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Population dynamics and description of larva and pupa of *Cyclocephala tucumana* Bréthes, 1904 in West-Central Brazil, and remarks on immatures of other *Cyclocephala* species (Coleoptera: Scarabaeidae: Dynastinae)

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ABSTRACT

Some species of *Cyclocephala* Dejean, 1821 (Coleoptera, Scarabaeidae, Dynastinae, Cyclocephalini) were reported as crop or pasture pests. Within this genus, *Cyclocephla tucumana* Bréthes, 1904 was noticed in cultivated areas in South Brazil, 2009 – 2010. Other study found larvae of the species associated with pastures in Aquidauana, Mato Grasso do Sul State (MS), 2009. In the present study, larvae of *C. tucumana* were collected in pasture areas from August 2015 to July 2016, in Cassilândia, MS. The material was reared in laboratory for the description of immatures, and the regional population was studied to clarify its dynamics. Immatures were abundant throughout the years and are described for the first time. Taxonomic discussion, updated key to larvae and pupae, and a teratological note are also added.

Introduction

Cyclocephala Dejean, 1821 (Cyclocephalini) is the largest genus of Dynastinae, which is a speciose subfamily of phytophagous Scarabaeidae (Melolonthidae *sensu* Cherman and Morón, 2014). The genus includes about 300 species (Ratcliffe and Cave, 2002) and 83 of them are registered in Brazil (Morón, 2004).

ssociated with several crops and can feed on cultivated plants roots. Larvae of *C. forsteri* Endrödi, 1966 (Coutinho et al., 2011), *C. lunulata* Burmeister, 1847 (Aragón-García and Morón, 2000), *C. parallela* Casey, 1915 (Cherry, 1985; Gordon and Anderson, 1981), and *C. verticalis* Burmeister, 1847 (Coutinho et al., 2011) were found in sugarcane crops (*Saccharum officinarum* L., Poaceae). Morón et al. (2014) described the immatures of *C. barrerai* Martínez, 1969, *C. faciolata* Bates, 1888, *C. lunulata*, and *C. sinaloae* Howden and Endrödi, 1966 feeding on roots of sugarcane, maize (*Zea mays* L.), and other grasses (Poaceae).

On the other hand, some cyclocephaline larvae feed on soil organic matter, such as *C. flavipennis* Arrow, 1914 (Salvadori and Pereira, 2006) and *C. paraguayensis* Arrow, 1904 (Albuquerque et al., 2014). Despite species richness and economic importance, descriptions of immatures of *Cyclocephala* are scarce (Morón et al., 2014). Before the present study, 21 species have their larvae described (see Rodrigues et al., 2018).

Regarding adults of *Cyclocephala*, several data on biology, life cycle, association with plants, and sexual behavior have been provided (e.g. Maia and Schlindwein, 2006; Maia et al., 2013; Mondino et al., 1997; Moore and Jameson, 2013; Nogueira et al., 2013; Oliveira and Ávila, 2011; Rodrigues et al., 2010, 2018).

In a preliminary effort to verify species of phytophagous scarabs associated with pastures in Cassilândia, Mato Grosso do Sul State (MS), Brazil, larvae of *C. tucumana* Bréthes, 1904 were collected and reared in the laboratory. Biological data of this species are known (Nogueira et al., 2013) and adults are visitors of passion flowers ("maracujá," *Passiflora edulis* Sims, Passifloraceae; Dias and Rodrigues, 2018). The purpose of the present study is to describe the morphology of immatures, clarify the taxonomy of this genus, and add new data of the population dynamics of the species. A report for pupa teratology is also added.

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Material and methods

Larvae of *C. tucumana* were collected at Chácara Buritizinho, a 60-hectare farm in the municipality of Cassilândia, MS, from August 2015 to July 2016. The experimental area is a pasture (*Urochloa decumbens* Stapf, Poaceae).

For immature collection, each sampling site consisted of a 25 cm^2 by 25 cm deep soil quadrant (Pardo-Locarno et al., 2005). A quadrant was buried every 15 days, totaling 51 quadrants. The collected material was taken to the laboratory of entomology of the Universidade Estadual do Mato Grosso do Sul (UEMS), Cassilândia. The rearing procedure followed Coutinho et al. (2011).

Some reared adult specimens (Fig. 1) were sent to Prof. Dr. Paschoal Coelho Grossi (Universidade Federal Rural do Pernambuco, Recife) for species identification.

Third-instar larvae and pupae were killed in boiling water and preserved in 70% alcohol. Observations and drawings were carried out in a Motic stereomicroscope, Zeiss Stemi SV6 stereomicroscope or Zeiss Axioscop microscope, the last two with a coupled light camera. Detached larval structures (e.g., mouthparts and legs) were slide mounted on Hoyer's medium (Johnson and Triplehorn, 2005). Part of the material was deposited in the UEMS entomology collection and part was deposited in the collection of the Museu de Zoologia da Universidade de São Paulo, São Paulo (MZSP). Photographs were taken with a Canon Rebel T3i DSLR camera with a Canon MP-E 65 mm f/2.8 lens and a dome illumination system (Kawada and Buffington, 2016), being processed using the Zerene stacker (Zerene Systems LLC, Richland, Washington, United States of America). Adobe Photoshop CS6 software was used for image processing. Cranium width, thorax width, and total length (mm) of each specimen were determined using a micrometer.

The terminology used followed Böving (1936) and Lawrence (1991) with some modifications by Sousa et al. (2018). Head chaetotaxy followed Ritcher (1966) and Sawada (1991), as summarized by Sousa et al. (2018). Lobes of thorax and abdomen followed Rodrigues et al. (2018). Hair-like setae were separated into the two well-defined groups minute setae or short–long setae (modification of Šípek et al. 2008; see Rodrigues et al. 2018).

