

Biological aspects of *Cyclocephala tucumana* Brethes, 1904 and *Cyclocephala melanocephala* (Fabricius, 1775) (Coleoptera: Scarabaeidae)

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Abstract: The studies were conducted on the biological aspects of *Cyclocephala tucumana* Brethes, 1904 and *C. melanocephala* (Fabricius, 1775) in Aquidauana, MS, Brazil. From January to December 2009 a light trap was installed to make collections of adults of *C. tucumana* and from January 2010 to February 2011 for collections of adults of *C. melanocephala*, at the experimental farm of the Universidade Estadual de Mato Grosso do Sul. Adults were maintained in plastic containers with soil and complete plants of *Brachiaria decumbens* Stapf cv. Basilisk to oviposition and start biological studies. Adults of *C. tucumana* were collected from September to November in the field; the embryonic period lasted on average 14.7 days, and the first, second and third larval instars lasted 47.7, 66.1 and 78.6 days, respectively. Pre-pupa and pupa phases lasted 98.2 and 15.1 days, respectively, and longevity of the adults was 13.3 days. From the egg to adult stage of *C. tucumana* was a period of average 211.2 days. Adults of *C. melanocephala* were collected from September to October 2010 and February 2011. The embryonic period lasted 17.8 days, and larvae in the first, second and third instars lasted 22.3, 21.0 and 27.0 days, respectively. The pre-pupa stage lasted 11.3 days and pupa phase lasted 13.3 days. The longevity of adults was 26 days, and the cycle from egg to adult lasted 113 days.

Keywords: life cycle, *Cyclocephalini*, *Dynastinae*, insects of the soil.

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Resumo: Foram desenvolvidos estudos sobre os aspectos biológicos de *Cyclocephala tucumana* Brethes, 1904 e *C. melanocephala* (Fabricius, 1775) em Aquidauana, MS. Foi instalada uma armadilha luminosa de janeiro a dezembro de 2009 para obter adultos de *C. tucumana* e de janeiro de 2010 a fevereiro de 2011 para obter adultos de *C. melanocephala*, na fazenda experimental da Universidade Estadual de Mato Grosso do Sul. Adultos foram mantidos em recipientes de plástico, contendo solo e plantas de *Brachiaria decumbens* Stapf cv. Basilisk, para oviposição e início dos estudos biológicos. Os adultos de *C. tucumana* foram coletados de setembro a novembro no campo, o período embrionário durou em média 14,7 dias, e o primeiro, segundo e terceiro instar larval duraram 47,7, 66,1 e 78,6 dias, respectivamente. As fases de pré-pupa e pupa duraram 98,2 e 15,1 dias, respectivamente, e a longevidade dos adultos foi de 13,3 dias. A fase de ovo a adulto de *C. tucumana* durou em média 211,2 dias. Os adultos de *C. melanocephala* foram coletados em setembro e outubro de 2010 e em fevereiro de 2011. O período embrionário durou 17,8 dias, as larvas no primeiro, segundo e terceiro instar duraram 22,3, 21,0 e 27,0 dias, respectivamente. A fase de pré-pupa durou 11,3 dias a pupa durou 13,3 dias. A longevidade dos adultos foi de 26 dias, e o ciclo de ovo a adulto durou 113 dias.

Palavras-chave: ciclo de vida, *Cyclocephalini*, *Dynastinae*, insetos de solo.

Introduction

According to Ratcliffe & Cave (2002) there are approximately 300 known species in the American genus *Cyclocephala* Dejean, 1821. In the various regions of Brazil, 83 species of the genus *Cyclocephala* are registered (Morón 2004).

In the city of São Gabriel da Cachoeira, AM, Brazil, Andreazze & Mota (2002) used light traps for attract *Cyclocephala guianae* Endrödi, 1969, *C. lunulata* Burmeister, 1847, *C. simulatrix* Hohné, 1923, and three *Cyclocephala* spp.. Andreazze & Fonseca (1998) collected 18 species of Dynastinae in Itacoatiara, AM with light traps, where nine species were of the genus *Cyclocephala*, identified as *C. colasi* Endrödi, 1964, *C. bicolor* Castelnau, 1840, *C. affinis* Endrödi, 1966, *C. hardyi* Endrödi, 1975, *C. testacea* Burmeister, 1847, *C. mecynotarsis* Hohné, 1923, *C. acellata* Burmeister, 1847, *C. variabilis* Burmeister, 1847 and *C. verticalis* Burmeister, 1847.

