

## ECOLOGY, BEHAVIOR AND BIONOMICS

### Natural History and Biology of *Chlamisus minax* Lacordaire (Chrysomelidae: Chlamisinae)

WILSON F. REU JR.<sup>1</sup> AND KLEBER DEL-CLARO<sup>2</sup>

<sup>1</sup>Programa de Pós-Graduação em Entomologia. Fac. Filosofia Ciências e Letras de Ribeirão Preto  
USP. Av. Bandeirantes 3900, 14040-901, Ribeirão Preto, SP

<sup>2</sup>Instituto de Biologia, Programa de Pós-Graduação em Ecologia e Conservação de Recursos Naturais  
Univ. Federal de Uberlândia, C. postal 593, 38400-902, Uberlândia, MG

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Biologia e História Natural de *Chlamisus minax* Lacordaire (Chrysomelidae: Chlamisinae)

RESUMO - Embora muito abundantes nos Neotrópicos, pouco se sabe sobre a biologia, ecologia e história natural dos besouros Chlamisinae brasileiros. No presente estudo investigamos diretamente no Cerrado aspectos da história natural e biologia de *Chlamisus minax* Lacordaire. Os resultados mostram que a espécie tem ciclo anual, com adultos presentes no campo durante a primavera e o verão, quando ocorre a reprodução. As fêmeas cobrem seus ovos com um “manto”, mais tarde as larvas adicionam a casca do ovo e fezes ao manto para a confecção de uma capa cônica, que recobre a larva protegendo-a de seus inimigos naturais. Os seis morfo-estágios larvais são herbívoros, alimentando-se de botões florais de *Heteropterys pteropetala* A. Juss. (Malpighiaceae). As larvas empupam nas plantas hospedeiras e suas pupas caem no solo permanecendo em diapausa de abril a outubro. Este é o primeiro estudo a investigar a biologia e história natural de um Chlamisinae brasileiro diretamente no campo.

PALAVRAS-CHAVE: Besouro, Cerrado, comportamento, herbivoria

ABSTRACT - Although very abundant in the Neotropics, there is little information about the biology, ecology and natural history of Brazilian Chlamisinae beetles. In the present study we investigated directly in the Cerrado vegetation the aspects of natural history and biology of *Chlamisus minax* Lacordaire. The results showed that the species has annual cycle and the adults are present in the field during the spring and summer when the reproduction occurs. The females cover their eggs with a mantle, and later on the rests of the egg and faeces are added by the larva to the mantle to produce a protective case. The six larval morpho-stages are herbivorous and feed on floral buds of *Heteropterys pteropetala* A. Juss. (Malpighiaceae). The larvae pupate in the host plants and after that they fall on the ground remaining in diapause between April and October. This is the first study to investigate the biology and natural history of a Brazilian Chlamisinae beetle directly in the field.

KEY WORDS: Beetle, behavior, Cerrado, herbivory

The Coleoptera order, with more than 227 thousands species, is the major animal taxa and groups around 23% of all described animals (Gullan & Cranston 1994). Researchers figure out that beetles can surpass 350,000 species considering the tropics. The Chrysomelidae is one of the three most important beetle families. There are no less than 40,000 species currently worldwide, but probably 100,000 species have existed since the Jurassic, when they first came into, and later diversifying during the Cretaceous with the advent of flowering plants (Jolivet *et al.* 2004). Few beetle families have been studied in such detail as the Chrysomelids. This is not only due to their economic

importance, but also to their incredible variety of forms and behaviors (see Jolivet *et al.* 2004 and quotations therein). The members of important Chrysomelidae subfamilies as Criocerinae, Eumolpinae, Galerucinae, Alticinae, Hispinae, Chlamisinae e Chrysomelinae, are of great economic interest for being agricultural plagues (Jolivet *et al.* 1988). However, in spite of the great diversity of chrysomelid beetles, few studies examining their natural history, biology and population dynamics have been carried out in the field, mainly in the tropics (Frieiro-Costa & Vasconcellos-Neto 2003).

The tribe Chlamisini is a well-defined monophyletic unit in the “Camptosomata”, a large group of leaf-chrysomelids

defined by having all immature stages in a protective case (Reid 1991). Chlamisini is a pantropical tribe with great diversity in the Neotropics and in the Americas, where the tribe is most diverse and *Chlamisus* is the largest genus (Reid 1991). The studies about *Chlamisus* are restricted to taxonomic issues (e.g. Bokermann 1964) and description of host plants (Jolivet 1978).

