# Notes on Biology and Behavior of Rhinoceros Beetle *Enema pan* (Coleoptera: Scarabaeidae: Dynastinae)

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**ABSTRACT** Dynastinae beetles (Coleoptera: Scarabaeidae) are important due to their role in recycling plant material and promoting nutrient turnover. However, some species are phytophagous and can attack crop plants, thus becoming pests. Here, we provide information on the biology and behavior of the rhinoceros beetle *Enema pan* (F.) (Oryctini), an abundant species in the area of Cerrado-Pantanal ecotone, Aquidauana, Mato Grosso do Sul, Brazil. Adults were collected with a light trap deployed daily from January 2006 to December 2007 in the experimental farm of the Universidade Estadual de Mato Grosso do Sul (Aquidauana campus). Adults were maintained in plastic containers and observations were made daily. Temporal distribution of adults of *E. pan* occurred in September and October (2006) and from October to December (2007). Flight started at 1930 hours and ended at 2330 hours. Twenty-four eggs (3.28 mm in length by 2.32 mm in width) with a whitish color were ovipositioned directly in to the soil. Adult longevity averaged 22.0 d in the laboratory conditions. Cephalic horn length, body length, and width of *E. pan* males are greater than those of females. The weight of adults of both sexes was similar. Cephalic horn length of the males of *E. pan* was positively correlated with his body size. Mating occurred between 0800 and 1030 hours and lasted on average 18.1 min in the laboratory. Several fights among males and other behaviors involving males and females were observed and are reported.

**KEY WORDS** allometry, Brazil, Oryctini, Pleurosticti, sexual selection

Dynastinae beetles (Coleoptera: Scarabaeidae) are distributed throughout the world and are most diverse in the tropics, especially in the Neotropics (Ratcliffe 2003, Gasca-Álvarez and Amat-García 2010). Adults range in size from 4 to 160 mm (Ratcliffe 2003), and some of the largest insects on Earth [e.g., *Dynastes hercules* (L.); Dynastini] fall into this subfamily. Males in some species posses prominent and often spectacular horns on the head and/or thorax, which together with their large size, have given rise to such popular names for them as "elephant," "Hercules," "rhinoceros," and "unicorn" beetles (Ratcliffe 2003).

Oryctini (Scarabaeidae: Dynastinae) is one of the most diversity tribes because of the number of species, its worldwide distribution, and the considerable areas of endemism in Central and South America (Mizi-

numa 1999). It comprises 26 genera and 230 species worldwide, with more than half of the genera and species occur in the Neotropical region (Ratcliffe and Cave 2006). Adults are active at night and often are attracted by light sources. During the day, they seek refuge and remain hidden. Some species feed on decaying plant matter or rotten fruit, whereas others bore into the stems of plants, such as sugarcane (*Saccharum* spp.) and palm trees (Ratcliffe 2003). Larvae develop in soil, plant debris accumulations, within the stems of plants, within ant hills or in rotting tree trunks and roots (Morón 1985, Ratcliffe 2003). Some species are pests of plants of economic interest, principally attacking the roots and stems of palm trees (Bodkin 1919, Cockerell 1946, Lourenção et al. 1999) and sugarcane (Ratcliffe 2003).

*Enema* Hope (Dynastinae: Oryctini) includes *Enema endymion* Chevrolat, which is distributed from Mexico to Bolivia and Brazil and *Enema pan* (F.), which occurs in tropical Central and South America (Ratcliffe 2003, Gasca et al. 2008). Endrödi (1976, 1985) reported four morphotypes described as subspecies based on differences in the male pronotal and head horns: *Enema pan aeneas* (Kirby), *Enema pan chorinaeum* (F.), *Enema pan enema* (F.), and *Enema pan pan* (F.). These morphotypes are considered synonyms of *E. pan* and represent variation within a single species (Ratcliffe 2003, Gasca et al. 2008). Despite

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their large size and occasional local abundance, little is known on the life history of these species (Ratcliffe 2003). Adults are nocturnal and attracted to light, and the larvae probably feed on humus in the soil (Ratcliffe 2003). *E. pan* seems to be restricted to forested areas, whereas *E. endymion* has been found both in forested and secondary scrub areas, often in very large numbers (Ratcliffe 2003).