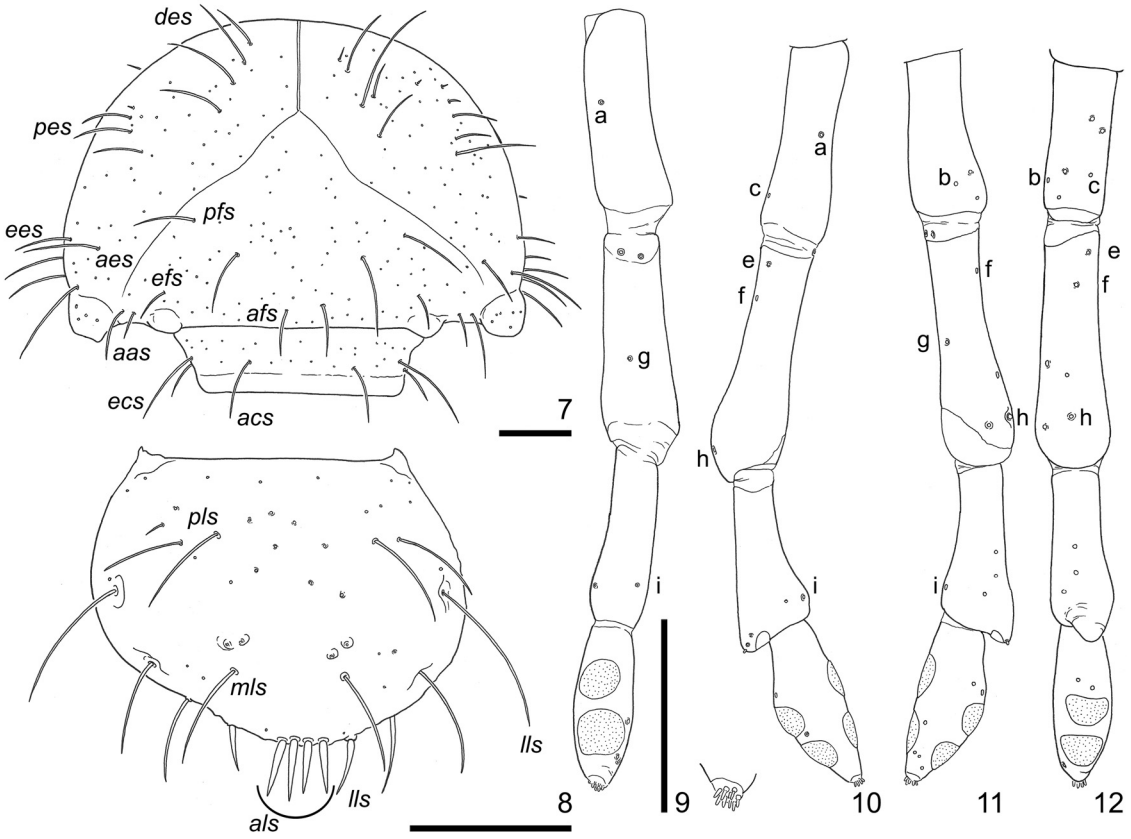
Results

Cyclocephala tucumana Bréthes, 1904

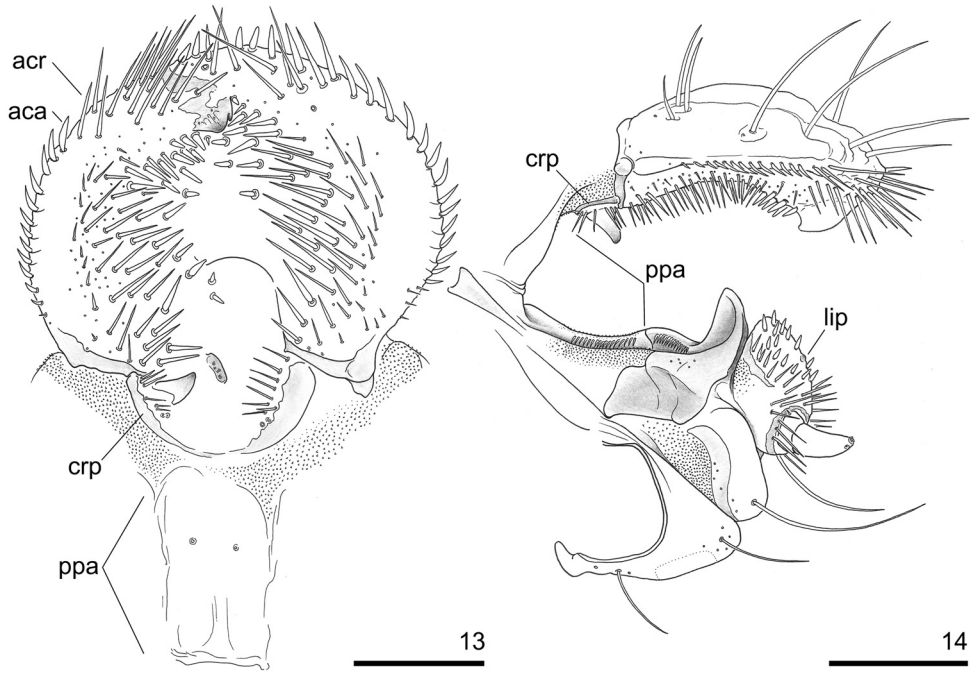
Third-instar larva (Figs. 3, 4, 7–44). Body (Fig. 3) length 17.41 mm (12.4–23.0), cranium width 3.3 mm (2.1 – 4.4), thorax width 4.96 mm (3.3–6.0); yellowish white, head and respiratory plates yellow; surface setose, setae yellowish brown. **Head** (Figs. 4, 7, setation in Table 1). Epicranial and epistomal sutures distinct; stemmata absent; antennifer somewhat cylindrical and with 4–7 punctures; cranium, clypeus, and labrum (Figs. 7, 8) with homogeneously distributed punctures, except in the anterior area of labrum. Each half of cranium and clypeus with (Fig. 7): 4–5 long and 0–2 minute dorsoepicranial setae (*des*), 4–6 long and 0–2 minute posteroepicranial setae (*pes*), 1–2 long anteroepicranial setae (*aes*), 5–9 long externoepicranial setae (*ees*), 2 long and 0–1 minute posterofrontal setae (*pfs*), 1 externofrontal seta (*efs*), 2–3 long anterofrontal angle setae (*aas*), 2 long anterofrontal setae (*afs*), 2 long externoclypeal setae (*ecs*), 1 long anteroclypeal seta (*acs*). Each half of **labrum** (Fig. 8) with 2–3 long posterolabral setae (*pls*), 1 long mediolabral seta (*mls*), 4 long laterolabral setae (*lls*), and 2–3 long anterolabral setae (*als*). **Antenna** (Figs. 9–12) with 4 antennomeres: I with 7 sensilla (1 dorsal, 1 outer, 5 ventral); II with 9 sensilla (3 dorsal, 6 ventral); III with 5 sensilla (2 dorsal, 3 ventral), ventrodistal process bearing a dorsal sensorial spot and 3 distal sensilla; IV with 7 sensilla (1 inner, 4 outer, 2 ventral), 2 dorsal and 2 ventral sensorial spots, and a distal sensorial area bearing about 9 prominent minute sensilla. **Epipharynx** (Figs. 13, 14). *Corypha*: epizygum distinct and clithra absent. *Haptomerum*: zygum beak-like, 2-toothed and with about 3 sensilla; heli absent. *Paria*: acroparia evidently separated from chaetoparia and right side with about 20 setae, left side with about 12 setae; each side of acanthoparia with 12 anterior setae and 1–4 minute posterior setae; gymnoparia narrow; right chaetoparia with 57–63 setae and 36–46 sensilla, left chaetoparia with 49–57 setae and 17–22 sensilla; dexiotorma slightly longer than laeotorma, left pterotorma rounded, apotorma indistinct, epitorma as an impressed rounded sulcus; plegmatia slightly distinct at middle or almost indistinct, proplegmatia and phoba absent. *Pedium* longer than wide and smooth. *Haptolachus* with right area bearing 6 setae and 2 sensilla and left area bearing 8 setae and 2 sensilla; nesium internum (sensorial cone) as a superficial plate, entire or divided at middle and with 4 sensilla; nesium externum (sclerotized plate) prominent and acute; crepis lateral area conspicuous and medial area almost indistinct. **Mandible** (Figs. 15–20). Incisor with 2 well-defined teeth (S2 inconspicuous), dorsoproximal area with 1 puncture. Ventral striated stridulatory area with about 19 thin anterior striae and 6 broad posterior striae. Ventral area with 3–4 medial punctures and posterior asperites. Scrobe (outer proximal area) with about 5 setae. Ventral processes well developed. Both molars with about 9 dorsoproximal setae in a row, 5–7 ventroproximal setae in a tuft, and brustia with 4–6 setae; right molar with 3 chisel-like teeth and calx slightly sinuous; left molar with 1 anterior chisel-like tooth, 2 dorsal and 1 ventral teeth, acia with truncate apex and bearing about 5 setae, calx semicircular. **Maxilla** (Figs. 21–23). Galea and lacinia fused (as a mala) and limited from each other by dorsal suture; galea with an uncus; lacinia with 3 unci; mala without conspicuous setae row. Stipe with stridulatory area bearing 9–10 obtuse teeth and a distal truncate tooth. Palp with 4 palpomeres: I with a dorsoproximal sensillum; II with an outer dorsal sensillum and 3–4 ventral sensilla; III with an outer seta, a ventral seta and 2 ventral sensilla; IV with or without an outer sensillum, distal sensorial area bearing about 13 sensilla. **Hypopharynx** (Figs. 14, 22) with asymmetrical sclerite, right lateral of sclerite with about 5 punctures, left lateral with about 7–8 long setae, lateromedial left area with a row of 21–25 stout setae; right anterior area with a prominent tooth. **Posterior preoral area**: each side of dorsal area (posterior to epipharynx, Fig. 13) with a sensillum; each side of ventral area (posterior to hypopharynx, Fig. 22) with 1–2 sensilla, left area with a row of 18–21 stout setae. **Labium** (Figs. 14, 22, 23). Submentum with an inconspicuous sclerite, each side with 2 setae and about 9 sensilla. Mentum with a transversal sclerite, each side with 1 seta and 3–6 sensilla. Prementum with a transversal sclerite, each side with about 7 setae distributed around palpus insertion; ligula (Figs. 14, 22) with 33–36 small stout setae, a small medial tubercle and a posterior transversal sclerite, right area with 11–13 long setae, left area with 17–23 long setae, posterior area bearing asperites. Palp with 2 palpomeres: I with a minute ventroproximal seta; II with a ventrodistal sensillum, distal sensory area with about 13 sensilla. **Thorax** (Fig. 3, setation in Table 2). Prothorax with a tergal lobe bearing 6–8 minute anterior setae, 8–10 short or long posterior setae, and 6 lateral setae; thoracic lateral sclerite with 4–6 setae; pleural anterior lobe with 2–3 setae, pleural posterior lobe with 10 setae, ventral anteromedial lobe with 36–40 setae, and ventral posterior lobe bare. Meso- and metathorax with tergal anterior lobe bearing 6–8 setae, tergal medial lobe with 31–40 setae, tergal posterior lobe bare, pleural anterior lobe with 2–3 setae, pleural posterior lobe with 3–9 setae, ventral anteromedial lobe with 23–24 setae, and ventral posterior lobe bare. **Legs** (Figs. 24–26). Pro-, meso- and metafemur with 2 small inner tubercles, each tubercle bearing 2 distal setae; pretarsus (Figs. 27–29) with 2 lateroventral setae and an acuminate apex, propretarsus as long as meso- and longer than metapretarsus. **Thoracic spiracle** (Figs. 30, 31, see

