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HEMILEUCA GROTEI (SATURNIIDAE): ITS MORPHOLOGY, NATURAL HISTORY, SPATIAL AND TEMPORAL DISTRIBUTION[1]

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ABSTRACT. The life history, including descriptions of immatures, illustrated last instar larva and adult genitalia, the larval foodplants utilized, parasites, predators, habitat characteristics, flight periods, and known range, are given for *Hemileuca grotei* Grote & Robinson.

The small saturniid moth, *Hemileuca grotei* Grote & Robinson, remains poorly known, and material is rare in private and museum collections. It is thus our primary purpose to provide information to help collectors obtain specimens from the field and to expand on the excellent treatment of this species given by Ferguson (1971). McDunnough (in Packard, 1914) stated that Kerrville is the type locality, but we are unable to substantiate this statement. The type material was collected in central Texas by Otto Friedrich (1800–1880), a German who spent much of his life studying Lepidoptera of the region (Geiser, 1932). The types may have come from New Braunfels or near there (Guerne) where Friedrich lived and collected for many years (Geiser, 1932).

In the earlier literature *H. grotei* was much confused with *Hemileuca diana* Packard (e.g., Schuessler, 1934). The pair figured in Packard (1914) on Plate 63 as *H. grotei* is actually *H. diana*. Claude Lemaire (Paris Museum) has kindly sent us material of *H. diana* from Santa Cruz Co., Arizona, reared from larvae collected on *Quercus oblongifolia* Coulter, Fagaceae. This species is larger and browner than *H. grotei* with better developed light bands. Ferguson (1971) reported *H. diana* from Texas based on 2 old specimens with vague data in the American Museum of Natural History. The occurrence of this species in Texas needs verification with further collecting. Re-

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ports in older literature of *H. grotei* occurring in Colorado and Arizona apparently all refer to *H. diana*.

Geographical Distribution and Biotope

Outside of Texas, *H. grotei* has been authentically recorded in the literature only from Jemez Springs, Sandoval Co., and Maxwell, Colfax Co., New Mexico (Ferguson, 1971). We add the following new county records for Texas: Bandera, Blanco, Burnet, Comal, Coryell, Eastland, Hamilton, Johnson, Kimble, Lampasas, Llano, Mills, Motley, Palo Pinto, Pecos?, San Saba, Taylor, Travis, and Williamson. Kilian Roever (pers. comm.) informed us that he has it from Burnet, Johnson, and Palo Pinto counties, and that he was unsuccessful in rearing larvae (*H. grotei* ?) found on *Quercus mohriana* Buckley from Pecos Co. Specific data were not provided, and we have not seen specimens from Palo Pinto or Pecos counties. It is possible that *H. grotei* occurs in southwestern Oklahoma. Spatial and compressed temporal distributions of *H. grotei* in Texas are shown in Fig. 1 (map).

In the lab, larvae accept many oak species except *Quercus nigra* Linnaeus. In nature the principal oak species utilized in Texas is *Q. fusiformis* Small, which grows commonly over much of central Texas. This tree has been confused taxonomically with *Q. virginiana* Miller which grows in coastal Texas, outside the range of *H. grotei*, and therefore does not serve as an oviposition substrate for females. We have found ova and larvae on *Q. havardii* Rydberg × *Q. stellata* Wangenheim, *Q. texana* Buckley, and *Q. marilandica* Muenchhausen, and they are probably selected by ovipositing females in that order. In vegetative overlap areas, relative abundance of these oaks is in the same order. Oviposition is probably not random on any of them.

In Texas, *Hemileuca grotei* is limited on the southern and southeastern boundaries of its range by the Balcones Escarpment where it is well established. Here the biotope is characterized by rolling limestone hills and scrubby oaks. To the northwest, in the High and Rolling Plains areas of the state, its distribution is poorly known. Here the biotope is characterized by scrubby, mostly shinnery, oaks growing in deep sand. Most of the land is privately owned, fenced, and used for grazing livestock. We have found, however, that by working along public roads, and in State Parks, one can obtain a good cross section sampling of the area being studied. More definitive habitat characteristics must await a better knowledge of the species through more extensive and detailed field studies, especially in the northwestern part of its range.

The occurrence of *H. grotei* in certain parts of the state undoubtedly has been altered through land development. In the late 1930s vast