In Brazil, few studies have been developed with the objective of studying the biology, behavior and/or diversity of Dynastinae beetles. The most recent work focuses on biological aspects of *Cyclocephala verticalis* Burmeister (Cyclocephalini), an abundant species in the state of Mato Grosso do Sul, which can be encountered in crops, pasturelands, and native palms (Puker et al. 2009; Rodrigues et al. 2010a, 2011). Andreazze (2001), Andreazze and Fonseca (1998), and Andreazze and Motta (2002) reported Dynastinae diversity in some localities of the state of Amazonas, and Gasca et al. (2008) provided a synopsis of Oryctini of the Brazilian Amazon forest. Some papers dealing with economic aspects of Dynastinae in Brazil were published for *Diloboderus abderus* (Sturm) (Pentodontini) and species of *Strategus* Hope (Oryctini). The former has significant importance and is commonly found causing damage and losses in crops during the winter and early spring in some areas of the state of Rio Grande do Sul (Silva and Costa 2002). There are some reports found in literature dealing with biology and behavior (Silva and Loeck 1996, Morelli 1997), biometrics (Silva and Grützmacher 1996), level of economic damage (Silva and Costa 1998), and pest control (Silva 1997, 2000; Silva and Boss 2002). Interaction of the species *Strategus* with palms (Arecaceae) was evaluated by Lourenção et al. (1999).

Motivated by the little knowledge on diversity and biology of Dynastinae occurring in the state of Mato Grosso do Sul (Brazil), studies were initiated to gather information on the species encountered in the Cerrado-Pantanal ecotone. The Brazilian Cerrado is a complex mosaic of native vegetation, including grassland, savanna and forest (Oliveira and Marquis 2002). The Pantanal is a large wetland of $\approx 160,000$ km$^2$ in the center of the South American continent with average elevation of 100 m and is located in Brazil (states of Mato Grosso and Mato Grosso do Sul), Paraguay, and eastern Bolivia (Alho et al. 1988). In a transition area between these ecosystems a great abundance of the rhinoceros beetle *E. pan* is found all years both in rural areas (e.g., crops, patches of Brazilian savanna and pasturelands) and in the city of Aquidauana (Mato Grosso do Sul, Brazil) at illuminated areas. In this work we provide information on the biology and behavior of this beetle.

## Materials and Methods

This study was developed at the Universidade Estadual de Mato Grosso do Sul (UEMS) (Aquidauana campus), in Aquidauana, Mato Grosso do Sul, Brazil,
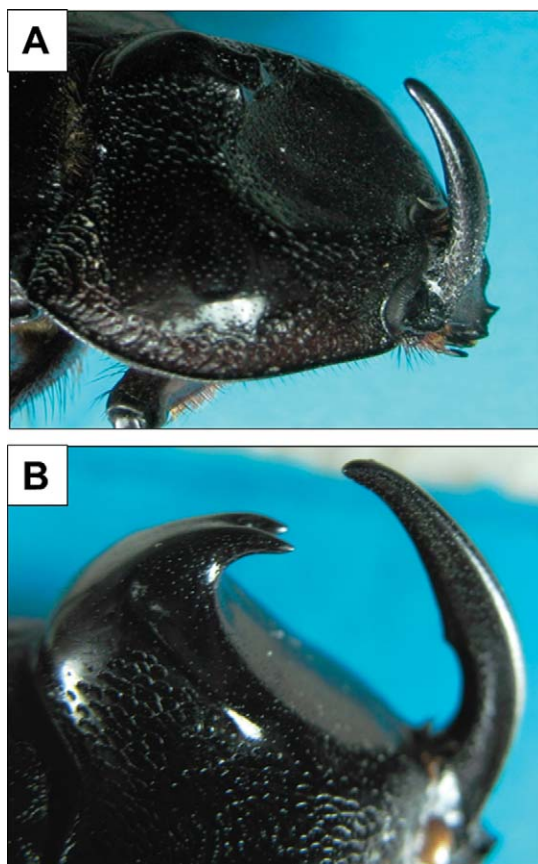


**Fig. 1.** Horns of the adults of *E. pan*: female (A) and male (B). (Online figure in color.)

in a transition area between the Cerrado and Pantanal ecosystems (20° 28′ S, 55° 48′ W).

**Temporal Distribution and Time Flight.** Adults of *E. pan* were collected with a light trap model Luiz de Queiroz (Gallo et al. 2002) deployed daily from January 2006 until December 2007. The trap used a 20 watt fluorescent lamp operated from 1800 to 0600 hours and was placed 1 m above the soil between crops and pasturelands at the experimental farm of the UEMS. This type of trap is considered efficient for collecting Scarabaeidae, being that several species are attracted to light, including *E. pan* (Ratcliffe 2003, Gasca et al. 2008). Flight time of this beetle was studied checking the light trap every 30 min from 1800 to 0600 hours from 14 to 23 October 2007 (methods of Stone 1986).