Andreazze (2001) collected 11 species of *Cyclocephala* in the National Park of Jaú, AM using light traps, being identified as *C. colasi* Endrödi, 1964, *C. bicolor* Castelnau, 1840, *C. guianae* Endrödi, 1969, *C. hardyi* Endrödi, 1975, *C. paraflora* Martinez, 1978, *C. testacea* Burmeister, 1847 and *C. verticalis* Burmeister, 1847, as well as four species identified only at the genus level.

In an area of *Eucalyptus grandis* in Santa Bárbara, MG, Brazil, Freitas et al. (2002) obtained *Cyclocephala laminata* Burmeister, 1847 with a light trap. Nine species of *Cyclocephala* were collected by Ronqui & Lopes (2006) in Tamarana, PR, Brazil with light traps, which were identified only at the genus level. In five locations of Paraná, in southern Brazil, Riehs (2006) used light traps to collect *C. variabilis* Burmeister, 1847, *C. clarae* Hohné, 1923, *C. suturalis* Ohaus, 1911, *C. signaticollis* Burmeister 1847, *C. paraguayensis* Arrow, 1903 and *C. variolosa* Burmeister, 1847.

In 23 municipalities in the region of Planalto, Rio Grande do Sul, Brazil, Cherman (2011) sampled larvae of Scarabaeidae in different cultures, and identified *Cyclocephala flavipennis* Arrow, 1914, *C. modesta* Burmeister, 1855, *C. putrida* Burmeister, 1847, *C. tucumana* Brethes, 1904 and *C. metrica* Steinheil, 1874. Salvadori & Pereira (2006) found that *C. flavipennis* feeds on decaying organic matter and Salvadori (1999) reported that this species, even at the densities sampled of approximately 80 to 100 larvae/m² in the field do not cause damage to crops.

In the Midwest region of Brazil, the occurrence of *C. melanocephala* (Fabr., 1775) was registered in sunflower crop (Camargo & Amabile 2001). In Aquidauana, MS, Brazil, Rodrigues et al. (2010) collected adults of *C. verticalis* with a light trap. In soybean fields of Macaraju, MS, Brazil, Santos & Ávila (2007) encountered larvae of *C. forsteri* Endrödi, 1966 feeding of roots of this legume. In a sugar cane field in Sidrolândia, MS, Brazil, Coutinho (2010) found larvae of *C. verticalis* and *C. forsteri* feeding of the root system. *Cyclocephala verticalis* was found feeding of roots of *Acrocomia aculeata* (Puker et al. 2009).

According to observations of Prance & Arias (1975) in the region of Manaus, AM, adults of *Cyclocephala hardyi* were encountered in flowers of *Victoria amazonica*, where they were frequently encountered feeding on and cross pollinizing this plant species. In experiments conducted in the municipalities of Goiânia and Vila Propício in Goiás, Brazil, Cavalcante et al. (2009) found as visitors to flowers araticum (*Annona crassiflora*) (Annonaceae), *Cyclocephala atricapilla* Mannerheim, 1829, *Cyclocephala latericia* Hohné, 1923 and *Cyclocephala octopunctata* Burmeister, 1847, being considered as important pollinators.

In Brazil, *C. melanocephala* is reported as occurring in various states including BA, ES, MG, MT, PE, RJ, RS and SC, while the occurrence of *C. tucumana* is registered in PR and RS (Camargo & Amabile 2001, Morón 2004, Cherman 2011). Information on

biological aspects of the *Cyclocephala* species occurring in Brazil are scarce. Based on the lack of information studies were developed with the objective of understanding the biological aspects of *C. tucumana* and *C. melanocephala* in Aquidauana, MS, Brazil.