The Cerrado vegetation covers around 25% of the original natural areas of Brazil, being considered the most diverse tropical savanna of the world and just a little is known about Chrysomelidae beetles in this ecosystem (see Oliveira & Marquis 2002 to a complete view of Cerrado). We do not know any study about the behavior, ecology or biology of *Chlamisus* conducted in Cerrado vegetation. In this paper we will provide information about the biology, natural history and behavior of *Chlamisus minax* Lacordaire in a natural area of Cerrado vegetation in central Brazil. This beetle is commonly found on inflorescences of the Malpighiaceae shrub *Heteropterys pteropetala* A. Juss. (HBK), mainly during the reproductive season of the host plant, between October and January. Like all Chrysomelidae Camptosomata, the Chlamisinae beetles are primarily phytophagous feeding mainly on the bark of their food plants (Erber 1988). The larvae of Chlamisinae can be considered oligophagous or monophagous (Erber 1988). Thus, additionally we investigated in this paper if *C. minax* feeds exclusively on *H. pteropetala* and which plant structures serve as food to larvae and adults.

### Material and Methods

The field work was conducted between September 1998 and May 2000 in a Cerrado (tropical savanna vegetation) in Uberlândia, MG, Brazil. The climate in the region is classified as Aw, according to Köppen, with well-characterized dry and rainy season (Araújo *et al.* 1997, Appolinario & Schiavini 2002). The study site was located in a natural reserve, a property of Clube de Caça e Pesca Itororó de Uberlândia (CCPIU - 48°17' W; 18°58' S). In that area with 628 ha, the Cerrado (strict sense) is the main landscape (Appolinario & Schiavini 2002).

The reserve is cut by a trail and in a first moment we established five perpendicular transects (100 m long) distant 50 m between each one. In this transects, between September and December of 1998, we examined all the plants present (0.5 – 1.5 m tall), in the 2 m of each side of each transect, searching for eggs, larvae or adults of *C. minax* once a week.

In the study site, several species of Malpighiaceae shrubs occur in patches of aggregate distribution, what is commonly observed with *H. pteropetala*, the main host plant of *C. minax*. In December 1998 we randomly chose one of these groups (0.5 ha) and tagged all *H. pteropetala* existent in the square, a total of 40 shrubs. Between December 1998 and May 2000, we weekly examined each plant registering the presence of eggs, larvae or adults of *C. minax* and also recording their position in the plant.

Once a month we recorded phenological data from each shrub as the presence of young leaves, blossoms, flowers and fruits. We took data from larvae and adults as size, if

they were feeding or not, characteristics of the feeding behavior, if there was some natural enemy present, and the behavioral response of the larvae or adult in the presence of their enemy. We additionally registered the sexual behavior of the adults. All behavioral observations were made according to the “all occurrence sample” method (Altman 1974, Del-Claro 2004).

In ten distinct shrubs, during the flowering season of 1999 (October – January) we covered one of their inflorescences with a bag made of bride. Each inflorescence had five eggs of *C. minax*. This procedure was made to enable us to follow the larval development of the beetle until adult directly in the field. The number of blossoms eaten by the larvae weekly was also registered.

Climate data were obtained from the Estação Climatológica e Recursos Hídricos from Universidade Federal de Uberlândia (UFU). Voucher specimens were deposited in the entomological collection of the Museu de Zoologia da Universidade de São Paulo (MZ – USP) and in the Museu de Biodiversidade do Cerrado (MBC - UFU).

### Results and Discussion

Due to their peculiar characteristics, *C. minax* eggs, larvae, pupae or adult were easily identified in the field. The females of *C. minax* cover their eggs with a mantle (Fig. 1) and this is a common feature of all subfamilies of Camptosomata. The mantle is subsequently worn as a protective case by the larvae and is enlarged as they grow (Fig. 1). For this reason *C. minax* like other Camptosomata are called “casebearers” (Erber 1988). The appearance of the adults varies from colored, patterned, species to uniformly dark, often shining metallic species (Erber 1988). *C. minax* adults are yellow-caramel colored with some black small spots. In the Cerrado vegetation, this Chlamisinae is a monophagous species feeding exclusively on the Malpighiaceae *H. pteropetala*. We have never found their eggs or larvae in other plant species. Occasionally we could found adults visiting or resting in other species, but never eating structures of other hosts than *H. pteropetala*.