**Biological and Behavioral Aspects.** Captured adults were first taken to the laboratory where they were quantified and sexed (females, smoothed prothoracic horns; Fig. 1A and B). Sixty-two females were dissected to determine the stage of reproductive period (methods of Crocker et al. 1999). To study the female reproductive system of *E. pan*, specimens were boiled for $\approx 3$ min and then the abdomen was detached and placed in a KOH–water solution for 2–3 d before the terminalia were ready to be removed. Terminalia were

then slide mounted, drawn, and transferred to a vial with glycerin, which was attached to the respective specimens. The nomenclature was in accordance with Zunino and Monteresino (1989), Krell (1996), and Ahrens (2006). Examined material. BRAZIL, Mato Grosso do Sul, Aquidauana, UEMS Experimental farm, light trap, 14x2006, S. R. Rodrigues leg., 4 ♀♀ (dissected).

Biological observations were made of 90 couples. Sixty couples were kept in 10 large plastic containers (55 by 35 by 20 cm) (six couples per container) and 30 couples in 30 smaller plastic containers (30 by 19 by 12 cm) (one couple per container). Containers were filled with soil and rotting wood and were covered with a cloth. Sprouts of *Brachiaria decumbens* Stapf "Basilisk" (Poaceae) were planted in each container. Each container was checked daily for collection of eggs (which were counted), behavioral observations, and removal of dead insects. Ripe native palm fruits [*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.] and decomposing mango (*Mangifera indica* L.) (Anacardiaceae) were offered ad libitum to adults of *E. pan.* Fruit from this palm species were offered based on previous observations in the laboratory and mango because of reports made by Pardo-Locarno et al. (2006).

One hundred and seventy dead adults were pinned, labeled, and dried at 60 ± 1°C during 48 h. Specimens were then weighed and measured (body length, cephalic horn length and prothorax width of males and females) (modified method from Silva and Grützmacher 1996).

Additional information on the behavior of *E. pan* was obtained by inspection of the beetles that were attracted by five lighted areas of the UEMS experimental farm during the period in which their flight time was studied (see above).

**Statistical Analyses.** Previously, to verify whether there was a difference between times of flight for *E. pan*, an analysis of variance (ANOVA) was performed. The data did not show homogeneity of variance and normal distribution; thus, a Kruskal–Wallis (KW) test was used for analysis. The correlation of monthly precipitation and average monthly temperature with the number of individuals was done using the Spearman correlation ($R$). Meteorological data were obtained from the weather station at the UEMS (Aquidauana, Mato Grosso do Sul, Brazil) 300 m from the light trap. Biometric data were submitted to the ANOVA analyses using the dimensions or weight as the response variable and sex of the individuals as the explanatory variable ($P < 0.05$). A Spearman correlation analysis ($R$) was performed between the length of male head ornaments with their body size (length and width of the body).

**Identification and Deposit of Voucher Specimens.** Specimens were identified by Dr. Sergio Ide and vouchers were deposited in the "Coleção Entomológica Adolph Hempel" from the Instituto Biológico (IBSP, São Paulo, Brazil) and the UEMS.

## Results

In 2006 flight activity occurred between September and October. One hundred and fifty-five individuals were collected, 93 in September and 62 in October. In 2007, the flight activity initiated in October and ended in December. Sixty-five adults were collected in October and another 46 in November, but only one in December. Populational fluctuation of *E. pan* was not correlated with precipitation and temperature of the area where this study was conducted (2006, precipitation: $R = 0.0397$, $P > 0.05$; temperature: $R = -0.0191$, $P > 0.05$; 2007, precipitation: $R = 0.1438$, $P > 0.05$; temperature: $R = 0.3655$, $P > 0.05$). Adults were observed in flight from 1930 to 2330 hours, with greatest activity from 1930 to 2030 hours (KW test: KW = 22.5364; $P < 0.01$) (Fig. 2).

The sex ratio was roughly 2:1; 267 specimens (174 females and 93 males) were collected during the 2 yr. In dissected females, the mean number of eggs in 2006 was 20.1 in September and 22.1 in October. In 2007, females presented mean egg counts of 14.8 in October and 21.2 in November (Table 1). The terminalia and reproductive tract have sclerotized, narrow paraprocts over the anal opening (Fig. 3 and 9); proctiger (Figs. 4 and 5, 9) divided in two longitudinal narrow plates and the apical ovipositor; gonocoxites (Fig. 3) lateral to genital opening (Fig. 6) with large, pubescent apex (Fig. 6); large and sacular bursa copulatrix (Fig. 7 and 8); elongated spermatheca and spherical accessory glands (Figs. 7 and 8).