Figs. 1–6. *Cyclocephala tucumana*; **1**, adult male, dorsal; **2**, external genitalia of adult female, ventrolateral; **3–4**, third-instar larva; **3**, lateral; **4**, head, frontal; **5–6**, terminalia of female pupa, ventral (normal genital ampulla, teratological genital ampulla). **fgl–fgr**, left and right lobes of female genital ampulla; **gcx**, left gonocoxite; **ggl**, left gonangulum; **gst**, left gonostyle; **ppt**, left paraproct (barely distinct). Scale, Figs. 1, 3, 5 = 1 mm; Figs. 2, 4 = 0.5 mm (Photos by Rafael Sousa, MZSP).

remarks) with 14–17 perforations in dorsal and ventral radius (DR, VR) and 13–15 in longitudinal radius (LR); perforations oblong; bulla slightly wider than the distance between respiratory plate arms. **Abdomen** (Fig. 5, setation in Table 2). Segment I with tergal anterior lobe bearing 8–12 thin and 0–2 stout setae, tergal medial lobe with 16–20 thin and 8–18 stout setae, tergal posterior lobe with 8–11 thin and 16–17 stout setae, pleural anterior lobe bare, pleural posterior lobe with 3–9 setae, spiracle lobe with 0–2 setae, tergal lateral lobe indistinct or distinct and bearing 0–2 setae, ventral anterior lobe with 6–16 setae, ventral medial lobe with 2 setae, ventral posterior lobe bare. Segment II with tergal anterior lobe bearing 6–10 thin and 23–28 stout setae, tergal medial lobe with 21–26 thin and 68–80 stout setae, tergal posterior lobe with 5–8 thin and 43–63 stout setae, pleural lobes and tergal lateral lobe as segment I, spiracle lobe with 4–9 setae, ventral lobes as segment I. Segments III–V with tergal anterior lobe bearing 2–6 thin and 38–50 stout setae, tergal lateral lobe with 2–4 setae, other lobes as segment II. Segment VI with tergal anterior lobe bearing 2–4 thin and 53–63 stout setae, tergal medial lobe with 25–28 thin and 55–64 stout setae, tergal posterior lobe with 12–16 thin and 24–33 stout



Figs. 7–12. *Cyclocephala tucumana*, third-instar larva; **7**, cranium and clypeus, dorsal; **8**, labrum, dorsal (epipharyngeal ventral setae omitted); **9–12**, left antenna (dorsal, inner, outer, ventral; dorsal side with apex detail; some sensilla numbered to easily the correspondence). Chaetotaxy (italic) on the text. Scale = 0.5 mm (antennal details with magnification four times bigger than antennae).



Figs. 13–14. *Cyclocephala tucumana*, third-instar larva; **13**, epipharynx; **14**, cibarium, lateral. **aca**, anterior-most acanthoparia seta; **acr**, lateroposterior acroparia seta; **crp**, right part of crepis; **lip**, tubercle-like process of ligula; **ppa**, posterior preoral area. Scale = 0.5 mm.

setae, ventral anterior lobe with 4–8 setae, other lobes as segments III–V. Segment VII with tergal anterior lobe bearing 10–25 thin and 0–6 stout setae, tergal medial lobe indistinct, tergal posterior lobe with 14–28 thin setae, tergal lateral lobe indistinct, ventral anterior lobe with 2–4 setae, other lobes as segment VI. Segment VIII with a tergal lobe bearing 25–28 thin setae, ventral lobe with 4

Table 1
Chaetotaxy of the known third instars of *Cyclocephala* (modified from Rodrigues et al. 2018).

species	parietals				frons				clypeus		labrum				raster			al
	des	pes	aes	ees	pfs	efs	aas	afs	acs	ecs	pls	lls	mls	als	tg	pr	pa	
C. barrerai	2-3	3	~3	4-5	2	0	1	1	0	1	3-4	~2	1	–	21-23	u	0	30-32
C. borealis	2-3	–	–	–	2	1	1-2	1-2	–	–	–	–	–	–	~25	u	0	20
C. celata	4	–	–	–	2	1	2	3	1	2	4-5	4	1	–	14-16	u	0	–
C. comata	2	2	2-3	–	2-3	0	–	0	1	1	2-4?	–	1	–	10-12	u	0	48-50
C. disticta	3-4	5-6	–	–	4-5	1	2	2	1	1	3-4	~4	1	2	7-9	u	0	~22
C. fasciolata	3	2	2-3	–	1-2	0	1	0	1	1	0	3	1	–	[8-9]	u	0	26-28
C. flavipennis	–	–	–	–	–	–	–	–	1	1	–	–	–	–	13-16	u	0	~22
C. fulgurata	3-4	5-6	2-3	~8	2	1	1	1	1	1	–	~3	1	–	12-15	u	0	34-38
C. gregaria	1	1	2-3	~3	2	1	1	1	1	1	–	~2	1	–	19-22	u	0	30-35
C. jalapensis	3	2	2-3	–	1	0	1	0	1	1	0	3	1	–	[16]	u	0	[26]
C. longula	7-8	–	–	–	3	1	2	2	–	–	–	–	–	–	–	u	0	–
C. lunulata	2-4	5-6 1**	2-3	~5	2	1	1	1	1	1	7-8	2-3	1	–	10-16 17-18* 20-28 !	u	0	26-34 ~20 !
C. lurida	3	~2	~3	~8	2	1	1	1	1	1	0	~4	1	2	13-16	u	0	~35
C. melanocepala	3-4	2	2-3	5-8	2-3	1	2-3	2	1	2	2-3	4-5	1	2	8-11	1-2	3-4	28-34
C. modesta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11-13	2-3	6-8	~25
C. paraguayensis	5	~5	~1	~8	1	1	2	1	1	2	1	~2	1	–	~15	4-5	3-4	~37
C. pasadenae	3-5	–	–	–	2-4	1	1	–	–	–	–	–	–	–	~15	u	0	–
C. putrida	–	–	–	–	–	–	–	–	–	–	–	–	–	–	~20	u	0	~37
C. signaticollis	3	2	3	–	1	–	3	1	1	1	–	–	–	–	13-16	u	0	20-30
C. sinaloae	3-4	3	~3	4-5	2-3	1	1	1-2	1	1-2	2-3	2-3	1	–	14-17	u	0	59-62
C. testacea	4	1	5-6	~8	–	1	–	2	1	3	5	–	1	–	28-30	0	~33	–
C. tucumana	4-5	4–6	1–2	5–9	2	1	2–3	1	1	2	2–3	4	1	2–3	15-22	15-22	6–7	16-20