*C. minax* is an univoltine beetle starting its cycle in the middle of October, just after the first spring rains in September, when the adults emerge from the pupal stage. The pupal stage occurs inside a cocoon that falls off the host plant on the ground in April and delays until October when the new adults wake up from their diapause (Fig. 2). It is possible that old adults can also have a diapause phase in the same period but we didn't observe it nor in the field neither in laboratory conditions.

The period of adult emergence is also at the beginning of the reproductive season of *H. pteropetala* (Fig. 3). The variation in the rainfall can have a strong influence on the vital activities of insects and their host plants (Del-Claro & Oliveira 2000) and the availability of host plants may greatly influence the population dynamics of herbivorous insects (Wolda 1980, 1988). The majority of Camptosomata species are thermophilous, what is shown by their numerical abundance in the tropics (Erber 1988). *C. minax* follows the steps of its taxa, that is, its cycle covers the hottest months



Figure 1. Egg (A) of *C. minax* and the first (B) and third (C) larval stage feeding on buds of the host plant *H. pteropetala*. *Camponotus crassus* Mayr (D) feeding on an extrafloral nectary of *H. pteropetala*.

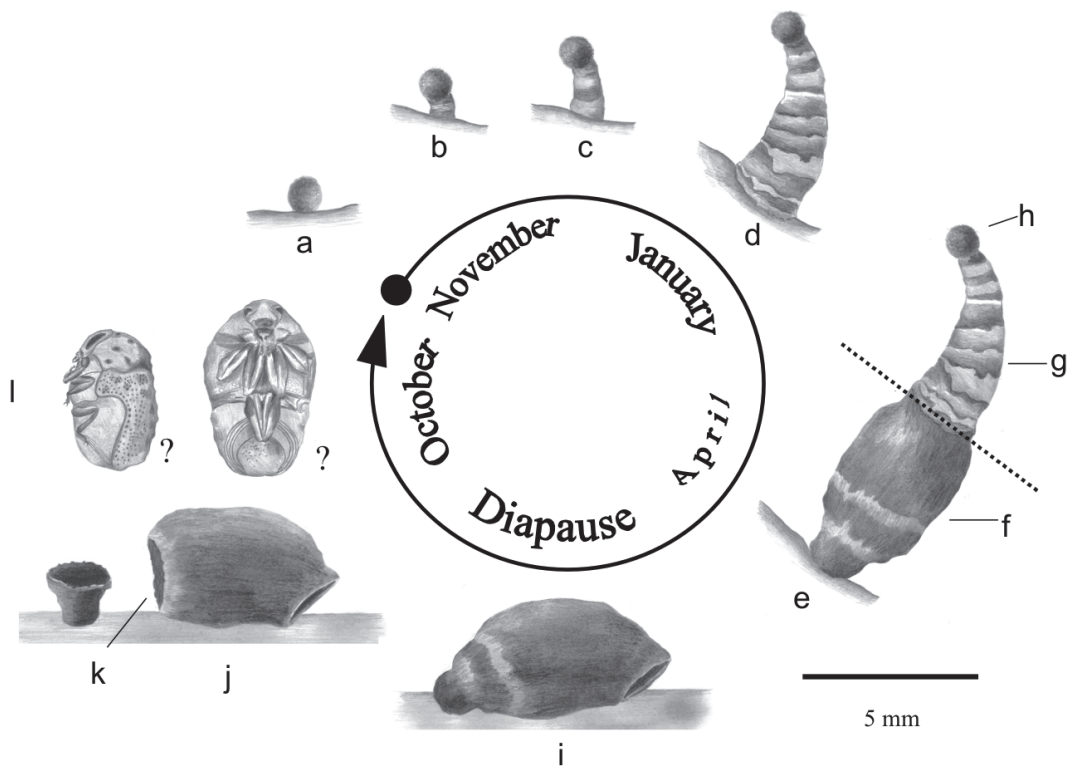


Figure 2. Illustration of the cycle of *C. minax*, showing the duration of the following stages: egg (a); first to second larva (b); third-fourth larva (c); fifth larval stage (d); sixth larval stage or pre-pupae stage (e, including f – the pupae or basis of the mantle, g- the upper mantle and h – the eggshell); the pupae (i), showing the opening pupae (j) and the section that is cut by the larva to exit (k); adults (l).