In the laboratory, adults of *E. pan* fed on ripe palm and mango fruit. When mango was offered, the adults of dug tunnels just below the fruit. Tunnels averaged 12.0 cm in depth (range, 10.0–14.0 cm; $n = 7$) and 2.5 cm in diameter (range, 2.0–3.0 cm; $n = 7$). Twenty-four eggs ($n = 3$ females) were found in the recipients where the adults were maintained. Eggs are white and have average dimensions of 3.28 mm in length by 2.32 mm in width ($n = 24$). After 6 d, just one egg hatched. The first-instar larva survived only 9 d and the width of the head capsule was 3.2 mm.

Mean longevity of adults was 22.0 d in the laboratory. The average longevity for females ($n = 112$) was 23.0 d (range, 2.0–95.0) and 19.5 d (range, 2.0–35.0) for males ($n = 93$). Males of *E. pan* measure, on average, 39.3 mm in length and 20.1 mm in width. These dimensions are significantly different from those of the females, which measured on average 38.4 mm in length and 19.1 mm in width (length: $F_{1,168} = 7.5002$; $P = 0.007$; width: $F_{1,168} = 17.8919$; $P < 0.001$) (Table 2). Mean length of the head horn in males was 16.0 mm, which is significantly different from that of females (7.0 mm) ($F_{1,168} = 682.6504$; $P < 0.001$) (Table 2). There were no significant differences in weight between males and females (1,362.2 and 1,331.4 mg, respectively) ($F_{1,168} = 0.5539$; $P > 0.05$) (Table 2). Length of the horn of *E. pan* males was positively correlated with their body size (length: $R = 0.2990$, $P = 0.007$, width: $R = 0.5241$, $P < 0.0001$), i.e., the longer and wider the male, the larger his cephalic horn.
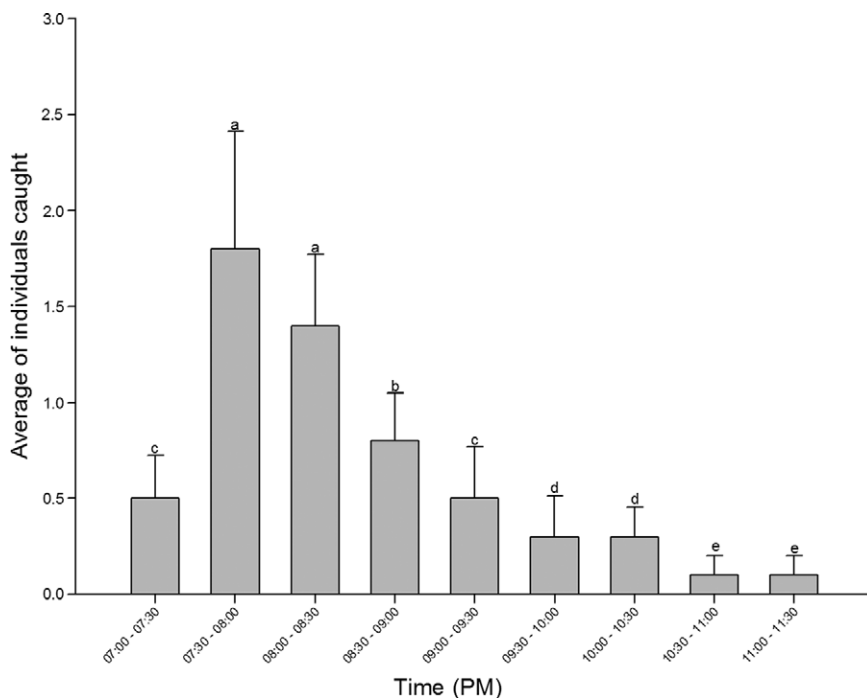
**Fig. 2.** Average number of adults of *E. pan* collected with light trap at different times, in Aquidauana, Mato Grosso do Sul, Brazil. Bars on columns represent standard errors. Different letters above bars indicate difference between means: KW test: KW = 22.5364, $P < 0.01$.