Materials and Methods

The study was developed at the Universidade Estadual de Mato Grosso do Sul (UEMS), in the municipality of Aquidauana, MS. Adults of *Cyclocephala tucumana* and *Cyclocephala melanocephala* were collected with a "Luiz de Queiroz" light trap installed daily between the pasture and field areas, at 6:00 PM and collected at 6:00 AM on the following day. Adults of *C. tucumana* were collected from January to December 2009, and *C. melanocephala* from January 2010 to February 2011.

During the periods of trapping, adults of *C. tucumana* and *C. melanocephala* were separated and quantified in the laboratory for observation of behavior and the oviposition period, as was performed by Rodrigues et al. (2010) when studying *Cyclocephala verticalis*.

Adults were maintained in plastic recipients (20 × 5 × 30 × 12 cm in depth) containing soil and complete plants of *Brachiaria decumbens* Stapf cv. Basilisk (Poaceae) so that the insects would mate and oviposition. Recipients were covered with a voile fabric that allowed plant growth and prevented escape of the insects.

Containers were inspected daily for acquisition of eggs and initiation of the biological study. When encountered, eggs were measured, transferred to Petri dishes containing sieved soil, moistened and maintained in laboratory conditions (26 °C, 12h photoperiod). Periodically (every two days) the plates were observed and larvae that hatched had their head capsule measured and durations verified, followed by transfer to individual 500 mL plastic containers containing soil and *B. decumbens* where plants were replaced weekly to monitor development and change of instar. When larvae reached the pre-pupae phase they no longer fed, but larvae remained on the soil at the surface of the recipient where they remained until reaching the adult phase (adapted from Rodrigues et al. 2010).

Biological variables evaluated for both species were the duration of the embryonic period, duration of the larval and pupal periods, and also longevity of the adults.

Specimens were deposited in the entomology collection of the Universidade Estadual de Mato Grosso do Sul, in Aquidauana, MS, Brazil.

Results

1. *Cyclocephala tucumana*

Regarding population dynamics of adults of *C. tucumana* was verified that these were found in the field during a short period of time, where 34 adults were collected in September (28.1%), in October 52 (43.0%) and in November 35 (28.9%) (Figure 1).

When dissecting some of the females it was found that in September there was an average of 10.5 eggs (4-14) (n = 6) per female, in October 10.8 (5-15) (n = 6) and November 6.5 (1-12) (n = 6). Thus, it can be inferred that the period in which females are encountered in flight in the field is also the oviposition period.

Eggs of *C. tucumana* were found individually at the bottom of recipients where adults were maintained, protected in chambers within the soil with average dimensions of 2 to 3 mm in diameter (n = 20), probably constructed with saliva from adults as well as soil. Eggs are white with average dimensions of 1.5 × 1.7 mm (n = 20). The embryonic period of *C. tucumana* lasted 14.7 days (Table 2).

In the first instar larvae possess an average width of 1.4 mm and body length of 3.8 mm, width of 1.4 mm and average weight of

0.0039 g. Larvae of the second instar had an average head capsule width of 2.1 mm, body length of 10.3 mm, width of 2.1 mm and weight of 0.0485 g (Table 1).

The third instar larvae presented head capsule width of 3.1 mm and body length of 16.6 mm, width of 3.1 mm, and weight of 0.1649 g (Table 1). From the first to third instar, it was observed that larvae significantly increase in size, showing an increase of 4.4 times its length and 2.2 times its width (Table 1). With regards to larvae weight, from the first to third instar the weight increased from 0.0039 g in the first instar to 0.1649 g in the third instar, an increase of roughly 42.2 times.

Larvae remained in the first instar for 47.7 days (Table 2). The second instar stage lasted 66.1 days and third instar phase 78.6 days (Table 2). The pre-pupal stage lasted 98.2 days on average, thus, duration of the larval stage was on average 191.9 days (Table 2).

When reaching the pre-pupa stage the larvae acquired a white color and no longer feed, and when transforming into pupae prepare a chamber in the soil where they remain protected. Normally chambers where the pupae remained were at the bottom of the recipients. Pupae presented average dimensions of 9.2 mm in length and in 4.3 mm

width (Table 1), and the average duration was 15.1 days on average (Table 2).