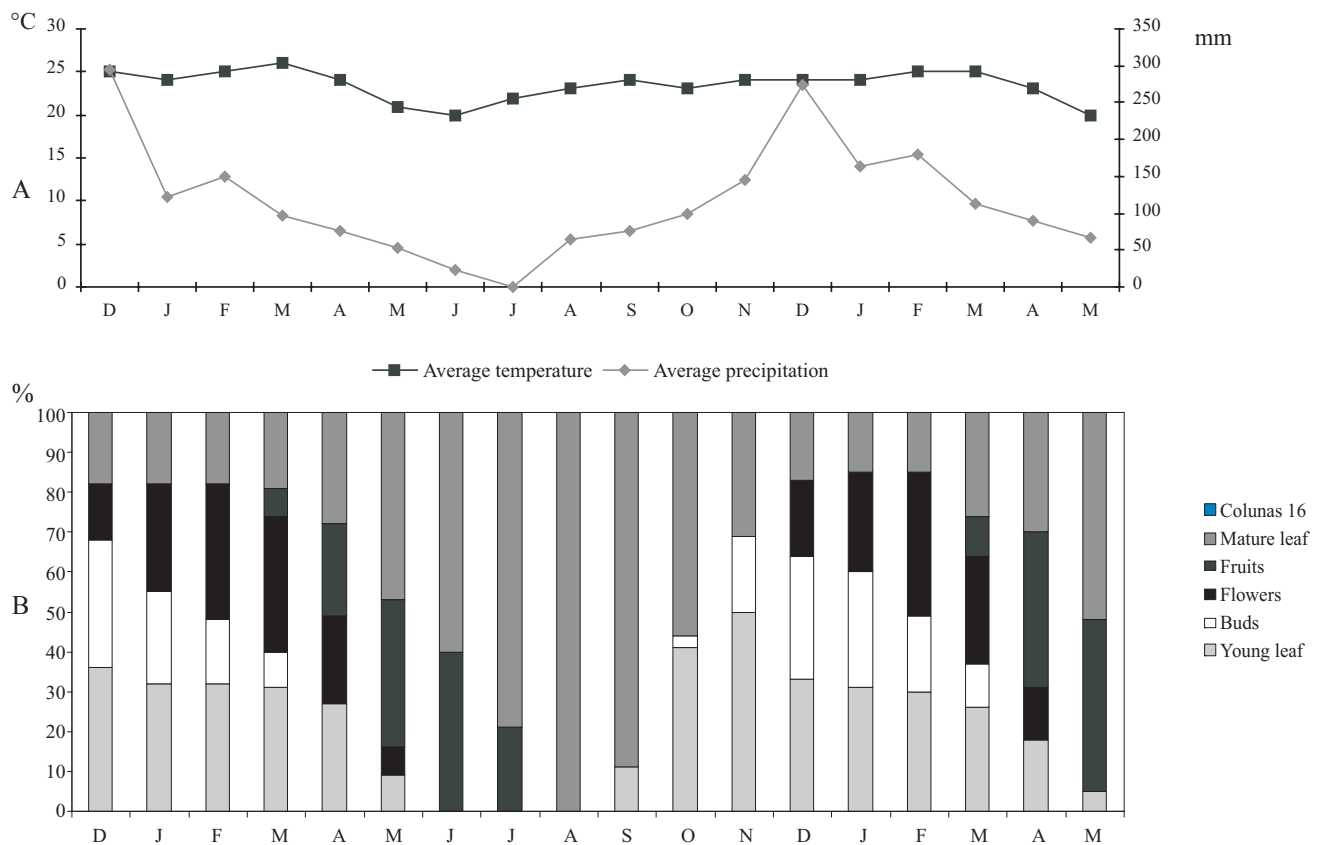


Figure 3. Meteorological conditions (A) and phenological data (B) of *H. pteropetala* in the Cerrado during December 1998 and May 2000.

of the year in cerrado vegetation (Figs. 2 and 3). This pattern also occurs in other Chrysomelidae beetles in different areas of Brazil (e.g. Medeiros & Vasconcellos-Neto 1994, Frieiro-Costa & Vasconcellos-Neto 2003).