In the laboratory, seven matings were observed occurring between 0800 and 1030 hours and lasted an average of 18.1 min (range, 8.0–27.0). Calling behavior or pheromone release was not observed before copulation. The male walked toward the female, which remained immobile, mounted her and copulation commenced. We observed that some males ($n = 3$) stayed on top of females for ≈15 min (range, 11–19) after copulation ended. Behavioral aspects of *E. pan* were observed in the field. Occasionally ($n = 7$) males held females between the thoracic and head horns for ≈11.1 min on average (range, 1.2–75.0), after which the females were released (Fig. 10A and B). Females held by males usually produced a sound that would attract other males ($n = 14$). Attracted males used their horned against the male holding the female and also walked on the couple. It was expected that copulation occurred just after the female was released, but during the time that this was observed ($n = 5$) copulation did not occur. When males were observed next to other males ($n = 10$), they moved their head horn up and down, trying to hold each other. Males who managed to hold other males ($n = 5$) would walk with the other upheld for 38 cm on average (range, 20–70 cm). The males being held attempted to free themselves and stridulated.

## Discussion

In this study, we recorded the presence of *E. pan* in the state of Mato Grosso do Sul (Cerrado-Pantanel ecotone), amplifying the understanding of its geographical distribution (see distribution of *E. pan* in Brazil in Morón 2004 and Gasca et al. 2008). Currently, little is known in regards to the life history of *E. pan.* Here, we monitored the daily flight activity of these rhinoceros beetles during 2 yr. It was verified that the beetles were encountered in flight during a short period of the year (September–December considering the 2 yr of the studies). In Mexico, adults of *E. pan* were captured with light traps in May (Morón 1979) and August (Carrillo-Ruiz and Morón 2003). In countries such as Costa Rica and Panama, the temporal distribution of *E. pan*

**Table 1. Quantity of eggs (mean ± SE) found in *E. pan* in September–October 2006 and October–November 2007**

| Mo | 2006 | | | 2007 | | |
|---|---|---|---|---|---|---|
| | Mean ± SE | *n* | Range | Mean ± SE | *n* | Range |
| Sept. | 20.1 ± 1.94 | 18 | 06–41 | | | |
| Oct. | 22.1 ± 2.59 | 21 | 02–42 | 14.8 ± 3.44 | 10 | 03–35 |
| Nov. | | | | 21.2 ± 2.71 | 13 | 01–34 |
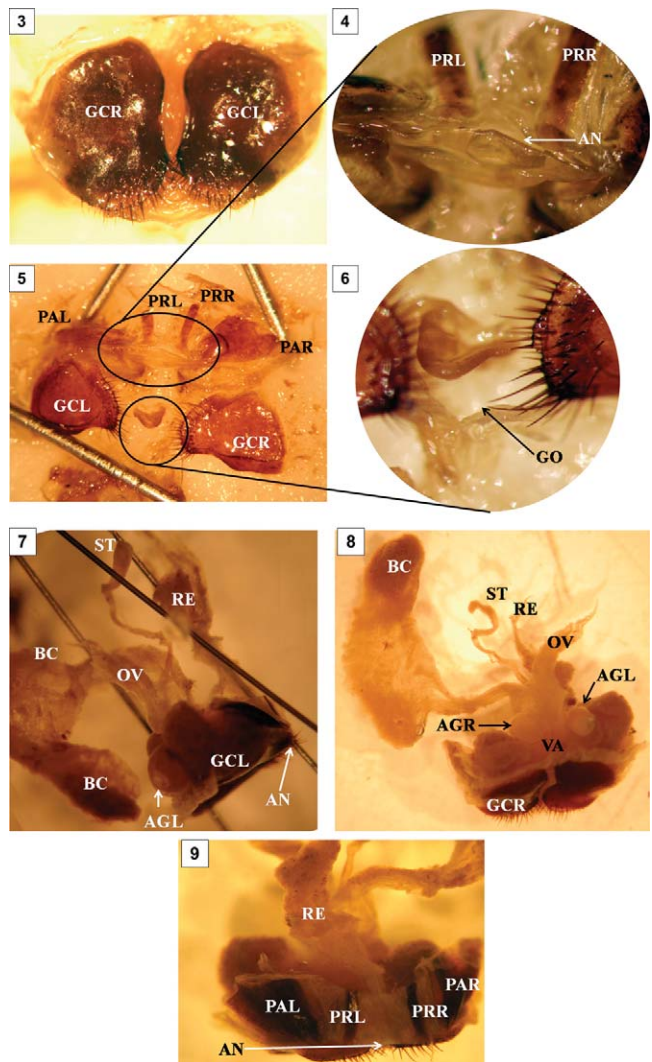
**Figs. 3–9.** *E. pan*, female terminalia and reproductive tract. 3, gonocoxites (ventral view); 4, apical region (distended); 5, anal area; 6, genital opening area; 7, lateral view; 8, ventral view; 9, distal region (dorsal view). AGL, left accessory gland; AGR, right accessory gland; AN, anus; BC, bursa copulatrix; GCL, left gonocoxite; GCR, right gonocoxite; GO, genital opening; OV, oviduct; PAL, left paraproct; PAR, right paraproct; PRL, left plate of proctiger; PRR, right plate of proctiger; RE, rectum; ST, spermatheca; VA, vagina. (Online figure in color.)