Upon reaching adult hood, it was observed that the average longevity was 13.3 days (Table 2). The adults measure 9.1 mm long by 4.1 mm in chest width (n = 10). They have light brown thorax and elytra. The head is dark tending to black in the frontal region between the eyes, and on the clypeus the color is dark brown. The biological cycle was completed with an average of 211.2 days, which allows for the formation of one generation per year, characterizing the species as univoltine.

2. *Cyclocephala melanocephala*

Adults of *C. melanocephala* were encountered in small quantity, finding two (28.6%) adults in September and five (71.4%) in October of 2010, and only one adult (12.5%) was obtained in February of 2011. Flight activity in the field thus occurred during a very short period (Figure 2).

In the rearing recipients eggs were encountered, which were isolated in chambers constructed of soil and saliva which have

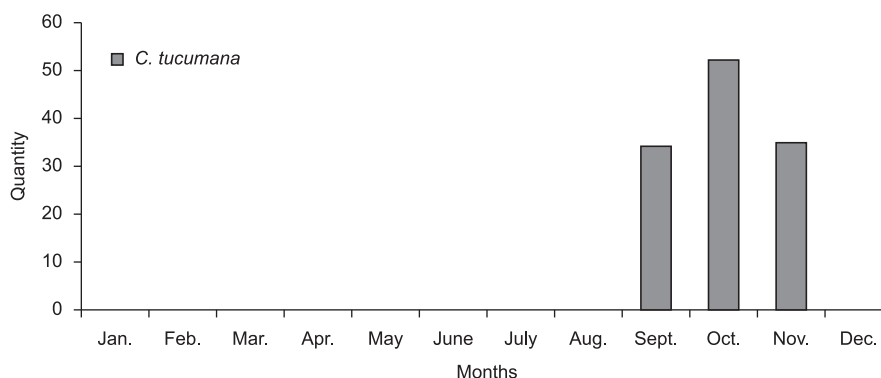


Figure 1. Number of adults of *Cyclocephala tucumana* collected in trap light from January to December 2009, in Aquidauana, MS.

Table 1. Means (\pm SE) of the length and width of the development stages of *Cyclocephala tucumana* in the laboratory ($26 \pm 1^\circ\text{C}$, 12h photoperiod).

| Stage | Length (mm) | | | Width (mm) | | |
|------------------------|-----------------|-----|-----------|----------------|-----|-----------|
| | Mean \pm SE | N | Amplitude | Mean \pm SE | N | Amplitude |
| Egg | 1.7 \pm 0.03 | 210 | 1.4-2.2 | 1.5 \pm 0.02 | 210 | 1.0-2.0 |
| Larval | | | | | | |
| 1 st instar | 3.8 \pm 0.05 | 155 | 3.0-4.0 | 1.4 \pm 0.01 | 155 | 1.2-1.4 |
| 2 nd instar | 10.3 \pm 0.68 | 98 | 0.9-14.0 | 2.1 \pm 0.02 | 98 | 1.8-2.6 |
| 3 rd instar | 16.6 \pm 0.47 | 81 | 13.0-21.0 | 3.1 \pm 0.02 | 81 | 2.85-3.25 |
| Pupal | 9.2 \pm 1.22 | 23 | 1.1-12.9 | 4.3 \pm 0.58 | 23 | 0.47-6.5 |
| Adult | 9.2 \pm 0.08 | 17 | 8.8-10 | 3.9 \pm 0.03 | 17 | 3.7-4.1 |

Table 2. Duration (mean \pm SE) of the development stages of *Cyclocephala tucumana* in the laboratory ($26 \pm 1^\circ\text{C}$, 12h photoperiod).

