



Biology, Ecology and Diversity

## Biology and management of the masked chafer *Cyclocephala distincta* Burmeister (Melolonthidae, Dynastinae, Cyclocephalini)

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### ABSTRACT

Adults of *Cyclocephala distincta* are flower visitors of Neotropical palms (Arecaceae) and commonly found in the Atlantic Forest of Pernambuco, Brazil. Males and females were collected in the wild and subjected to captive rearing and breeding. The egg hatching rate, the life cycle, longevity of immatures and adults, and oviposition parameters in captivity were analyzed. The average duration of the life cycle of *C. distincta* was 108.2 days ( $n = 45$ ). The egg stage lasted on average 10.9 days, and the egg-hatching rate was 73.9%. The immature stage lasted on average 93.4 days. The larvae stage exhibited negative phototaxis, and the size of their head capsules increased at a constant rate of 1.6 between instars, following Dyar's rule. The average duration of the first instar was 24.8 days ( $n = 88$ ), whereas the second and third instars lasted for 17.2 ( $n = 76$ ) and 40.4 ( $n = 74$ ) days respectively, and survival rates were 21.6%, 86.4% and 97.4%. The pre-pupal stage was recorded, and pupal chambers were built before pupation. The average number of eggs laid per female was 15.5, the total reproductive period lasted for 3.3 days, and the total fertility was 81.2%. Adults that emerged in captivity exhibited an average longevity of 18.9 days. Adult *C. distincta* exhibited thanatosis behavior upon manipulation, a strategy observed for the first time in *Cyclocephala*.

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### Introduction

One group of insects which stands out for including highly specialized pollinators are the scarab beetles of the tribe Cyclocephalini, often associated with attractive floral scent volatiles produced by their host plants during episodes of floral thermogenesis (Bernhardt, 2000; Gottsberger, 1990, 1999; Gottsberger and Amaral, 1984; Gottsberger and Silberbauer-Gottsberger, 1991). *Cyclocephala* Dejean contributes with over 85% of the richness of cyclocephaline scarabs, with about 500 described species (Ratcliffe et al., 2013). Little is known about the biology of *Cyclocephala*, but it is generally observed that the adults of many species exhibit crepuscular/nocturnal habits (Ratcliffe, 2008; Riehs, 2006) and feed on pollen, flower parts and nutritious exudates produced by the flowers they visit (Gibernau et al., 1999; Gottsberger, 1986).

Females of *Cyclocephala* lay their eggs directly on soil (Mondino et al., 1997; Santos and Ávila, 2007). The larvae dwell underground, where they feed on grass roots, decaying organic matter or on the petioles of plants (Grebennikov and Scholtz, 2004; Ponchel, 2006;

Ratcliffe, 2003; Ratcliffe and Cave, 2006; Stechauner-Rohringer and Pardo-Locarno, 2010). Depending on the feeding substrate, the larvae can either be treated as contributors to the environmental balance (Gassen, 2000) or destructive agricultural pests (Potter et al., 1996; Ritcher, 1966). The biological cycle of *Cyclocephala* is considered univoltine (it was described as bivoltine only for *C. lunulata* Burmeister, 1847), however, it has only been studied in about 1% of the currently described species (Cherry, 1985; Gavotto, 1964; Nogueira et al., 2013; Rodrigues et al., 2010; Santos and Ávila, 2007; Souza et al., 2014; Stechauner-Rohringer and Pardo-Locarno, 2010).

*Cyclocephala distincta* Burmeister, 1847 is native to the Guianas, Colombia and Brazil. Adults of the species are known flower visitors of palms, and even assumed as likely pollinators of some species (Arecaceae) (Endrödi, 1985; Voeks, 2002). However, interactions of the larvae with plants are currently unknown. Larvae of several other congeners have been historically documented as pests (Bran et al., 2006; Potter et al., 1996). Nonetheless, most of these species have only been poorly studied regarding their biology, including *C. distincta*, thus hindering the development of strategies for the conservation of native pollinators and efficient pest management. This work aims to evaluate the biological aspects of *Cyclocephala distincta* through the analysis of egg-hatching rates, the life cycle and oviposition parameters.

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## Material and methods

Adult *C. distincta* ( $n = 227$ ) were collected in the wild at the Campo de Instrução Marechal Newton Cavalcante (07°50' S; 35°06' W, Abreu e Lima, Pernambuco, Brazil). The CIMNC fragment is considered one of the largest continuous patches of the Atlantic Forest north of the São Francisco River, with lowland dense rainforest (IBGE, 1992). Sampling was carried for three months (December 2010, January and February 2011), between 6:00 p.m. and 5:00 a.m., using light traps. The trap consisted of a vertical white cloth illuminated by a black light 250W, during the new, growing or waning moon stages, when most nocturnal insects exhibit a lower discernment between natural and artificial light sources (Almeida et al., 2012; Nowinszky, 2004). The breeding in captivity was reared under natural environmental conditions of temperature ( $29.3 \pm 0.7$  °C) and relative humidity ( $56 \pm 1.9\%$ ), and a fixed photoperiod of 12:12h.