occurs between April and September (Ratcliffe 2003). Adults of *E. pan* may be encountered during practically the entire year in the Brazilian Amazon (Gasca et al. 2008). Therefore, seasonal variation of the species in different regions is probably related to the adaptation of the populations to the different biotic factors, abiotic factors, or both of each location.

**Table 2. Body length, cephalic horn length, prothorax width, and weight dried (mean ± SE) of adults of *E. pan***

| Parameter | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | Mean ± SE | $n$ | Range | Mean ± SE | $n$ | Range |
| Body length (mm) | 39.3 ± 0.27* | 80 | 30.1–44.5 | 38.4 ± 0.21 | 90 | 33.9–43.0 |
| Body width (mm) | 20.1 ± 0.16* | 80 | 17.4–26.6 | 19.1 ± 0.16 | 90 | 16.7–27.6 |
| Horn length (mm) | 16.0 ± 0.35* | 80 | 9.8–22.8 | 7.0 ± 0.09 | 90 | 4.5–8.8 |
| Wt (mg) | 1,362.2 ± 32.36[NS] | 80 | 771.9–2,479.6 | 1,331.4 ± 26.50 | 90 | 565.2–2,050.3 |

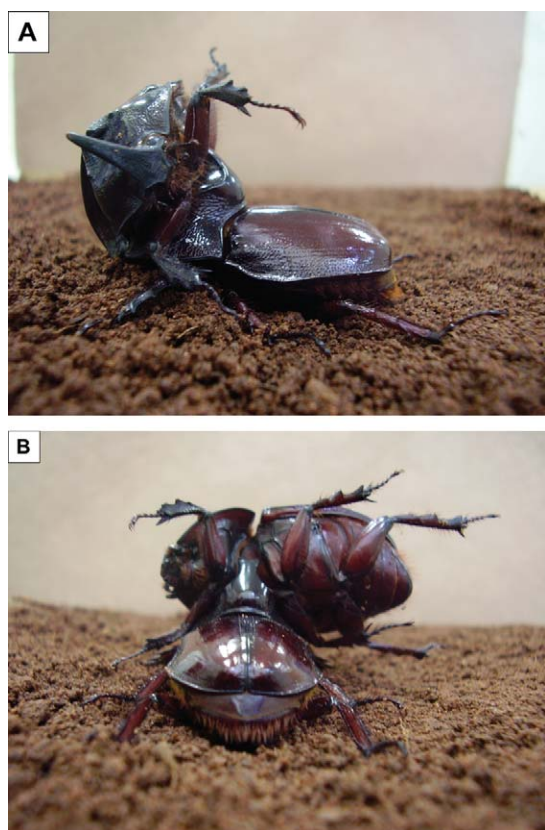* Significant by ANOVA ($P < 0.05$).
[NS] Not significant by ANOVA ($P > 0.05$).

**Fig. 10.** *E. pan*, simulation of male holding female: lateral view (A), rear view (B). Photographed by A.P. (Online figure in color.)



**Fig. 11.** Average monthly temperature and precipitation in an area of the Cerrado-Pantanal ecotone (Aquidauana, Mato Grosso do Sul, Brazil), from January to December 2006 (A) and from January to December 2007 (B).

In this study, no relationship was encountered between the abiotic factors (precipitation and temperature) and population fluctuation of *E. pan* adults, probably for a short temporal distribution of insects and the rainfall highly distributed throughout the year (Fig. 11A and B). Although not statistically proven by the correlation analysis, we believe there is a soil moisture threshold that stimulates and/or facilitating the emergence of the adults of *E. pan.* In 2006, the first adults of *E. pan* were captured only in mid-September, after a yearly precipitation accumulation of 673 mm (Fig. 11A). In the following year, there was no rainfall in September and adults of *E. pan* were not collected. Only in the beginning of October and after accumulation of 679.9 mm of rainfall that the first adult of *E. pan* was captured in the light trap (Fig. 11B). In Costa Rica and Panama, adults of *E. endymion* are abundantly attracted by light traps, especially during the beginning of the rainy period (Ratcliffe 2003). This relationship has been observed for other Dynastinae and Rutelinae beetles, as for example in *Cyclocephala signaticollis* Burmeister (Cyclocephalini) (Mondino et al. 1997) and *Leucothyreus dorsalis* Blanchard (Geniatini) (Rodrigues et al. 2010b).

