boheman, 1840) in Rio de Janeiro, Brazil by Abreu *et al.* (2003). It is also known in other exophytic beetle larvae such as Cassidinae and Criocerinae (Chrysomelidae) and Cionini (Curculionidae) (Crowson 1981). This kind of camouflage was not mentioned for *P. distigma* by Fitzgerald *et al.* (2004) and Costa *et al.* (2004), and was not observed in the Bauru (São Paulo) and Dourados (Mato Grosso do Sul) populations of *P. schuppeli*, represented by mature larvae. The cycloalectic formation (*sensu* Jovilet *et al.* 1990) characteristic for *P. distigma* (Fitzgerald *et al.* 2004 and Costa *et al.* 2004) has not been observed in *P. schuppeli*, neither in the field nor in the laboratory. The circular aggregation reported for *P. distigma* by Fitzgerald *et al.* (2004) and Costa *et al.* (2004) has not been observed either.

Three distinct behaviors using mandibles were observed in *P. schuppeli*: **a)** larvae can grab the margin of an adjacent leaf with their mandibles, making it possible for their bodies to pass from one leaf to another thus facilitating dispersal or escape; **b)** larvae can strongly hold onto a leaf with their mandibles making difficult to dislodge them, as was also reported for *P. distigma* by Fitzgerald *et al.* (2004); and **c)** larvae can try to or actually bite when disturbed by an aggressor. Also, when disturbed, the larvae can wag the head towards the disturbance, if as wanting to strike something. Occasionally, the larvae can raise the anterior fourth of the body backwards, looking like an inverted C-shape. The larva can move alternately the raised portion of the body forwards and backwards, or remain motionless with the head directed backwards. This behavior is different from the head vibration performed by moving larvae of *P. distigma* and may be associated with acoustic or vibrational communication among conspecifics, inciting group activity (Costa *et al.* 2004). It was also observed that the larva can eject a dark liquid from its mouthparts, a defensive behavior, well known in other insects, and described for *P. schuppeli* by Ferreira & Camargo (1989) and for *P. distigma* by Fitzgerald *et al.* (2004).

The globular lattice-like pupal cocoons are translucent white (Figs 40–45). In the field they were found attached to the adaxial face of the leaves, usually forming clusters, sometimes one cocoon above the other (Fig.40). A few cocoons were also found attached to the ground. The cocoon is built by the last instar larvae with materials extruded from their anus. According to Crowson (1981), the nature and origin of these substances have scarcely been investigated, and the material in weevils is most probably formed by the peritrophic membrane rather than produced by the Malpighian tubules, the latter being the usual source in the Coleoptera. However, Kenchington (1982) published a X-ray diffraction study on the larval cocoon silk of the weevils *Hypera postica* (Gyllenhal, 1833) and *H. rumicis* (L., 1758) and showed using histological preparations of larvae about to spin the cocoon, that the lumen of the Malpighian tubules were filled with silk secretion, and that the silk was most likely secreted by the Malpighian tubules and stored in the rectum. Our observations of the mature larva of *P. schuppeli*, showed that, with the help of the mouthparts, the larvae gather the liquid secretion extruded from the anus (Fig. 43) and rapidly place it – as it hardens very quickly – on the adaxial face of the leaf surface such that it forms the attachment point of the cocoon. Next, the larva catches more material from the anus and molds strings with the mandibles, which are stuck to the cocoon base. The larva continues catching secretion, molding strings, and building an irregular and very loose lattice around its body (Figs 41 and 42). The remarkable aspect of the construction is how the larva gives the final shape to the cocoon, by building, tearing up and rebuilding it. By pressing the body against the newly constructed lattice, over and over, the larva breaks and stretches some parts of the not yet completely hardened cocoon mesh (Fig. 41). Immediately after, the larva repairs the damage, constructing a new set of strings or reinforcing the old ones. The entire process of cocoon construction takes approximately two hours and agrees well with the observations published for *Coniatus repandus* by Fornasari (2004).