Egg-hatching rate and life cycle. A total of 127 adults were kept in plastic terraria (4 dm<sup>3</sup>) filled with circa 3 dm<sup>3</sup> of potting soil (Gnúmus Ltda). On average, 25 individuals of *C. distincta* (2 ♀: 1 ♂) were allocated per terrarium. A diet of fresh sliced apples and plantains was offered to the beetles (roughly 3.0 g per individual) and replenished every three days (Lai and Shin-ping, 2008; McMonigle, 2006; Souza et al., 2014). Egg-hatching rate, size, viability, coloration, duration, longevity, and behavior of each stage of life cycle were observed. The total duration of life cycle and longevity of adults emerged in captivity were compared between the sexes through Student's t test.

The immature stages were maintained as following:

**Egg:** On a daily basis, freshly oviposited eggs were removed from the terraria and placed in smaller plastic containers (250 cm<sup>3</sup>) also filled with c. 167cm<sup>3</sup> of potting soil (Gnúmus Ltda).

**Larvae:** Immediately after hatching, the larvae were transferred to individual plastic containers (250 cm<sup>3</sup>) also filled with c. 167 cm<sup>3</sup> of potting soil (Gnúmus Ltda). To feed the larvae, we prepared an even mix of fresh humus (Gnúmus LTDA) and finely pulverized dead wood and crushed leaf-litter (c. 50 g) that was collected at the site where the adults were captured. This feeding substrate was replenished every three days.

**Pre-pupa and pupa:** The larvae that reached the pre-pupal stage, and then pupated, were kept in the same containers. Food supply was interrupted.

Females of *C. distincta* captured in the wild ( $n = 100$ ) were individually placed in plastic containers (250 cm<sup>3</sup>) filled with 167 cm<sup>3</sup> of potting soil (Gnúmus LTDA) and fed with a diet of sliced apples and plantains (roughly 3.0 g per individual), replenished every three days (Lai and Shin-ping, 2008; McMonigle, 2006; Souza et al., 2014). To estimate the oviposition parameters, we recorded the pre-oviposition period (time interval between the day of capture to the first posture); number of postures per female; number of eggs per posture; inter-posture period; total reproductive period (interval between the first and last posture in captivity), and overall fertility (ratio of the total number of larvae and total number of eggs).

## Results and discussion

During sunlight hours, adult beetles kept in the terraria buried themselves in the substrate and displayed no other activities that could be visualized. Copulation and feeding occurred during nighttime (between 6:00 p.m. and 8:00 p.m.), but independently of each other. In other species of the genus, mating activities were not restricted to any period of the day (Rodrigues et al. [2010] for *C. verticalis* Burmeister, 1847; and Souza et al. [2014] for *C. celata* Dechambre, 1980). Adult *C. distincta* exhibited negative phototaxis, and when handled exhibited thanatosis (Fig. 1). This behavior was characterized by the retraction of all legs and lack of movement from the antennae and maxillary palps. This is the first record of thanatosis for the genus.



**Figure 1.** Male *Cyclocephala distincta* exhibiting thanatosis behavior. Adult mean size: 10 mm.

### Larvae hatching rate and life cycle

#### Egg

Each egg was accommodated inside an individual cell built by the female out of the soil substrate of the terraria. About 80% of these egg cells were entirely closed, while the remainder exhibited a small opening (approx. 3 mm diameter). The construction of egg cells had been previously described for *C. verticalis*, *C. signaticollis* Burmeister, 1847, *C. melanocephala* (Fabricius, 1755), *C. tucumana* Brethes, 1904, *C. paraguayensis* Arrow, 1913 and *C. celata* (Albuquerque et al., 2014; Morelli, 1991; Nogueira et al., 2013; Rodrigues et al., 2010; Souza et al., 2014) and it is assumed to be a strategy of parental care, since it offers extra protection to the fragile, recently oviposited eggs (Triplehorn and Jonsson, 2011). According to Potter and Gordon (1984), the shell of freshly oviposited eggs of *C. lurida* Bland, 1863 is thin and highly susceptible to desiccation. The same authors also observed that larvae of this species that hatched from eggs subjected to water stress were significantly smaller in size and were sometimes unable to disengage from the chorion membrane.

Freshly oviposited eggs of *C. distincta* were in average 1.2 mm long and 1.0 mm wide ( $n = 30$ ), elliptically shaped, and exhibited a whitish color. During embryonic development, the eggs gradually increased in size and assumed a spherical shape, as previously observed for *C. signaticollis*, *C. parallela* Casey, 1915, *C. paraguayensis* and *C. celata* (Albuquerque et al., 2014; Cherry, 1985; Gavotto, 1964; Souza et al., 2014). The increase in egg size is due to the absorption of water during growth and is made possible by the serosal layer of the egg membrane (Hinton, 1981). The egg stage lasted  $10.9 \pm 0.2$  days ( $n = 408$ ). Egg-hatching rate was 73.9% (Table 1).

#### Larvae

Both the head and body of newly hatched larvae exhibited a whitish-transparent coloration. One day after hatching, the head assumed an orange coloration, and the body became transparent. The larvae exhibited negative phototaxis and defecated when handled (Fig. 2A). Although no distinguishable odor was detected in the feces of *C. distincta*, the release of fecal material is a widely recognized defense mechanism developed by various animal taxa (Alpert and Ritcher, 1975). The released odor may repel possible predators and increase the chances of survival of the prey (Alpert and Ritcher, 1975). The behavior of defecation when handled was similar to that of *C. verticalis* (Coutinho et al., 2011).

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