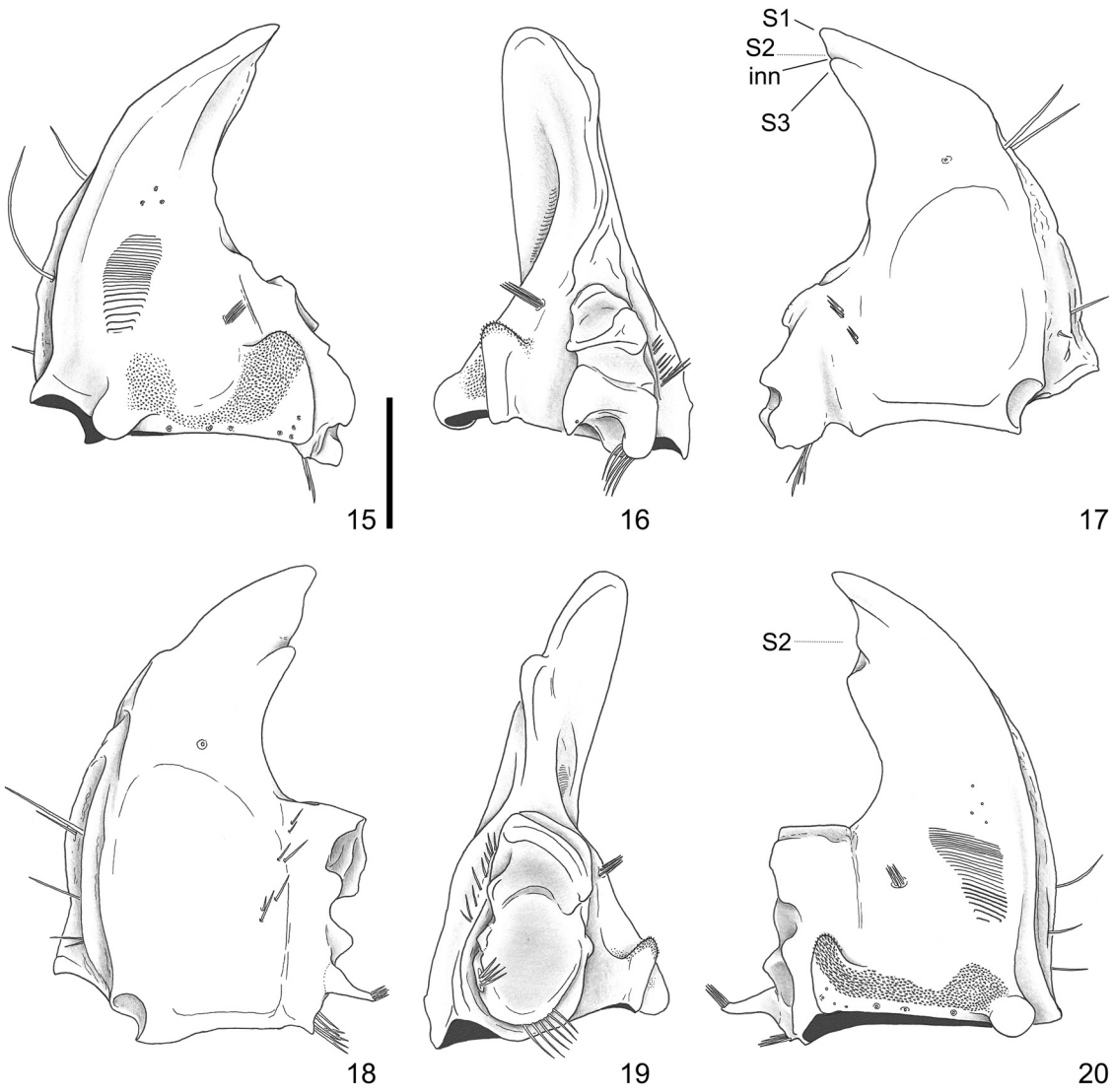
The chaetotaxy is given for one side of the structure, except for ventral anal lobe (**al**). ~, about; –, setae not quantified or figured by studies.
Raster and anal lobe: only hamate setae quantified, when hamate setae absent the number of hair-like setae is given between square brackets.
Preseptular setae (**pr**): tegillar setae anterior to palidia-septula. **u**, unapplied (i.e. when palidia-septula are absent, it is impossible define the preseptular setae).
Cyclocephala lunulata: general chaetotaxy by Bran et al. (2006);* redescription of Stechauner-Rohringer and Pardo-Locarno (2010);** redescription of Morón et al. (2014); ! according raster illustration by King (1984: Fig. 7).
***Cyclocephala longula*=*C. abrupta*.*Cyclocephala lurida*=*C. immaculata*.**
Setae group: **aas**, anterofrontal angle setae; **acs**, anteroclypeal setae; **aes**, anteroepicranial setae; **afs**, anterofrontal setae; **al**, ventral anal lobe setae; **als**, anterolabral setae; **des**, dorsoepicranial setae; **lls**, laterolabral setae; **mls**, mediolabral setae; **ecs**, externoclypeal setae; **ees**, externoepicranial setae; **efs**, externofrontal setae; **pa**, palidium setae (pali); **pes**, posteroepicranial setae; **pfs**, posterofrontal setae; **pls**, posterolabral setae; **pr**, tegillar preseptular setae; **tg**, tegillar setae (including **pr**).

Table 2
Thorax and abdomen chaetotaxy of *Cyclocephala tucumana*.

segments	dorsal lobes					dorsolateral lobes					ventral lobes			
	tl*	tal	tml	tpl	ts	pl*	pal	ppl	esl	tll	vl*	val	vml	vpl
t1	20–24	u	u	u	4–6	u	2–3	10	u	u	u	36–40	u	0
t2–3	u	6–8	31–40	0	u	u	=	3–9	u	u	u	23–24	u	=
a1	u	8–12 [0–2]	16–20 [8–18]	8–11 [16–17]	u	u	0	=	0–2	u or 0–2	u	6–16	2	=
a2	u	6–10 [23–28]	21–26 [68–80]	5–8 [43–63]	u	u	=	=	4–9	=	u	=	=	=
a3–5	u	2–6 [38–50]	=	=		u	=	=	=	2–4	u	=	=	=
a6	u	2–4 [53–63]	25–28 [55–64]	12–16 [24–33]	u	u	=	=	=	=	u	4–8	=	=
a7	u	10–25 [0–6]	u	14–28	u	u	=	=	=	u	u	2–4	=	=
a8	25–28	u	u	u	u	u	=	=	=	u	4	u	u	u
a9	10–15 21–24	u	u	u	u	9–11	u	u	u	u	=	u	u	u

The chaetotaxy is given for the entire lobe, main interval related to thin setae, small stout setae between square brackets.
When two setae group are well defined in a lobe (as **a9-tl** of *C. tucumana*), each group is separate as anterior and posterior, respectively.
=, similar to immediately anterior segment; **u**, unapplied (when lobe is indistinct).
Segments: **t1–3**, pro-, meso- and metathorax; **a1–9**, abdominal segment I–IX.
Dorsal lobes: **tal**, tergal anterior lobe; **tl**, tergal lobe; **tml**, tergal medial lobe; **tpl**, tergal posterior lobe; **ts**, tergal sclerite of prothorax.
Dorsolateral lobes: **esl**, spiracular lobe; **pla**, pleural anterior lobe; **ppl**, pleural posterior lobe; **tll**, tergal lateral lobe.
Ventral lobes: **val**, ventral anterior lobe; **vl**, ventral lobe; **vml**, ventral medial lobe; **vpl**, ventral posterior lobe.
* When segment lobes are undivided, the general lobe (**tl**, **pl**, **vl**) chaetotaxy is given.

setae, dorsolateral lobes as segment VII. Segment IX with a tergal lobe bearing 10–15 anterior setae and 21–24 posterior setae, pleural lobe with 9–11 setae and ventral lobe with 4 setae. Tergite X (Fig. 44) with a curved anal opening and an anterior U-shaped thin sclerotized bar, sclerite delimiting an anterior thin area and a wide posteromedial area, each side of anterior area with 5–7 dorsolateral setae and 7–11 lateral setae, posteromedial area with about 130 anterior thin setae and about 40 posterior stout setae. **Spiracles** (Figs. 33, 35–37, 39–42, see remarks): I–VI smaller than VII–VIII, respiratory plates with 9–12 perforations in DR and VR, and 6–9 in LR; bulla slightly wider than the distances between respiratory plate arms. **Raster** (Figs. 43–44, setation in Table 1). Each side of



Figs. 15–20. *Cyclocephala tucumana*, third instar larva; **15–17**, right mandible (ventral, inner, dorsal); left mandible (dorsal, inner, ventral). **S1–3**, distal, medial, and proximal teeth of incisor (pointed line showing inconspicuous or barely distinct tooth), **inn**, incisor notch (between S2 and S3). Scale = 0.5 mm.

