

Scientific Note: Observations on the courtship and other biological aspects of *Athis hechtiae* (Dyar, 1910) (Castniidae) in Tehuacán, Puebla, Mexico

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Abstract: *Athis hechtiae* is a giant butterfly-moth endemic to Mexico, and frequently seen in the Tehuacán-Cuicatlán Valley in Puebla and Oaxaca. Details on courtship as well as ecology, plant associations and other previously unknown bionomic and behavior details are provided.

Key words: *Athis*, bionomics, *Hechtia roseana*, *H. tehuacana*, Lepidoptera.

Resumen: *Athis hechtiae* es una polilla diurna endémica de México, frecuentemente observada en los estados de Puebla y Oaxaca en el Valle de Tehuacán-Cuicatlán. Se proporcionan detalles sobre el cortejo, así como ecología, asociaciones con plantas y otros aspectos bionómicos y de comportamiento previamente desconocidos.

Palabras clave: aspectos bionómicos, *Athis*, *Hechtia roseana*, *H. tehuacana*, Lepidoptera.

The Neotropical Castniinae (Castniidae) contains a number of taxa distributed from North America, Mexico, through Central America, and all the way to Argentina and Chile, in South America (Miller, 1972, 1986; González & Cock, 2007; González *et al.*, 2008, 2019; Ríos & González, 2011). The Mexican species of Castniidae are unusually diverse and several are known to be endemic (Miller, 2000; González, 2008; Vinciguerra *et al.*, 2011; González & Hernández-Baz, 2012; González & Stüning, 2007; González *et al.*, 2019; Galindo *et al.*, 2020). Among those endemic species is *Athis hechtiae* (Dyar, 1910) (Fig. 1), originally described (as *Castnia hechtiae*) based on one male collected in Tehuacán in 1909 by the well-known German-Mexican Roberto Müller (1859-1932), a pivotal figure in the development of the Mexican lepidopterology, while the moth was apparently resting “on [a] *Hechtia*” plant (Bromeliaceae) (Dyar, 1910; Hoffmann, 1932; Beutelspacher, 1992). Even though the genus *Athis* Hübner is the largest of the subfamily and some systematic and faunistic research has been focused on several species in the genus, little is known about many aspects of their eco-ethology (Miller, 1972, 1986; González & Fernández Yépez, 1992, 1993; González, 2004; Vinciguerra & González, 2011).

Tehuacán is a valley located in eastern central Mexico which lies between the states of Oaxaca and Puebla. The region seems to have several endemic plant species (Dávila-Aranda, 1983; García-Díaz & Turrent-Carriles, 2019a, 2019b, 2020). The Tehuacán and the contiguous Cuicatlán valleys are both part of the Tehuacán Valley Matorral, a xeric shrubland ecoregion that it is part of the deserts and xeric shrublands

biome (Byers, 1967; Dávila-Aranda, 1983; SEMARNAT-UAM, 1997). Several species of cacti (Cactaceae), bromeliads (Bromeliaceae), *Yucca* (Asparagaceae) and *Acacia* plants (Fabaceae) are present in the Tehuacán Valley (Fig. 2A) (Dávila-Aranda, 1983; García-Díaz & Turrent-Carriles, 2019a, 2019b, 2020). Among the most common bromeliads in the area is *Hechtia tehuacana* B. L. Robinson, and *H. roseana* L. B. Sm., two species distributed only in the Tehuacán-Cuicatlán Valley, in Oaxaca and Puebla states (Espejo Serna *et al.*, 2004; López-Ferrari & Espejo-Serna, 2014).

Athis hechtiae is a giant-butterfly moth (Castniidae) frequently found in Tehuacán, Puebla (Dyar, 1910, 1912; Hoffmann, 1932; Beutelspacher, 1992; Vinciguerra *et al.*, 2011). Over the last few years, the first author (JG) has observed interactions among males of *Athis hechtiae* in San Diego Chalma, in the municipality of Tehuacán, Puebla. He also observed males and females engaged in courtship and *in copula* at least eight times. On one occasion, JG observe larvae boring inside a plant and a pupa emerging from another, and in both cases the hostplant was found to be *Hechtia tehuacana*, a confirmed host of this moth species in Tehuacán.

Athis hechtiae is common in the Tehuacán Valley Matorral eco-region in open areas as high as 1200-2000 m above sea level, with an abundance of bromeliads and *Yucca* species (Fig. 2A), where it can be found flying from late May to the beginning of August, depending on the rainy season. During the years that adults emerge early, it is possible to see a small batch of individuals appearing around late May to early June. When they are late in the season, a last batch can be observed



Figure 1. *Athis hechtiae* (Dyar) from San Diego Chalma, Tehuacán, Puebla, Mexico. **A.** male; **B.** female. Scale bar 1 cm.

early in August. Adults are most abundant from mid-June to mid-July, and males tend to emerge first, with females emerging about 10-15 days later. Males and females start flying around 10:30-11:00 on sunny days, with temperatures that might vary between 22-24°C. On cloudy days they were observed to fly later, around 12:00. Although less active, adults were also observed to fly during cold days or in light drizzle, with some individuals seen flying at temperatures as low as 16-18°C, but no individuals were seen flying in rain. During the earlier hours of the day, males were observed flying more commonly than females, whereas as higher temperatures were reached in the middle of the day (28-35°C at 12:00-12:30) individuals of both sexes became lively and skittish while flying from plant to plant, becoming most active from 12:30-14:00. Adults tended to fly in open spaces, where vegetation was low and there was abundance of *Hechtia* species (mainly *H. tehuacana* and *H. roseana*). Once the temperature decreased or the day became cloudy, individuals rested quietly on the leaves of bromeliads, *Hechtia* or *Agave* (Asparagaceae) plants, but also on the twigs of dry shrubs.