**FIGURES 35–40.** *Phelypera schuppeli* (Boheman, 1834): 35—small hole made by larva on leaf of *Pachyra aquatica* Aubl., 36—larva eating, note leaf margin beginning to be destroyed, 37—group of four larvae, 38—larvae with dorsum covered with feces, 39—leaf almost completely eaten by larvae, 40—cocoon with pre-pupae and pupae (photos: 35, 39 and 40 by D. de C. Bená, 27–29 by F. F. Albertoni).





**FIGURES 41–46.** *Phelypera schuppeli* (Boheman, 1834): 41—larva building an irregular and very loose lattice around its body, 42—detail of larva molding strings and building the cocoon walls, 43—detail of larva gathering liquid secretion extruded from the anus, 44—pupa inside cocoon, 45—opening cut in the lattice wall to show mature pupa inside the cocoon, 46—teneral adult feeding completely on the cocoon walls (photos by F. F. Albertoni).





**FIGURES 47–52.** Natural enemies of *Phelypera schuppeli* (Boheman, 1834): 47—pentatomid *Supputius cincticeps* sucking a larva, 48—pyrrhocorid *Dysdercus* sp. feeding on the dead body of a parasitized pre-pupa inside the cocoon, 49—pupae of the parasitoid wasp *Jaliscoa* sp. inside weevil cocoon, 50—habitus of female parasitoid wasp *Jaliscoa* sp., 51—female head of *Jaliscoa nudipennis*, 52—male head of *J. nudipennis* (photos: 47–49 by F. F. Albertoni, 50–52 by V. A. Costa).

As soon as the construction of the cocoon is accomplished, the larva defecates. Next, the yellowish shades of the body coloration starts to change to orange, the body bends and shortens, the larva molts and the pupa emerges. The pupa remains free inside the cocoon (Figs 44 and 45). The pupal phase lasts about four days. The teneral adult remains about 12 hours inside the cocoon and breaks the lattice walls of the cocoon with its mandibles to get free (Ferreira & Camargo 1989). Just after getting free, the adult feeds on completely the cocoon (Fig. 46) and disperse. The same behavior was observed in the Cepurini *Ishorhinus undatus* by Aiello & Stockwell (1996); however, in the Hyperini *Donus velutinus* (Boheman, 1842) and *Coniatus repandus* Germar, 1817, the adults ate their way out of the cocoons but did not consume them completely (Fornasari 2004; Skuhrovec 2009).

Adults of *P. schuppeli* feed on the young branches, unlike the larvae which prefer the young expanding leaves. The length of the entire cycle, from egg to adult, under laboratory conditions lasts about 16.6 days (Ferreira & Camargo 1989). Ferreira & Camargo (1989) and Diniz & Morais (1996) reported many aspects of the biology of Pteromalidae parasitoids that attack pre-pupae and pupae of *P. schuppeli*. During our study, we discovered some other aspects regarding possible natural enemies of *P. schuppeli*. We observed larvae of *P. schuppeli* being fed upon in the field (Pirenópolis, GO) by two species of Heteroptera. Photographs were sent to Dr. Jocélia Grazia Vieira (Universidade Federal do Rio Grande do Sul) who identified the species as *Dysdercus* sp. (Pyrrhocoridae) and *Supputius cincticeps* (Stål, 1860) (Pentatomidae). *Dysdercus* sp. was found feeding on the dead body of a parasitized pre-pupa inside the cocoon (Fig. 48). The genus *Dysdercus* comprises phytophagous species, but some are known to resort to cannibalism or necrophagy in search of water (José Antônio Marin Fernandes, pers. comm.; Goodchild 2009). Aiello & Stockwell (1996) also reported *Dysdercus* sp. feeding on larvae of *Isorhinus undatus* that were in the process of making their cocoons. According to those authors (*l.c.*), in Panamá, these bugs are normally seed predators of *Pseudobombax* spp. (Malvaceae). However, attacks by species of *Dysdercus* on active feeding larvae of Hyperinae were not observed. *Supputius cincticeps* was observed sucking a weevil larva, holding its body with the rostrum (Fig. 47). Fitzgerald *et al.* (2004) reported a species of Pentatomidae piercing the larva of *P. distigma* and dragging it from a small cycloalectic formation. Ferreira & Camargo (1989) also noticed predation of *P. schuppeli* larvae by unidentified assassin bugs (Reduviidae).