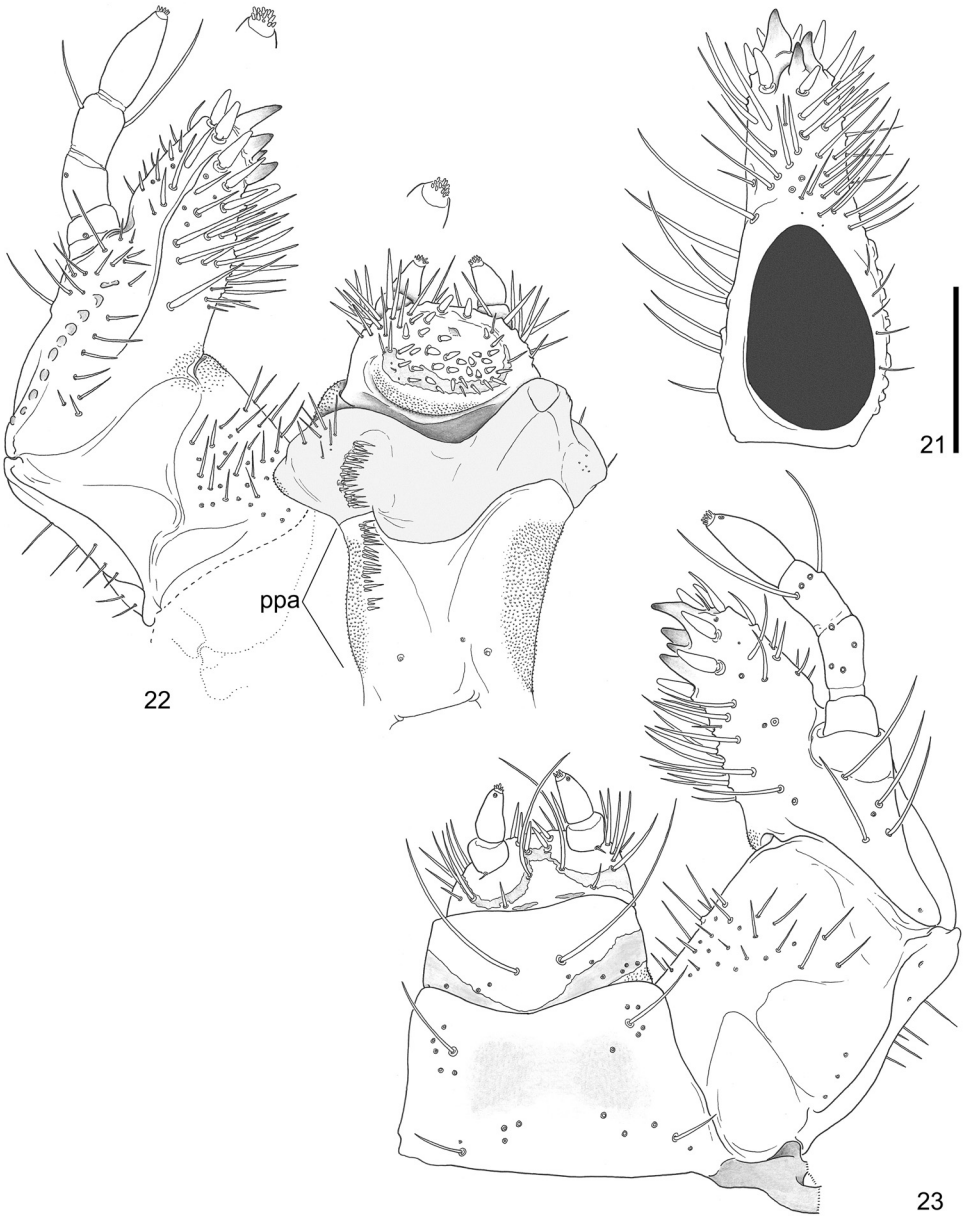
tegillar area with 15–22 hamate setae, each side of campus with 1–2 setae, palidia and septula restricted to anal ventral lobe, consequently all tegillar area is preseptular (i.e., anterior to septula), barbula indistinct. **Anal ventral lobe**, each palidium with 6–7 stout pali, each palus associated with a small transverse sclerome, septula somewhat oval, each side with 8–10 hamate lateral setae.

Material examined. Brazil, Mato Grosso do Sul, Cassilândia, Chácara Buritizinho, 04.viii.2016, leg. Bruno M.R. Dias, 8 third-instar larvae and 1 third-instar cast skin (MZSP – 10364).

Remarks. *Cyclocephala* larvae are known for 22 species (descriptions given in brackets): *C. barrerai* (Morón et al., 2014), *C. borealis* (Johnson, 1941; Ritcher, 1944, 1966), *C. celata* (Souza et al., 2014b), *C. comata* (García et al., 2009), *C. distincta* (Souza et al., 2014a), *C. fasciolata* (Morón et al., 2014), *C. flavipennis* (Pereira and Salvadori, 2006), *C. fulgurata* (Bran et al., 2006), *C. gregaria* (Bran et al., 2006), *C. jalapensis* (Morón et al., 2014), *C. longula* (= *C. abrupta*; Ritcher, 1944, 1966), *C. lunulata* (Bran et al., 2006; King, 1984; Morón et al., 2014; Stechauner-Rohringer and Pardo-Locarno, 2010), *C. lurida* (= *C. immaculata*; Ritcher, 1944, 1966), *C. melanocephala* (Rodrigues et al., 2018), *C. modesta* (raster figured in Morelli, 1991), *C. paraguayensis* (Albuquerque et al., 2014), *C. pasadanae* (Ritcher, 1944, 1966), *C. putrida* (raster figured in Morelli, 1991), *C. signaticollis* (Morelli, 1991; Remedi-de-Gavotto, 1964), *C. sinaloae* (Morón et al., 2014), *C. testacea* (Morelli and Alzugaray, 1994), *C. tucumana* (present study).

Regarding the above-mentioned species, only *C. melanocephala*, *C. modesta*, *C. paraguayensis*, *C. testacea* and *C. tucumana* have palidia. Palidia of *C. testacea* are long (each palidium with more than 30 pali) and abruptly divergent posteriorly; the other four species have short palidia (each palidium with less than 10 pali) and they are slightly divergent only in *C. modesta*. *Cyclocephala paraguayensis* and *C. melanocephala* are easily separate from others by the bifurcate pali (see Rodrigues et al. 2018: Fig. 44a). Finally, *C. modesta* and *C. tucumana* have palidia present on ventral anal lobe and pali are simply acuminate. Palidia of *C. tucumana* are restricted to anal lobe and palidia of *C. modesta* are extended anteriorly to raster.