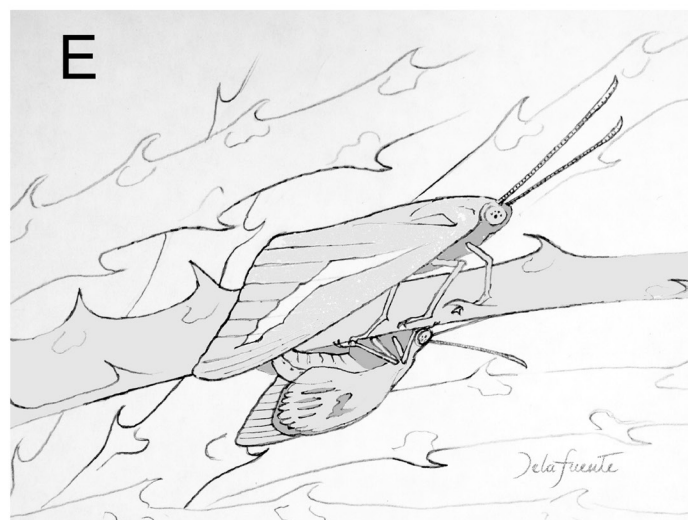
Males flew fast, in an “up and down” fashion, most often around 1.5-2.5 m above ground and vegetation, and females were similar but slower in flight. The females were observed flying between branches of the tallest shrubs as well as low down among bromeliads, *Yucca* and *Agave* plants, and shrubs.

Males typically perched with their forewings almost covering the hindwings, in a stegopterous position, as do most Castniidae (Miller, 1986; Ríos & González, 2011; Vinciguerra *et al.*, 2011; González *et al.*, 2019). They mainly tended to perch on the leaves, green or dried, of *Hechtia* plants (Fig. 2B), where their cryptic coloration provided camouflage among the leaves. It was also often observed that once perched, an individual slowly walked towards the tip of the leaf. Males were territorial and easily disturbed if other males or potential predators approached close to them. If another male or any medium to large butterfly flew near a *Hechtia* where a male was perched, the latter chased the intruder away, and males were frequently seen chasing each other up to 15-20 m above ground.

JG observed birds capturing and eating these high-flying moths, whereas birds were less successful capturing moths during their faster, regular flights at a height of 2-2.5 m above ground. After males returned back to near the ground, they returned to their original perching site or to a site near to it.

Females frequently rested on the middle to upper and open sections of *Hechtia* plants (Fig. 2C). They were not observed to slowly walk to leaf tips as did the males, and when they decided to leave their perching site, they did so by flying up to 2 m above ground. Males were commonly observed to appear while the female was resting or engaged in short flights in search of other *Hechtia* plants. One to four males typically pursued the female for a few meters until the female chose one male, frequently the one closest to her. When the pair reached a suitable host plant, most frequently *H. tehuacana* but also *H. roseana*, both individuals walked close to the center, and the male mounted the female. If they were in an internal area of the center of the plant, the pair moved to the center with their heads pointing in opposite directions, but still engaged in copulation (Fig. 2D). If the female stayed near the tip and on the upper side of a leaf, the male moved below, opposite and to the underside of the leaf, with both individuals oriented in the same direction (Fig. 2E). Copulation lasted about four to five minutes. After this time, the individuals left in opposite directions and the female located a nearby host plant on which to oviposit. Females were easier to observe due to their larger size and the slightly orange color of their forewings.

To oviposit, the female walked to the center of the host plant, which is more densely covered with thorns, and they laid their eggs there at the base of the leaves. Females were frequently observed with wings damaged by thorns. Based on several eggs (62) released by recently captured females and placed in an envelope, the smooth, elongate eggs are beige, 1-2 mm long and 0.6 mm wide. Pinkish larvae with a sclerotized, brown head, wider than the body, emerged from some of these eggs after 14 days, but unfortunately the larvae died within a couple of hours following eclosion.



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Figure 2 (p. 88, facing page). Details on the natural history of *Athis hechtiae* (Dyar) in the locality of San Diego Chalma, Tehuacán, Puebla, Mexico. **A.** General view of a section of the Tehuacán Valley Matorral eco-region showing cacti (Cactaceae), bromeliads (mainly *Hechtia* spp.) (Bromeliaceae), *Yucca* (Asparagaceae) and other plants typical of xeric environments, Tehuacán, Puebla. **B.** Male of *A. hechtiae* perching on dry leaf of a *Hechtia* plant. Notice the typical stegopterous perching, slightly showing a minute part of the hindwings. **C.** Female resting on dry leaf of a *Hechtia* plant. Notice the ripped edges of the wings, mainly caused by flying and moving along the thorny leaves of the *Hechtia* plants during oviposition. **D.** Male and female of *A. hechtiae*, in copula, in the central area of *Hechtia tehuacana*. The female is seen on the right, with wings open and looking toward the apex of the leaves. The male is looking toward the center of the plant and its wings are up. **E.** The figure shows a male (bottom) and a female (top) of *A. hechtiae*, in copula, near the apex of a leaf of a *Hechtia* plant (drawing by Roberto de la Fuente).