| Stage | Duration (days) | N | Interval of variation | Viability (%) |
|------------------------|------------------|-----|-----------------------|---------------|
| Egg | 14.7 \pm 0.24 | 210 | 9-22 | 73.8 |
| 1 st instar | 47.7 \pm 1.69 | 155 | 29-93 | 63.2 |
| 2 nd instar | 66.1 \pm 2.04 | 98 | 28-109 | 82.6 |
| 3 rd instar | 78.6 \pm 1.77 | 81 | 34-113 | 66.6 |
| Pre-pupal | 98.2 \pm 2.01 | 54 | 76-121 | 42.5 |
| Larval duration | 191.9 \pm 0.79 | 54 | 185-201 | 25.7 |
| Pupal | 15.1 \pm 0.63 | 23 | 12-23 | 73.9 |
| Adult | 13.3 \pm 1.05 | 17 | 8-20 | 100 |
| Egg to adult | 211.2 \pm 9.70 | 17 | 179-270 | 8.1 |

average dimensions of 9.7 to 9.75 mm in diameter (n = 4). Eggs have a white color and average dimensions of 2.65 × 2.30 mm (Table 3). It is possible that the chambers were constructed by females, which provide a protective environment for the egg.

The incubation period of eggs was on average 17.8 days (Table 4). Larvae of the first instar remained 22.3 days in this phase, in the second instar larvae remained 21.0 days and in the third instar an average of 27.0 days (Table 4). The pre-pupal stage lasted 11.3 days on average. Thus, larval duration was 70.7 days (Table 4).

First instar larvae of *C. melanocephala* had an average length of 5 mm, weight of 0.0163 mg and average head capsule width of 1.4 mm. Second instar larvae had an average length of 10.7 mm, weight of 0.0405 mg and head capsule width of 2.45 mm. The third instar larvae had an average length of 21.0 mm, weight of 0.1882 mg and head capsule width of 3.50 mm (Table 3). From the first to third instar the larvae increased 4.2 times, showing a considerable increase in their size.

Upon reaching the pre-pupae phase the insects stop feeding and remain in chambers with external average length of 32.0 mm and average width of 18.0 mm, and inner average length of 22.0 mm and width of 14.0 mm, constructed at the bottom of the rearing recipient. In this stage the pre-pupae have a greyish to white color.

The pupal stage lasted 13.3 days and adults had an average longevity of 26.0 days (Table 4). Pupae of *C. tucumana* had an average length of 12.1 mm and average width of 5.3 mm, and the adults had an average length of 11.9 mm and average chest width of 4.9 mm (Table 3). The elytra of adults are light brown, but the chest is red.

Duration of the egg to adult phase of *C. melanocephala* lasted 113 days on average in the laboratory, where the formation of two generations per year may be possible. In the laboratory a single moment of mating was observed when inspecting the rearing recipients, and on this occasion it was observed that copulation lasted seven minutes followed by the male remaining on top of the female for three minutes.

Discussion

The period of flight activity of two species studied was similar to other Scarabaeidae collected in the region of Aquidauana, MS, as observed by Rodrigues et al. (2008a, b, 2010).

Eggs of *C. tucumana* had dimensions similar to those of *C. verticalis* which measured 1.5 × 1.8 mm (Rodrigues et al. 2010) and *C. parallela* with average diameter of 1.9 mm (Cherry 1985), however, the eggs of *C. melanocephala* are larger. Regarding the

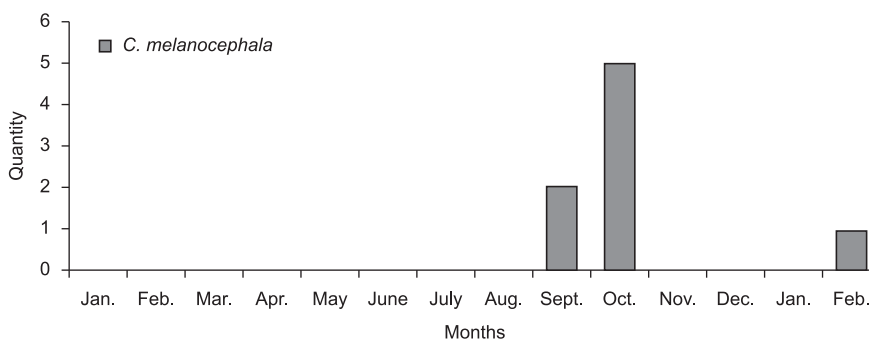


Figure 2. Number of adults of *Cyclocephala melanocephala* collected in trap light from January 2010 to February 2011, in Aquidauana, MS.