The chaetotaxy of head, raster, and anal lobe (Table 1) is useful as supplement to larvae identification key below. Rodrigues et al. (2018) described the chaetotaxy for thoracic and abdominal lobes of *C. melanocephala* and highlighted the entire body setation as a possible identification tool. In the present study, body setation is also quantified, and the comparison between *C. melanocephala* and *C. tucumana* showed several setal group differences, mainly between setae of tergal lobes (Tables 2 and 3).



Figs. 21–23. *Cyclocephala tucumana*, third-instar larva; **21**, right maxilla, inner (cardo omitted); **22**, maxilla, hypopharynx and ligula, dorsal; **23**, maxilla and labium, ventral. **ppa**, posterior preoral area. Scale = 0.5 mm (palp details with magnification four times bigger than the maxillolabial complex).

Eight larvae and a cast skin were here studied. Usually the spiracles have their bulla slightly wider than the distance between respiratory plate arms (Figs. 31, 33, 35–37, 39–42), but one of studied larvae has spiracles with bulla narrower than the distance between respiratory plate arms (Figs. 32, 34, 38). This variation was not noticed to other Cyclocephalini larvae.

Addendum to the key for Cyclocephalini proposed in Rodrigues et al. 2018.

7(2) – Palidia present, sometimes pali irregularly distributed and septula barely distinct, but pali even easily differentiated from tegillar setae **8a**

7' – Palidia absent **11**

8a(7) – Palidia restricted to anal lobe .... ***C. tucumana* Bréthes**, 1904

8a' – Palidia anterior or not restricted to anal lobe **8b**

8b(8a) – Each palidium with more than 30 setae .... ***C. testacea*** Burmeister, 1847

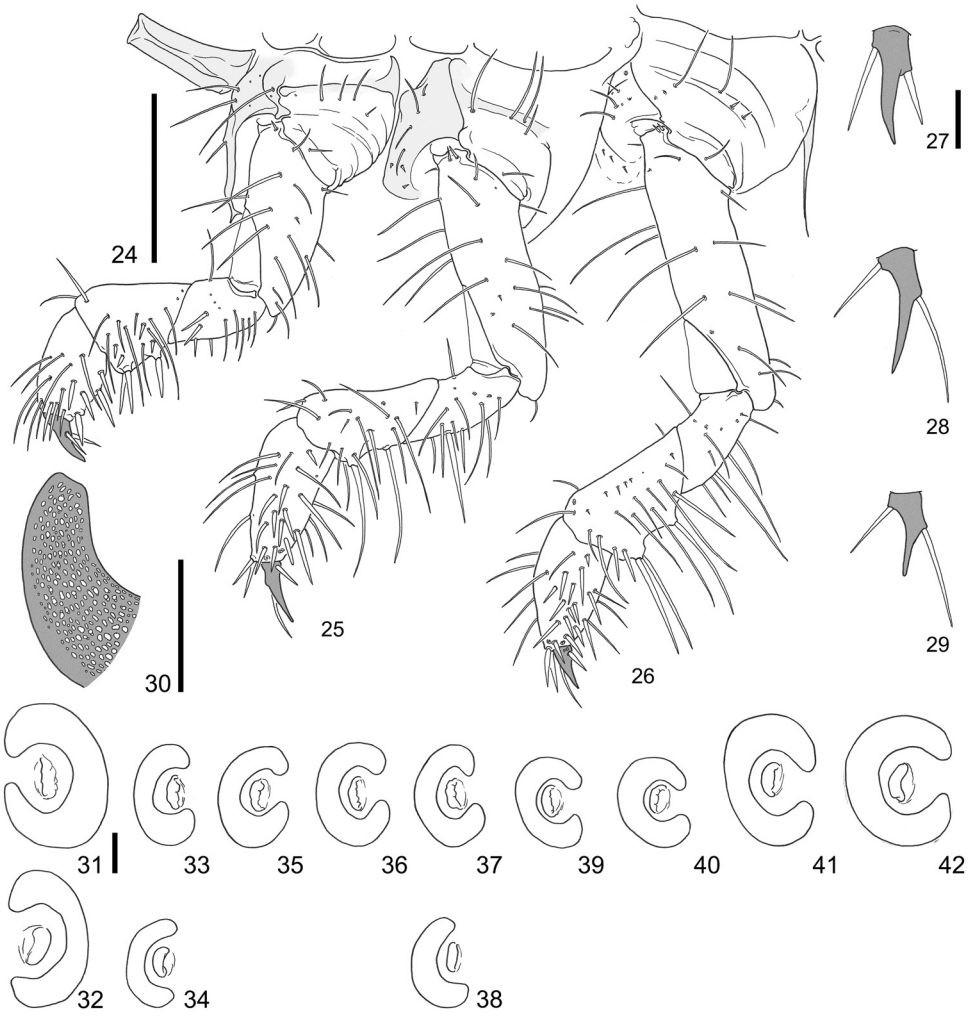
8b' – Each palidium with less than 10 setae **9**

Pupa (Figs. 5, 6, 45–54). Body (Figs. 45–48) length 11.6–13.3 mm; thorax width 5.8–6.1 mm; whitish yellow, integument macroscopically smooth and glabrous but covered by a thin and short microscopic pubescence, which gives a velvety appearance to the surface (magnification of 30x). **Head** (Figs. 49–50). Vertex hidden under pronotum from dorsal view (Fig. 45). Epistomal suture distinct laterally and indistinct medially. Canthus small. Clypeus trapezoid, wider in male (Fig. 49) than in female (Fig. 50). Labrum somewhat quadrate (Figs. 46, 47). Maxillary palps (Figs. 46, 47, 49–50) prominent, about twice longer in male than in female. Labium slightly rounded. Antenna with two defined regions: scape–pedicel and funicle–clava. **Thorax**. Pronotum wider than long, greatest width at posterior margin, lateral margins rounded, each side of the anterior area with a slightly raised tubercle. Prosternum with posterior process rounded; precoxal area hidden by the head in ventral view. Mesonotum seeming longer than pronotum and pronotum as long as metanotum in

Table 3
Thorax and abdomen chaetotaxy of *Cyclocephala melanocephala*.

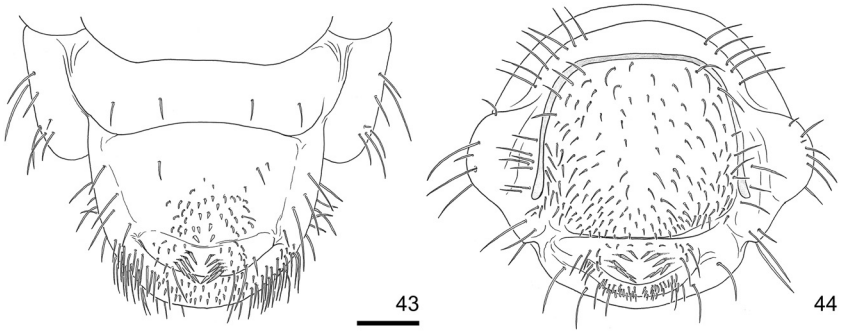
segments	dorsal lobes					dorsolateral lobes					ventral lobes			
	tl*	tal	tml	tpl	ts	pl*	pal	ppl	esl	tll	vl*	val	vml	vpl
t1	40–50	u	u	u	6–8	u	4–5	9–17	u	u	u	46–54	u	0
t2–3	u	15–19	44–60	16–20	u	u	4–7	2–4	u	u	u	34–40	u	2
a1	u	10	22–24 [12–14]	11 [15]	u	u	0	0–3 # 3–4	2	0	u	6–8	2	0
a2	u	6 [27]	25 [57]	8 [46]	u	u	=	=	4–5	1–2	u	=	=	=
a3–5	u	2 [38–55]	22–26 [60–80]	5–7 [50–57]	u	u	=	=	=	=	u	=	=	=
a6	u	=	=	11 [27]	u	u	=	=	=	=	u	4	=	=
a7	u	15–17 [3–5]	16 [3–5]	10 [4]	u	u	=	=	=	=	u	0	=	=
a8	24–28	u	u	u	u	u	=	=	=	u	u	=	=	=
a9	=	u	u	u	u	9	u	u	u	u	4	u	u	u

The chaetotaxy is given for the entire lobe, main interval related to thin setae, small stout setae between square brackets.
*zx =, similar to immediately anterior segment; #, minute setae, evidently shorter than other setae; u, unapplied (when lobe is indistinct).
Segments: **t1–3**, pro-, meso- and metathorax; **a1–9**, abdominal segment I–IX.
Dorsal lobes: **tal**, tergal anterior lobe; **tl**, tergal lobe; **tml**, tergal medial lobe; **tpl**, tergal posterior lobe; **ts**, tergal sclerite of prothorax.
Dorsolateral lobes: **esl**, spiracular lobe; **pla**, pleural anterior lobe; **ppl**, pleural posterior lobe; **tll**, tergal lateral lobe.
Ventral lobes: **val**, ventral anterior lobe; **vl**, ventral lobe; **vml**, ventral medial lobe; **vpl**, ventral posterior lobe.