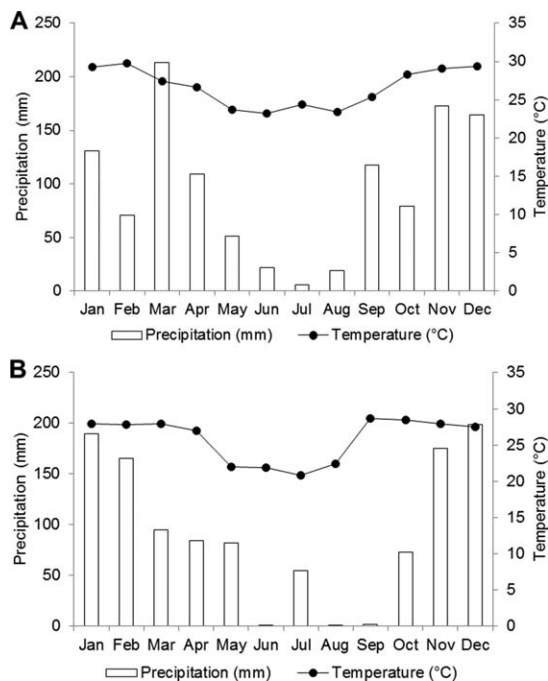The peak of greatest flight activity lasted roughly 1 h (1930–2030 hours), and this is probably related with decreasing luminosity, as well as a decrease in temperature and possibly increase in soil moisture content, which may function to stimulate flight activity. The time of flight activity of other Oricyni has not yet been effectively studied, but it is known that in Mexico, adults of *E. pan* remain below the soil during the day and emerge in large number at dusk (Morón 1979). Individuals of *Xyloryctes thestalus* Bates and *Xyloryctes ensifer* Bates (Orictyni) are captured with light traps with greatest incidence between 2000 and 2100 hours for the first species and between 2000 and 2200 hours for the second species (Morón 1981). In Colombia, adults of *Podischnus agenor* (Olivier) (Oryctni) have frequently been observed flying in lighted areas between 2000 and 0500 hours, and individuals of *Heterogomphus dilaticollis* Burmeister (Oryctni) have been observed in flight between 1830 and 0500 hours (Neita and Orozco 2009).

During the 2 yr (2006 and 2007) in which adults of *E. pan* were collected, some females were selected to verify the presence of eggs during the flight period. Females that were captured by the light trap possessed developing eggs; therefore, it can inferred that the beetles exit the soil sexually mature. To better understand the reproduction of this rhinoceros beetle species, the female reproductive organs were analyzed, helping to expand knowledge on morphology of the female reproductive system in Dynastinae beetles.

Adults were confined to the plastic containers and fed ripe palm and decomposing mango fruit. Adults of *E. pan* dig tunnels below the mango fruits. In nature,

these tunnels are probably constructed for shelter, to store the aliment for its progenies, or both (e.g., Knaus 1924). Other species of Oryctini also produce galleries similarly to *E. pan,* including for example, adults of *Coelosis biloba* (L.) (Oryctini) that dig tunnels for refuge during the day and are night active only (Pardo-Locarno et al. 2006); adults of *X. thestalus* (Oryctini) were observed both in the field and in the laboratory digging individual galleries 20–25 cm in depth where they remained during the day (Morón and Zaragoza 1976); and larvae of *Strategus cessus* Leconte (Oryctini) may be encountered feeding within the tunnels (40 cm in depth) constructed by the adults (Morón and Deloya 1991). Males of *H. dilaticollis,* when sexually mature, produce galleries in the soil of up to 60 cm deep; however, mating occurs outside the tunnels (Neita and Orozco 2009).

Eggs were ovipositioned individually in the soil, but only one hatched. The small number of eggs and females ovipositing is believed to be due to laboratory conditions, especially the volume of soil present in the containers and the food offered that may be inadequate to stimulate egg laying. The low viability of eggs may be caused by a series of factors related to confinement of the adults (e.g., small space for flying, low number of matings, unavailability of food suitable for the progeny). The size and characteristics of the eggs of *E. pan* that were found in this study were similar to other Oryctini, *Strategus mormon* Burmeister (Knaus 1916).

