Field observations of *Agapema dyari* Cockerell, 1914 (Lepidoptera: Saturniidae) in western Texas

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Abstract: Observations of oviposition, larval behavior, and cocoon placement were made for *Agapema dyari* at Fort Davis in western Texas in 2002, 2003, 2013, and 2016, with additional observations at two other field sites. The population level at the main field site was seen to drop significantly between 2003 and 2013. The larvae spend the cold nights at the base of the hostplant (*Condalia ericoides,* Rhamnaceae), moving to the tops of the plants at various times during the day to thermoregulate. For alternate hosts, the larvae freely accepted *Condalia hookeri,* but rejected *Ziziphus mucronata*. Seven to 31 eggs were counted in a sample of 8 egg masses. Cocoons are double layered, both of which are reticulate, and are attached to outer branches of the hostplant. Two new county records are given for the distribution of the species. Mature larvae of *A. dyari* are often found in company with those of *Hemileuca chinatiensis* on the same plants.

Freilandbeobachtungen im westlichen Texas über *Agapema dyari* Cockerell, 1914 (Lepidoptera: Saturniidae)

Zusammenfassung: Freilandbeobachtungen zu Eiablage, Raupenverhalten und Kokonplazierung von *Agapema dyari* wurden 2002, 2003, 2013 und 2016 im westlichen Texas bei Fort Davis durchgeführt, mit ergänzenden Beobachtungen von zwei anderen Plätzen. Die Populationsdichte fiel stark zwischen 2003 und 2013 am Hauptbeobachtungsplatz ab. Die Raupen verbringen die kalten Nächte an der Basis der Futterpflanzen (*Condalia ericoides,* Rhamnaceae), tagsüber bewegen sie sich zur Thermoregulation zu verschiedenen Zeiten bis in die obersten Zweige. Als alternative Futterpflanze wurde in der Zucht *Condalia hookeri* angenommen; die Rhamnacee *Ziziphus mucronata* wurde nicht akzeptiert. Eine Zählung der Eizahlen in 8 Gelegen ergab zwischen 7 und 31 Eier. Die Kokons sind zweiwändig, beide Schichten netzartig gesponnen, und werden in den äußeren Zweigen der Futterpflanzen befestigt. Zwei neue County-Nachweise werden erbracht. Ausgewachsene Raupen von *A. dyari* werden oft in Vergesellschaftung mit *Hemileuca chinatiensis* an denselben Pflanzen gefunden.

Introduction

The genus *Agapema* Neumoegen & Dyar, 1894 (Saturniidae: Saturniinae: Saturniini) consists of seven known species of nocturnal, univoltine moths that range in Mexico and the southwestern United States (Ferguson 1972, Peigler & Kendall 1993). Pairs of all the species were shown in color by d'Abrera (1998) and compared to most Saturniinae the moths are small and drab-colored. *Agapema dyari* Cockerell, 1914 (Figs. 1, 2) is an inhabitant of the Trans-Pecos vegetational area of the Chihuahuan Desert (Correll & Johnston 1979: map 1), and is distributed in southeastern New Mexico, western Texas, and adjacent Chihuahua. Moths of most species in the genus fly in the autumn, with eggs hatching in late winter, and larvae maturing in early spring. The purpose of this paper is to report on the biology of *Agapema dyari,* for which very little information has heretofore been published.

Materials and methods

The primary field site for this study is in a large open field, about 3 km southeast of Fort Davis beside Highway 118, in Jeff Davis County, Texas (Fig. 7). The area is easy to access by car and on foot. It is unfenced, without cattle, and is thus ungrazed. The hostplant for *A. dyari* is javelina bush (*Condalia ericoides*, Rhamnaceae), called tecomblate in Spanish. This very thorny plant is scattered but common, with single bushes usually several meters apart. It is the main woody plant at this locality, but other plants present include blue grama (*Bouteloua gracilis*, Poaceae), several small composites (Asteraceae) and legumes (Fabaceae), prickly pears (*Opuntia*, Cactaceae), and a few shrubs of allthorn (*Koeberlinia spinosa*, Capparaceae).