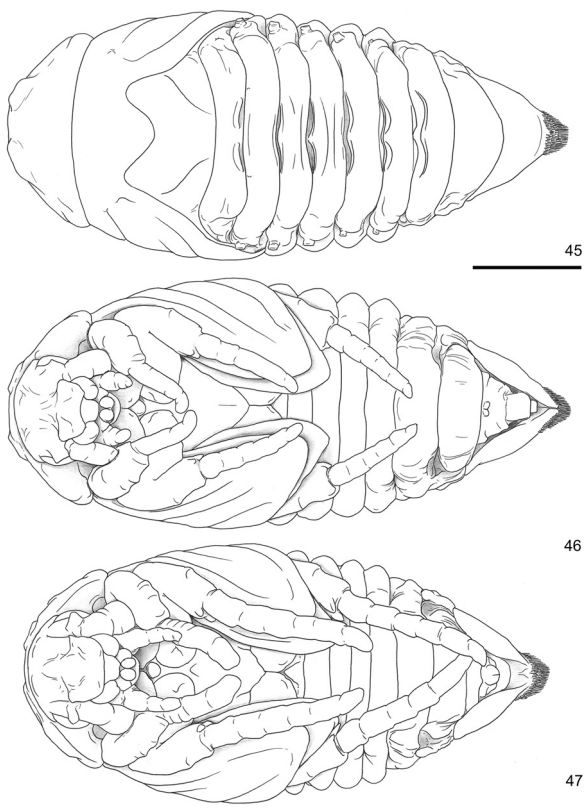


Figs. 24–42. *Cyclocephala tucumana*, third-instar larva; **24–26**, left legs and pleurites (anterior, medial, posterior); **27–29**, right pro-, meso-, and metapretarsus, dorsal; **30**, detail of ventral arm of mesothoracic spiracle; **31–32**, mesothoracic spiracle; **33–34**, abdominal spiracle I; **35–36**, abdominal spiracle II and III; **37–38**, abdominal spiracle IV; **39–42**, abdominal spiracles V–VIII. Scale, Fig. 24 = 0.5 mm; Figs. 27, 30, 31 = 0.1 mm.

dorsal view (Fig. 45). Elytra curved ventrally around the body and slightly striated. Pro-, meso- and metacoxae contiguous; each femur-tibia hidden in dorsal view; mesofemur-tibia superposed to wings in ventral view; protibia with three outer tubercle-like teeth; meso- and metatibial with 2 tubercle-like spurs; male tarsi (Fig. 47) evidently longer than female tarsi (Fig. 46). Mesothoracic



Figs. 43–44. *Cyclocephala tucumana*, third-instar larva; **43**, raster, ventral; **44**, abdominal segment X, posterior. Scale = 1 mm.



Figs. 45–47. *Cyclocephala* tucumana, pupa; **45–46**, female (dorsal, ventral); **47**, male, ventral. Scale = 2.5 mm.

spiracle present in a cavity between the pronotum, elytron and anterior and medial legs. **Abdomen**. Six dioneiform organs present between tergites I–II, II–III, III–IV, IV–V, V–VI, VI–VII; tergites without conspicuous transversal carina. Abdominal spiracles I–IV with peritreme, I hidden under the wings, II–V slightly prominent, V with peritreme (Fig. 48) or as a cuticular invagination (see remarks), VI–VIII as cuticular invagination, VII–VIII smaller than VI. Tergite IX ventrally folded and distally setose; urogomphi absent. **Male terminalia** (Fig. 51). Proximal genital ampulla as two trapezoid pieces, each piece lateral to posterior genital ampulla; posterior ampulla discoid and with a distal impressed line; sternite X exposed and somewhat trapezoid. **Female terminalia** (Fig. 52). Sternite IX with genital ampulla formed by two small tubercles, posterior area delimited as a quadrate plate (see remarks); tergite X small and ventrally exposed.

Remarks. Morón (1993) studied pupae of 46 species of phytophagous Scarabaeidae (Cetoniinae, Dynastinae, Melolonthinae, Rutelinae) distributed in 13 tribes (the number could be different according to the used classification). The author noted that all examined taxa have same abdominal spiracles pattern: I–IV with peritreme and V–VIII as a cuticular invagination. The same condition was observed to the following Cyclocephalini: *Cyclocephala celata* (Souza et al., 2014b); *C. distincta* (Souza et al., 2014a); *C. fulgurata* (Bran et al., 2006); *C. gregaria* (Bran et al., 2006); *C. lunulata* (Bran et al., 2006); *C. melanocephala* (Rodrigues et al., 2018); *C. signaticollis* (Morelli, 1991); *C. testacea* (Morelli and Alzugaray, 1994); *Dyscinetus dubius* (Neita-Moreno and Yepes, 2011); *D. rugifrons* (Vincini et al., 2000). Spiracles of pupae of *C. tucumana* may be the same as those above mentioned or spiracle V may have peritreme as I–IV (Fig. 48; the present study examined 2 male and 5 female pupae, a male and 2 female pupae have V with peritreme).

Female terminalia of *C. tucumana* has a different feature from known Cyclocephalini pupae. Sternite IX is divided into an anterior wide trapezoid area and a quadrate posterior plate. A preliminary study of female pupae could interpret this posterior plate as being the sternite X (Fig. 52). Sousa et al. (2018) used some phytophagous scarab pupae (Cetoniinae, Dynastinae, Melolonthinae, Rutelinae) to interpret the terminalia structure and identified the placement of segments IX and X. In the present study, one studied female pupa (Figs. 53,54) has its terminalia fully distended, probably an artificial condition resulting from the preservation process. This peculiar pupa was compared to the original material used by Sousa et al. (2018) to the interpretation of the abdominal posterior segments (Figs. 52–54). The possible adult structure related to the posterior plate of sternite IX of female pupa is unknown, the adult female external genitalia (Fig. 2) has gonangulum, gonocoxite, and gonostyle, but any posterior structure is distinct.