Average longevity of *E. pan* males and females is little >20 d in laboratory conditions. However, one female remained alive for 3 mo in the laboratory. We observed that the adults fed on palm and mango fruit, different from *C. biloba,* which can survive for weeks in the laboratory without feeding (Pardo-Locarno et al. 2006).

Specimens of *E. pan* encountered in Panama ($\approx$ 47 mm in length by 28.2 mm in width) (Ratcliffe 2003) and in the Brazilian Amazon (males, 45.0–58.5 mm in length by 23.5–31.6 mm in width) (Gasca et al. 2008) are notably larger than those encountered in the Brazilian Cerrado-Pantanal ecotone. The different food source may have contributed to the difference in size among adults. Males from in the Brazilian Amazon, Costa Rica, and Panama are larger than females (Ratcliffe 2003, Gasca et al. 2008), a pattern similar to that encountered in the current study. As was observed in *E. pan,* males of *D. abderus* are significantly larger than females, but weight was similar in both sexes (Silva and Grützmacher 1996).

In the laboratory, behavioral activity involved before, during, and after mating was observed (see Results). Adults were observed mating during the morning in the laboratory, but we cannot be sure that this occurs in nature. In the field, this probably occurs with the formation of couples at night and later adults may dig nests to perform intercourse, perhaps at day or night. Several studies report information on the construction of nests and perhaps this is extremely important to allow that adults can mate. For *E. pan,* this need be studied in-depth in the field. It is known, for example, that mating of *H. dilaticollis* (Neita and Orozco 2009) frequently occurs at the entrance of the galleries that are dug in the soil. Mating of *Strategus aloeus* (L.) (Oryctini) (=*Strategus julianus;* see the revision of Ratcliffe 1976) seems to occur spontaneously, without prior courting and lasting between 5 and 15 min (Morón 1976), as was observed here in *E. pan.*

We found that males had larger cephalic horn than females and also possessed prothoracic horns (Fig. 1). During this study, through observations performed in the field, we observed the fascinating behavior of males to capture and carry other males and females using their horns. Similarly to others Dynastinae (see Beebe 1944), we believe that the significant relationship between body size of males of *E. pan* and its head ornament may be possibly related to sexual selection and the reproductive success of males. Those with larger horns probably have higher reproductive success because they can carry females, thus decreasing sexual competition. Moreover, males with smaller body and horn sizes probably rely on a different strategy to ensure his partner. Besides this function of transporting the female and/or apparatus for defense against other males, the horns can play an important role in the excavation of nests for the couple. Similarly, adult males of *S. aloeus* use their horns in combat with other males (Morón 1976). Battles between males of *S. aloeus* in defense of feeding and/or reproduction territories may last up to 3 h, suggesting that this conduct is involved with sexual selection (Morón 1976). We think that to produce horns is expensive for insects and small ornaments cephalic were observed in females of *E. pan.* However, the use of this apparatus was not observed both in laboratory conditions and field.

When males carry the females or when fighting with other males, the adults emit sounds (males and females), but little is known on its origin and/or function. We suspect that the tentative release of females held by males is a result of the stridulatory sounds produced by the females. Stridulation by held males did not attract other males or promote release. When studying other Dynastinae, Forrest et al. (1997) found auditory organs behind the head of *Euetheola humilis* Burmeister (Pentodontini); they reported that the same type of structure can be present in species of *Cyclocephala* Dejean, *Dyscinetus* Harold (Cyclocephalini), and *Oxygrylius* Casey (Pentodontini). Morón and Zaragoza (1976) reported the presence of stridulatory organs located in the upper leg and cavities of this region in adults of *X. thestalus* (in males and females). These authors suggest that the beetles use this mechanism to attract the opposite sex, and may be used by males to intimidate other males; combat between males is probably due to possession of females.

However, we believe that the sound emitted by the female of *E. pan* may be a mating strategy, as it attracts other males. As disputes typically occur, it is likely that the largest male intimidates its opponents and is the male selected for mating. Evolutionary this strategy of the female may be interesting, because their offspring

may possess large horns. The genetic potential and the quality and quantity of food ingested during the larval stage also certainly influence the morphology of adults.

In conclusion, we provide interesting information on the biology and behavior of *E. pan,* but in general, little is still known on the life history of other Neotropical Dynastinae. This is even more pronounced for Brazilian species that inhabit the Cerrado and Pantanal ecosystems for which the understanding of biology, diversity, and ecology of these beetles is very limited. Life history of *E. pan* and especially the actual role of the cephalic horns of males in selection and sexual conflict must be better evaluated in future studies.

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