I first visited this locality on 16. iii. 2002, and observed many hundreds of larvae of *Agapema dyari,* which were feeding on every bush of *C. ericoides*. I went there again in x. 2003, and was able to collect adult moths of *A. dyari* using ultraviolet light, and several fresh ovipositions on the hostplants. I visited the site again on 23.–24. iii. 2013 (Steele & Peigler 2015), and again on 11.–13. iii. 2016. Most of the observations of larval behavior recorded here were made in 2016, with a few in 2013. A large fire in spring of 2011 burned the plants to the ground in the main field site, but recovering sprouts were present in 2013 and further recovery was seen in 2016, with the *C. ericoides* approaching their original size as observed in 2002.

Additional field sites visited in iii. 2016 were on a hillside near the entrance to Victorio Trail, less than 1 km from Fort Davis on Highway 118, and at a roadside park on Highway 67 in western Pecos County, about 35 km southwest of Fort Stockton. In the latter locality, *C. ericoides* only occurs on elevated and rocky ridges, because the level areas are dominated by creosote bush (*Larrea tridentata*, Zygophyllaceae), which inhibits growth of other plants. *Agapema dyari* has not been previously recorded from Pecos County. To this new county record I can add one more based on a male collected in Sterling City, Sterling County, Texas, on 20. xi. 1976 by K. W. Stewart, in the collection of the late Bryant Mather.

Results and discussion

At the main field site near Fort Davis, the population levels of *A. dyari* were much lower in 2013 and 2016 compared to 2002, although I was able to collect 63 larvae there on 11.–12. iii. 2016. In their comments about *Agapema galbina* (Clemens, 1860) in the Lower Rio Grande Valley (Cameron and Hidalgo counties) of Texas, Collins & Weast (1961: 75) stated that "In some years hundreds of cocoons can be collected, in others none can be found."

Their observations and mine collectively indicate that populations of *Agapema* can fluctuate greatly over a period of years at any given locality, a pattern that I have also observed for populations of three species of *Hemileuca* (Saturniidae: Hemileucinae) in Texas and *Callosamia securifera* (Maassen, [1873]) (Saturniinae: Attacini) in South Carolina.

Mature larvae of *Hemileuca chinatiensis* (Tinkham, 1943) were found on the same bushes of *C. ericoides* as *A. dyari*, in Jeff Davis County in 2013 and 2016, and in Pecos County in 2016. No larvae of *H. chinatiensis* were found in 2002 in Jeff Davis County, and they were less common in 2013 and 2016 than were those of *A. dyari*. A total of 30 mature larvae of *H. chinatiensis* were collected on 11.–12. iii. 2016 at Fort Davis, but only three in Pecos County on 11. iii.

Oviposition

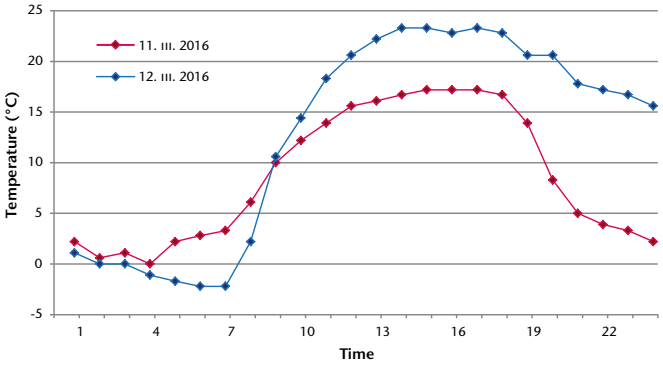
The eggs (Fig. 3) measure 1.2 mm wide and 1.8 mm long. They are laid in small masses on outer twigs or thorns of the hostplant in October. When freshly deposited, they are snow white and easy to find. They then turn brown, but after hatching, the coloration of the remaining chorions is creamy white. Most eggs are deposited so that they are standing on their ends, but a few are attached by their sides. They are attached to the twigs and to adjacent eggs by reddish brown glue. The egg masses do not encircle the twigs.