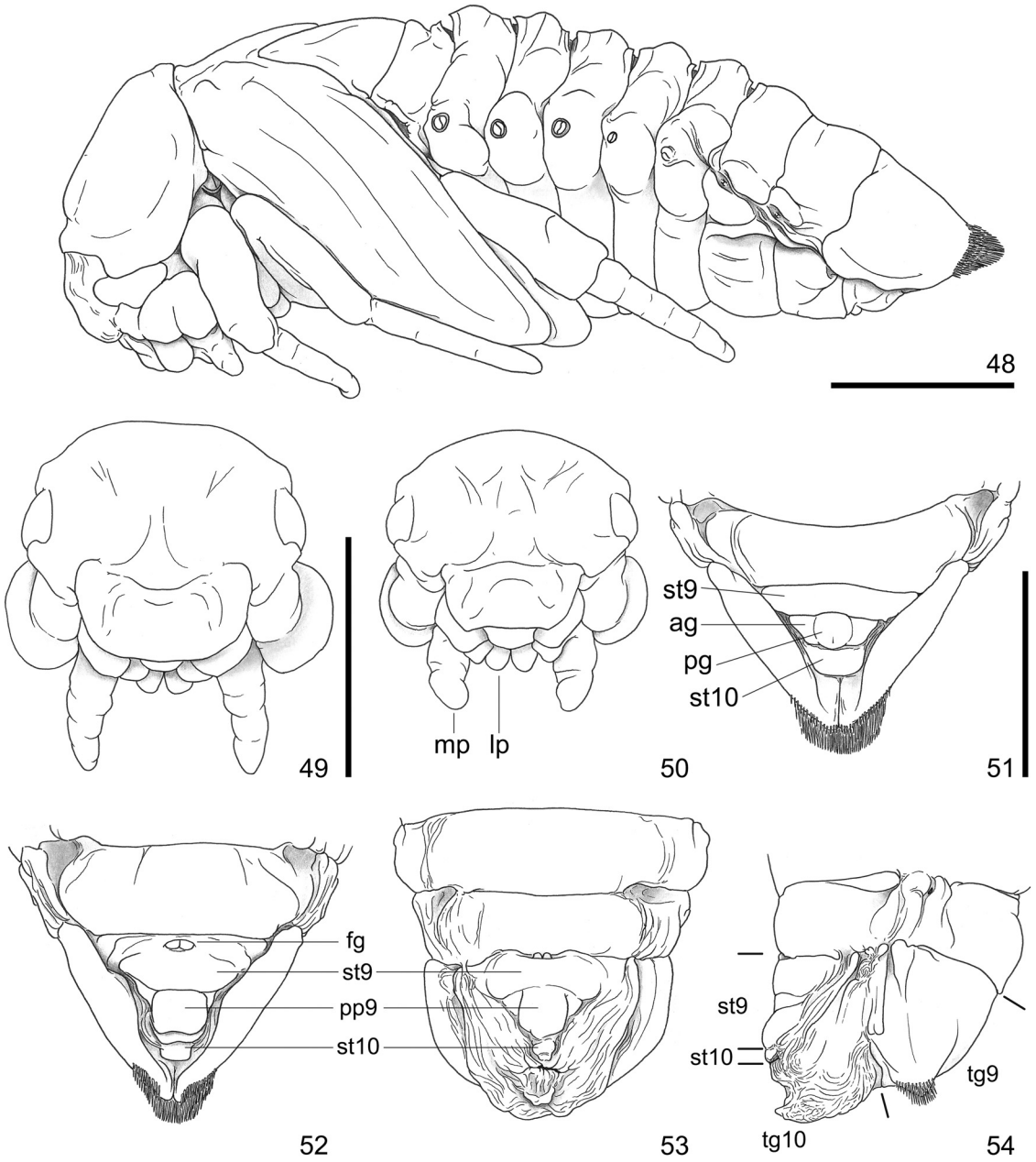
Still regarding female terminalia, one studied female pupa has a teratological condition in the genital ampulla (compare Figs. 5 and 6), the ampulla is removed to left and has its right tubercle transversally widened, and the left tubercle is prominent and conical (Fig. 6). Pupal teratology has been seldom reported in Scarabaeoidea (see Gasca-Álvarez et al., 2017) and the present note is a contribution to the study of malformation in beetles.

Material examined. Brazil, Mato Grosso do Sul, Cassilândia, Chácara Buritizinho, 04.viii.2016, leg. Bruno M.R. Dias, 4 female pupae (MZSP – 10364), 07.ix.2016, leg. Bruno M.R. Dias, 1 female pupa and 2 male pupae (MZSP – 10365).

Key for known pupae of Cyclocephala *(modified from Rodrigues et al. 2018)*

Ten known pupae of *Cyclocephala* are included in the key; other two known pupae need more data to be distinguished from other ones: Morón et al. (2014) characterized *C. jalapensis* with six dioneiform organs, and Johnson (1941) figured pupae of *C. borealis* and described the genital ampullae to both sexes.

1 – Abdomen with 4 dioneiform organs between tergites III–IV, IV–V, V–VI, VI–VII ..... ***C. signaticollis*** Burmeister, 1847



Figs. 48–54. *Cyclocephala tucumana*, pupa; **48**, female, lateral; **49–50**, head, frontal (male, female); **51–52**, terminalia, ventral (male, female); **53–54**, female terminalia with abdomen fully distended (ventral, lateral). **ag**, male anterior genital ampulla; **fg**, female genital ampulla; **lp**, labial palp; **mp**, maxillary palp; **pg**, male posterior genital ampulla; **pp9**, posterior plate of abdominal sternite IX; **st9–10**, abdominal sternite IX–X; **tg9–10**, abdominal tergite IX–X. Scale = 2.5 mm.

1' – Abdomen with more than 4 dioneiform organs, organs present between tergites I–II and II–III **2**

2(1) – Abdomen with 5 dioneiform organs between tergites I–II, II–III, III–IV, IV–V, V–VI **3**

2' – Abdomen with 6 dioneiform organs between tergites I–II, II–III, III–IV, IV–V, V–VI, VI–VII ..... **.4**

3(2) – Anterior margin of abdominal tergite VII about 2.5 times wider than the posterior-most dioneiform organ (between VI–VII) ..... ***C. melanocephala*** (Fabricius, 1775)

3' – Anterior margin of abdominal tergite VII about 1.75 times wider than the posterior-most dioneiform organ (between VI–VII) ..... ***C. paraguayensis*** Arrow, 1913

4(2) – Ventral fold of abdominal tergite XI forming a posterior tubercle-like process bearing some relatively long setae (see Souza et al. 2014a: Figs. 16–18) ..... ***C. distincta*** Burmeister, 1847

4' – Ventral fold of abdominal tergite XI posteriorly obtuse or acute, but never with a tubercle-like prominence **5**

5(4) – Protibia with two outer tubercle-like teeth, mesotibia with an inner tubercle-like spur ..... ***C. celata*** Dechambre, 1980

5' – Protibia with three outer tubercle-like teeth, mesotibia with two inner tubercle-like spurs **6**

6(5) – Ventral fold of abdominal tergite XI posteriorly acute ..... ***C. fulgurata*** Burmeister, 1847

6' – Ventral fold of abdominal tergite XI posteriorly obtuse ... **7**

7(6) – Profemur-tibia articulation area hidden in dorsal view (similar to Fig. 45) **8**

7' – Profemur-tibia articulation area visible in dorsal view as a small area next to pronotum posterior angle and elytral humeral area **9**

Table 4
Number and density of larvae of *Cyclocephala tucumana* collected in Cassilândia, MS, from August 2015 to July 2016.

Period	Specimens	Density (specimens/m^2)
August 2015	1	0.16
September 2015	3	0.50
October 2015	1	0.16
November 2015	32	5.33
December 2015	33	5.50
January 2016	12	2.00
February 2016	8	1.33
March 2016	13	1.44
April 2016	21	3.5
May 2016	23	3.83
June 2016	18	3.00
July 2016	19	3.16
	Total = 184	Mean = 2.49

8(7) – Body length less than 15 mm; female with abdominal sternite IX divided in an anterior area and a posterior quadrate plate (Fig. 52) ..... ***C. tucumana*** Bréthes, 1904

8' – Body length more than 20 mm; female with abdominal sternite IX entire ..... ***C. testacea*** Burmeister, 1847

9(7) – Pubescence of ventral fold of abdominal tergite XI almost hidden in dorsal view, male anterior genital ampulla slightly constricted medially ..... ***C. gregaria*** Heyne and Taschenberg, 1908

9' – Pubescence of ventral fold of abdominal tergite XI evident in dorsal view, male anterior genital ampulla strongly constricted medially ..... ***C. lunulata*** Burmeister, 1847

Biology

Regarding population dynamics of larvae of *C. tucumana*, 184 larvae were collected, with a populational density of 0.16 – 5.50 larvae/m^2. Larvae occurred throughout the year, but they were more abundant in November and December (Table 4). Pupae lasted 14.54 days (11 – 24), similar to Nogueira et al. (2013), who found that the pupal stage lasted about 15 days.

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