The females were larger ( $5 \pm 0.5$  mm;  $x \pm 1$  SD;  $n = 7$ ) than males ( $4 \pm 0.3$  mm;  $x \pm 1$  SD;  $n = 8$ ), as in other chrysomelids, like the Cassidinae (e.g. Frieiro-Costa & Vasconcellos-Neto 2003). The Chlamisinae feed mainly on the bark of their host-plant and some species such as those of genus *Exema* Pierce, nibble at the epidermis of green leaves, stems and flowers (Karren 1964). Adults of *C. minax* fed on young leaves and stalk of floral buds exclusively of *H. pteropetala*. The copula was observed by the end of October, when plants produce the first inflorescences, occurring in day-light at the basis of the stem of young inflorescences ( $n = 5$ ). In Camptosomata one copulation may last from hours to days and a single female can probably mate with several males one after other (Erber 1988). In the field the copula of *C. minax* lasted more than 3h. During the copulation the male mounted the female at an angle around  $80^\circ$ , resting his legs on the female's back, holding the edge of thorax and elytra with its tarsi. Similar to other Chlamisinae (Erber 1988), oviposition began soon after mating and each egg was entirely enveloped in small plates of excrement. The eggs were deposited one by one, isolated, generally in

stems nearby the inflorescences (Fig. 1).

The first eggs were found in the first days of November what suggests a sazonal similarity in the reproductive cycle of Brazilian chrysomelids. Medeiros & Vasconcellos-Neto (1994) registered a similar condition to four distinct species of leaf-beetles (Chrysomelinae) in a forest of Southeast Brazil. Frieiro-Costa & Vasconcellos-Neto (2003) found the first egg-clutches of *Omaspides tricolorata* Boheman (Cassidinae) at the end of October and beginning of November.

Casebearer beetles became difficult to determine exactly the change between each of their larval stadia, due to the existence of the protective case (Erber 1988). Pierce noted four larval stages to the chlamisine *E. canadensis* Pierce (Erber 1988). The larval of *C. minax* had six morphometric stadia and completed its development in about three months (Fig. 2). This long larval period is common to many Camptosomata species (Erber 1988). Until the fourth larval stage we could perceive the transition between stages mainly due to a conspicuous change in the larval behavior.

The larva of Camptosomata remains within their case with the abdomen curved. This ensures, on the one hand, that they can remove the faeces from the anus with their mandibles and add them to the larval case. On the other hand, the "enlarged" abdomen prevents the case from being lost

(see Erber 1988 for details). During the moult the larva did a 180° turnover inside the case exhibiting for some minutes its abdomen, extending it, and after that returning to its normal position. After this stage the larvae clearly increased the case.

The larvae ate floral buds and even flowers of the host plant (Fig. 1). The stems covered with bride produced in their inflorescences  $187 \pm 26$  buds ( $x \pm 1SD$ ,  $n = 10$  inflorescences) and in an average each larva ( $n = 5$  larvae/inflorescence) was able to eat  $12 \pm 2$  buds per week. By the end of the season around a third of the buds and flowers of each inflorescence had been destroyed. The host plant has a pair of extrafloral nectaries in the basis of its leaves, including the small leaves of the inflorescences. These active nectaries attract ants to climb on *H. pteropetala* only during the young phase of each leaf (Fig. 1). The ants commonly attack herbivores in the leaves and inflorescences of the plant. When found by an ant, the adults of *C. minax* fly away or simply fall on the ground below the host plant, but the larvae do a different thing. When danger threatens, the larvae retract into the case, and the strongly sclerotised head capsule forms a secure seal. Depending on how the larvae have retracted into the case, still strongly attached to the buds structures, the sealing effect does any ant attack non-effective.

The larva reaches the sixth stadia during February and at the end of this month the host plant has few buds and flowers and the fruits begin to be abundant. They pupate in March and more delayed individuals in early April (Fig. 2). During the pupation process the upper part of the mantle is broken resting only the larger basis (Fig. 2). Larvae of phytophagous beetles will probably pupate on their host-plants (Massuti 1960) or in the region where this main branch emerged from the ground (Frieiro-Costa & Vasconcellos-Neto 2003). However, in *C. minax* the pupae fall from the host plant on the ground below and remain in there until the beginning of the next reproductive season in October.

As far as we are concerned this is the first study to investigate directly in the field the biology and natural history of a Brazilian Chlamisinae species. There are other interesting species of Chlamisinae beetles in the Brazilian Cerrado, having as host plants Sterculiaceae, Euphorbiaceae, Myrtaceae, Maleastomataceae, but mainly Malpighiaceae shrubs (Jolivet 1978). They are relatively easy to recognize in the field and, although, some species could be new and the systematic sometimes confusing, species like *C. minax*, due to its peculiar behavior and interesting interactions encourage lovers of natural history to study these animals and their secrets inside a case.

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