In x. 2003, I collected and preserved seven viable egg masses, some of which are shown in Fig. 3. The numbers of eggs per mass were 7, 8, 10, 11, 26, 28, and 31, with a mean of 17.28. I collected an eclosed egg mass at the same field site in March 2016 that contained 22 eggs.

Larval behavior

Fully grown larvae of *Agapema dyari* (Figs. 4, 5) are 39–45 mm long for ones that are presumed to be ♂♂, and 50–54 mm long for presumed ♀♀. The light markings on the dorsum of mature larvae enhance their camouflage by resemblance to flowers on the hostplant. When confined in a container with freshly cut *Condalia ericoides,* I observed that mature larvae of *A. dyari* and *H. chinatiensis* prefer to eat the flowers, but will also eat the leaves.

As pointed out by Collins & Weast (1961: 74), *Agapema* larvae are winter feeders. Larvae probably mature early in the year because pupae are better able to survive hot dry summers, and they are less vulnerable to attacks by parasitoids during cooler weather. The larvae in all instars are black, which enhances their ability to absorb heat from the sun. Since the hostplant does not produce flowers until mid March, younger larvae ostensibly feed on old foliage from the previous year. Mortality of early instar larvae is apparently high, because most bushes of the hostplant in iii. 2016 (on which larvae were found) had only one mature larva, although occasionally two to four larvae were found on a single plant. No mature larvae were found on the ground moving between hostplants, unlike those of various species of *Hemileuca* that commonly move on



Graph 1: Air temperatures for Fort Davis, Texas, on 11.–12. iii. 2016. Data from National Weather Service.

the ground between hostplants. In iii. 2016, larvae were found on less than 20% of the bushes that were searched, whereas as mentioned earlier, larvae were found on 100% of the bushes in iii. 2002 in the same field.

On 24. iii. 2013, I observed that the caterpillars can tolerate temperatures below freezing, when the night temperature dropped below –2.7°C. On that early morning, larvae were found curled up at the base of the plants, usually in small excavations of loose soil. It was possible to find them, because the bushes that had larvae were marked with flags the previous day (see Steele & Peigler 2015). On the field trip in iii. 2016, I was able to make more detailed observations between the middle of the day on 11. iii. and the morning of 13. iii. On these days the weather was much milder than in 2013, and the sky was sunny and cloudless all day on 11. and 12. iii. Table 1 provides the air temperatures hour by hour for Fort Davis on 11.–13. iii. 2016. I made the following observations, with all times given in Central Standard Time. Larvae retreat to the bases of the bushes during the night and remain there until 11:00 h, when they begin to ascend. They feed for a few hours in the tops of the plants, but in the hottest part of the day, around 13:00 h to 16:00 h, they retreat, moving down to the shady bases of the bushes. After 17:00 h, they are again in the tops of the bushes feeding. The larvae are usually positioned horizontally when feeding in the tops of the plants, making them easy to find. I was not able to observe their movements after nightfall, but the following mornings none could be found again until late morning. Larvae of *H. chinatiensis* exhibited a similar behavior, but appeared later in the evening, around 18:00 h.

There are some noteworthy parallels between the thermoregulatory behavior of caterpillars of *Agapema dyari* and those of *Hemileuca oliviae* Cockerell, 1898, as documented in New Mexico and Colorado by Capinera et al. (1980), but there are also differences. The larvae of *H. oliviae* are active in the morning and late afternoon, retreating during the midday. Since they feed on a grass (*Bouteloua gracilis*), they have to move to nearby larger forbs to seek shade during the hottest part of the day. They also thermoregulate by alternating between vertical and horizontal positions in the sunshine, and can reduce their body temperature more when their anterior ends are oriented downward. When I found larvae of *A.*