We observed micro-wasps passing through the cocoon meshes to lay eggs inside the pre-pupa. The wasps (Fig. 50) were identified by Dr. Valmir Antonio Costa (Instituto Biológico de Campinas, SP) as *Jaliscoa nudipennis* Bouček, 1993 (Pteromalidae). The wasps seemed to select the intersegmental lateral and ventral regions of the abdomen as oviposition sites, usually between the segments III/IV and IV/V. When molested by wasps, the weevil pre-pupa can quickly turn around its body inside the cocoon, thus hampering the parasitoids to lay their eggs. However, this behavior is not effective enough to deter the wasps from ovipositing. According to Bondar (1943), parasitoid wasps can also lay the eggs inside the pupae of *P. griseofasciata*. The pre-pupal phase lasts 3.8 days in healthy individuals but consumes more time in parasitized ones, according to Ferreira & Camargo (1989). This longer time may be caused by the parasitoids, which can release chemicals that inhibit or delay the ecdysis to the pupal phase (Sharkey & Fernández 2006). The parasitoidism results in the shrinkage and death of pre-pupae or pupae, as observed by previous authors (Bondar 1943; Ferreira & Camargo 1989; Diniz & Morais 1996). The wasp larvae leave the host and spin a cocoon which is attached by a posterior peduncle to the weevil cocoon (Fig. 49), as reported by Lima (1956) and Diniz & Morais (1996). As soon as the adult wasps emerge, they begin to copulate. Wasps are short-lived and die two to three days after the adult emergence.

*Jaliscoa nudipennis* is remarkable in the strong polymorphism of the male head, which varies from small round (as in females, Fig. 51) to large transversely diamond shaped and with eyes more distantly separated (Fig. 52). Parasitoidism of wasps on pre-pupae of *P. schuppeli* was previously reported by Lima (1920), Ferreira & Camargo (1989), and Diniz & Morais (1996), probably by the same species of Pteromalidae. Ferreira & Camargo (1989) sent pteromalid wasps to Dr. E. Eric Grissel (Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington), who identified the species as belonging to a new genus near *Trichokaleva* Bouček, 1972. According to Dr. Walmir Costa (pers. comm.), Diniz & Morais (1996) have collected the same wasp species on *P. schuppeli* between 1990 and 1992. On that occasion, wasps were sent to Dr. Zdeneck Bouček (The Natural History Museum, London) who identified the pteromalid as belonging to an undescribed genus related to *Psilocera* Walker, 1833. Dr. Bouček described the genus *Jaliscoa* in 1993, based on a single female from Jalisco (Mexico) and without host record, but unfortunately he had no time to study and include the Brazilian specimens sent by Dr. Diniz and Dr. Morais in his paper, which was concerned with North and Central American species of Pteromalidae and Tetracampidae. Voucher specimens of *Jaliscoa nudipennis* were deposited in the MZSP.

Our data support the hypothesis that cocoons provide an anchorage point to accommodate a pupa restraint to the leaf substrate, but not that they afford protection against the attacks of parasitoids and some predators. However, Aiello & Stockwell (1996) reported a failed attempt of an assassin bug to pierce an immature of *Isorhinus undatus* inside a cocoon. They suggested that the cocoon can protect the weevil immatures from some predators, mainly bugs, because the holes are small enough to prevent the predator's rostrum from reaching the cocoon occupants. Further observations would be desirable to clarify this matter.

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