Table 3. Means (±SE) of the length and width of the development stages of *Cyclocephala melanocephala* in the laboratory (26 ± 1 °C, 12h photoperiod).

| Stage | Length (mm) | | | Width (mm) | | |
|------------------------|-------------|----|-----------|-------------|----|-----------|
| | Mean ± SE | N | Amplitude | Mean ± SE | N | Amplitude |
| Egg | 2.65 ± 0.07 | 10 | 2.45-2.80 | 2.30 ± 0.06 | 10 | 2.20-2.55 |
| Larval | | | | | | |
| 1 st instar | 5.0 ± 0.03 | 8 | 4.8-5.0 | 1.2 ± 0.03 | 8 | 1.1-1.3 |
| 2 nd instar | 10.7 ± 0.43 | 6 | 9.0-11.0 | 2.3 ± 0.02 | 6 | 2.20-2.35 |
| 3 rd instar | 21.0 ± 0.45 | 6 | 19.0-22.0 | 3.3 ± 0.02 | 6 | 3.25-3.40 |
| Pupal | 12.1 ± 0.35 | 6 | 11.0-13.0 | 5.3 ± 0.14 | 6 | 4.9-5.7 |
| Adult | 11.9 ± 0.48 | 6 | 9.5-12.5 | 4.9 ± 0.96 | 6 | 4.2-5.0 |

Table 4. Duration (mean ± SE) of the development stages of *Cyclocephala melanocephala* in the laboratory (26 ± 1 °C, 12h photoperiod).

| Phase | Duration (days) | N | Interval of variation | Viability (%) |
|------------------------|-----------------|----|-----------------------|---------------|
| Egg | 17.8 ± 0.20 | 10 | 17-18 | 80.0 |
| 1 st instar | 22.3 ± 0.75 | 8 | 21-24 | 75.0 |
| 2 nd instar | 21.0 ± 1.53 | 6 | 19-24 | 100.0 |
| 3 rd instar | 27.0 ± 1.73 | 6 | 24-30 | 100.0 |
| Pre-pupal | 11.3 ± 0.67 | 6 | 10-12 | 100.0 |
| Larval duration | 70.7 ± 1.76 | 6 | 68-74 | 100.0 |
| Pupal | 13.3 ± 0.67 | 6 | 12-14 | 100.0 |
| Adult | 26.0 ± 0.58 | 6 | 25-27 | 100.0 |
| Egg to adult | 113 ± 3.5 | 6 | 112-117 | 60.0 |

embryonic period, *C. tucumana* exhibited shorter duration in this phase when compared with *C. melanocephala*.

The head capsule width of *C. tucumana* and *C. melanocephala* present similar values. However, Santos & Ávila (2007) found that the average width of the head capsule of *C. forsteri* was greater than the two mentioned species, measuring 2.49, 4.18 and 7.04 mm in first, second and third instar, respectively.

The larval phase of *C. tucumana* lasts 191.9 days, being longer than that of *C. melanocephala* which lasted 70.7 days. The larval phase of *C. verticalis* is 195.7 days (Rodrigues et al. 2010), very similar to that observed for *C. tucumana*.

The behavior observed for construction of chambers by pre-pupae of the two species studied was also observed by Rodrigues et al. (2010) for *C. verticalis* reared in the laboratory.

Duration of the cycle from egg to adult of *C. tucumana* allows for the formation of one generation per year, as observed for *C. verticalis* by Rodrigues et al. (2010). According to Santos & Ávila (2007), *C. forsteri* completes its life cycle in one year, and according to Mondino et al. (1997), *C. signaticollis* Burmeister, 1847 also completes its cycle in one year.

The cycle from egg to adult of *C. melanocephala*, was similar to that observed for *Anomala testaceipennis* Blanchard, 1856 which required 139.4 days to complete its development (Rodrigues et al. 2008a).

The coupling behavior of *C. melanocephala*, which remained on top of the female after terminating coupling was reported by Rodrigues et al. (2010) for *C. verticalis*, where even after finishing copulation the male remained fixed on the female, presenting a defensive position, possibly trying to ensure fertilization of the egg with its genetic material.

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