Fig. 1: *Agapema dyari,* male, Fort Davis, Texas, x. 2013, shown beside cocoons. **Fig. 2:** *A. dyari,* pair, Fort Davis, Texas, x. 2013. **Fig. 3:** *A. dyari,* natural deposits of eggs collected in the field in x. 2004. **Fig. 4:** *A. dyari,* mature larva, dorsal view, Pecos County, Texas, III. 2016. **Fig. 5:** *A. dyari,* mature larva, lateral view showing maroon prolegs, Fort Davis, Texas, III. 2016. **Fig. 6:** *A. dyari* cocoon, Fort Davis, Texas, III. 2016. **Fig. 7:** Field site in Fort Davis, III. 2016, plants of *Condalia ericoides* in center. **Fig. 8:** Plant of *C. ericoides* at field site in Fort Davis, III. 2016.

dyari in a vertical position, their anterior ends were just as likely to be oriented upward as downward, although more observations at various temperatures would be desirable.

There were a few nests of the rough harvester ant (*Pogonomyrmex rugosus* Emery, 1895, Formicidae) at the main field site, so I took the opportunity to test their predatory potential on larvae of *Agapema dyari*. A mature (L_5) larva was placed within 2 cm of the entrance hole of a nest. It was crawled upon (but not attacked) by several ants, and the larva quickly moved away from the nest within 2 min., and apparently did not sustain any stings from ants. I then placed a much smaller L_4 larva of *A. dyari* beside the same entrance at 18:50 h. Several ants immediately approached it, crawling over it, but generally moved away. However, within 4 min., two ants had attached to the posterior end of the larva with their mandibles, and other ants continued to crawl over it. At 19:07 h the thrashing larva was finally dragged by the ants into the hole. These observations indicate that larvae of *A. dyari* may possess some chemical protection from ants. In nature, it is unlikely that a caterpillar moving on the ground would be encountered by more than one foraging ant, and as far as I know, the ants do not forage for prey above ground level on plants.

Hostplants

The primary hostplant for *A. dyari* is *Condalia ericoides* (Fig. 8). It probably utilizes other species of *Condalia,* such as *C. viridis,* but I am not aware of any records in nature for hosts besides *C. ericoides* and *Rhus microphylla* (Anacardiaceae) (Peigler & Kendall 1993). *Condalia ericoides* was not available in San Antonio, so I fed the larvae *Condalia hookeri,* which I have established in my yard. They freely accept this evergreen plant, but prefer to eat new, developing leaves instead of mature leaves from the previous year. *Condalia hookeri* does not produce flowers until April and May in San Antonio. A common name in English for *Condalia hookeri* is brasil, and in Spanish it is called capul negro.

Larvae of *A. dyari* were also offered buffalo thorn (*Ziziphus mucronata*, Rhamnaceae), an African tree that I have established in my yard in San Antonio. Even when confined with no other choices, larvae of *A. dyari* refused to eat this alternate hostplant, although it belongs to the same plant family as *Condalia*. However, Powell & Opler (2009: 240) reported that the Asian *Ziziphus jujuba* (which they called by its synonym *Ziziphus zizyphus*) is fed upon by *Agapema anona* (Ottolengui, 1903) in Arizona.

Cocoons

Larvae of *A. dyari* spin their cocoons among the thorny branches of the hostplant. The cocoons are always located near the outer tips, in contrast to those of *Agapema anona* that are constructed deep within the *Condalia* bushes on or near the main stems, as I observed near Arivaca, Pima County, Arizona, on 14. iii. 2002. Cocoons are usually oriented with the anterior ends up, but if they are positioned horizontally, the anterior ends are always slightly higher than the posterior ends. Often, two or three cocoons are in contact with each other, but larvae of this species do not spin their cocoons in a single large mass like those of *A. galbina* and *A. anona*. Remnants of old cocoons from the previous year are sometimes seen on the hostplants, and are brittle and crumble when touched.

Cocoons of *A. dyari* are pale white when first spun, darkening within a few hours to light brown (Fig. 6). They measure 30–36 cm long and 14–18 cm wide. After extended exposure to sunlight, the cocoons bleach to a pale tan. These cocoons are reticulate, and composed of two layers. The outer layer is a coarse mesh, and the inner layer a finer mesh. The pupa can be seen within the cocoon, especially when lit from behind. Like many species of Saturniinae, the cocoon has a pre-formed exit.

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