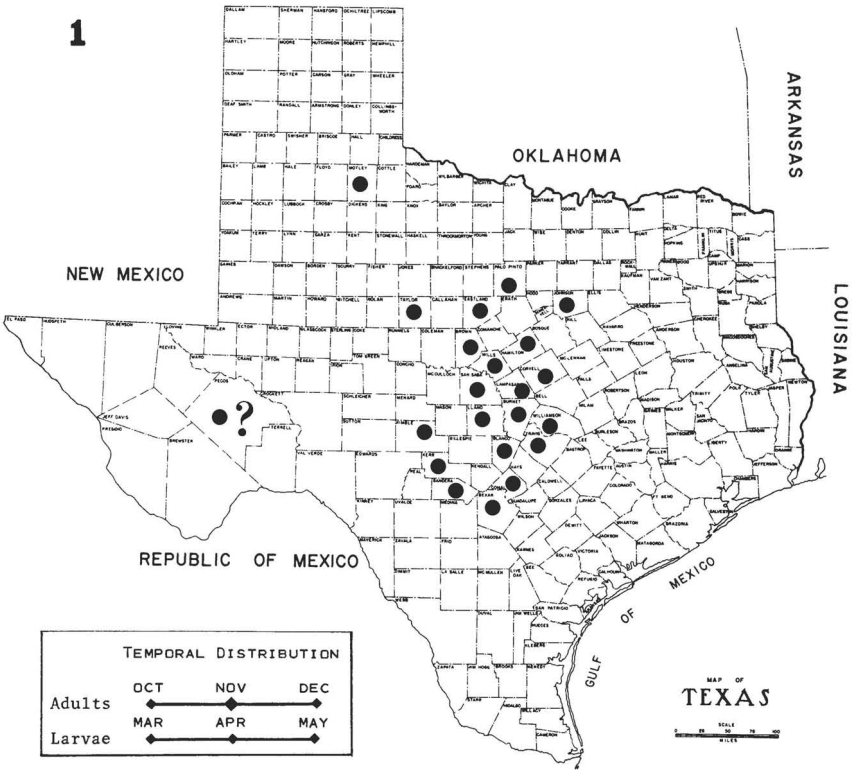


FIG. 1. County map of Texas showing known or reported locations for *H. grotei*.

areas of shinnery oak, *Q. havardii*, grew in the area west and south of Lubbock (Tharp, 1939). At that time this area was known as the Sandy South Plains. Today it is represented as the southwestern portion of the High Plains or vegetational area 9 of Correll & Johnston (1970). Since then irrigation has come to the area, and much is under cultivation; however, some isolated areas still exist on both sides of the Texas/New Mexico state line. We believe that with careful searching *H. grotei* could be found in these undisturbed areas. To the east of this area, the most promising section is along the north-south line dividing the High and Rolling Plains vegetational areas (Correll & Johnston, 1970). Here the Cap Rock Escarpment divides the 2 areas, and along this line in deep sand one will find shinnery oak, *Q. havardii*, and also *H. grotei*. Shinnery oak may be found at various other locations almost throughout the Rolling Plains area. The interested collector would be well advised to search these areas carefully.

It appears to us that the overall or composite biogeographical habitat of *H. grotei* is climatologically intermediate between *H. maia* (Drury) (humid eastern) and *Hemileuca oliviae* (Cockerell) (dry or semi-arid western). We do not know enough about the biology of *H. diana* to say where it fits into the biogeographical picture, but we do have doubts that it currently exists in Texas.

Field Observations

Locating egg masses on oak branches is difficult for several reasons: the egg rings contain considerably fewer eggs than those of *H. maia* and *Hemileuca nevadensis* Stretch; the evergreen foliage of *Q. fusiformis* and the dead, brown, persistent leaves of *Q. texana* provide additional camouflage; the deciduous *Q. havardii* provides greatest visibility, but *H. grotei* is less common on this tree. Unless the collector is especially interested in studying the eggs, it would be far more expedient to wait until about mid-March and search for larvae. At the southern limit of its range, eggs of *H. grotei* hatch in early March. One observed hatching was 10 March. The exact time will vary from year to year throughout its range depending on the climate for a given season. Based on recently hatched egg masses without finding larvae, we have reason to believe that from time to time, unseasonably warm days in certain parts of the range may cause premature hatching of eggs, and the young larvae die for lack of food. Although egg shells frequently remain on the twigs for several seasons, we distinguish between current and prior year hatchings.

Larvae are best collected while still gregarious in the early instars. At this time they are black, more easily seen, and are less likely to be parasitized. In the later instars larvae disperse across the ground to other trees, their color pattern changes, and they are better camouflaged. Larvae are not generally difficult to bring to pupation in captivity. Cut oak branches placed in water will remain fresh for some time. For best results the branches should be placed in large containers with a screen or cloth covering to allow good air circulation, to prevent escape, and to keep out parasites.

In the search for immatures, one should direct his activities to oak clumps, semi-isolated shrubs, or small trees with a southern or southwestern exposure. It is in spots such as this that females deposit their eggs on twigs at various levels on the trees. Some are low, well within reach of the collector, while others are beyond his reach. When the eggs hatch, the young larvae move gregariously to the terminal end of the branch where they feed on the new growth. At this time they are easy to find.

Although some of our data are based on reared material removed

from the source locality, we see a general pattern that eggs eclose earlier, and adults fly later, in the southern part of the range. Specifically, in Bexar Co. larvae will mature by early May, but not until mid- or late May in Eastland Co. Adults fly in mid- to late November in the southern areas and in late October to mid-November in Brown, Eastland, and Mills counties. All of these times will vary according to weather conditions for the particular year. Some pupae do not yield adults until the fall of the following or even the second year after pupation. The overall flight period in Texas, based on data at hand, is from late October to late November, peaking about mid-November.

As with some other species of *Hemileuca,* the adults emerge during the morning (ca. 0930 h Central Standard Time). A male was observed in Mills Co. by Peigler on 29 October in flight at 1232 h. Kendall has observed adults flying from mid-morning to mid-afternoon. The flight is rapid, and the red anal tuft of the males is visible only when hovering to alight. Frequently on cool days before the sun warms the earth's surface or on very cloudy days, adults may be found hanging to oak twigs and can be collected directly into the killing jar. Adults do not come to artificial light.

Parasites, Predators, and Disease

Parasites

The incidence of parasitism appears to be high, although we find no previously published records for parasitism of *H. grotei;* larvae may be parasitized by Hymenoptera, but we have found only Diptera. Three of the four parasites found are parasitic on other Lepidoptera species as indicated below. Parasitized larvae grow until the time for pupation when they suddenly die instead of pupating. The parasite larvae then leave the host to pupate, usually in the ground; if denied soil in which to pupate, adults may not eclose later. Eggs of tachinids can be seen adhering almost anywhere on the body of the caterpillar, but they are often on the prolegs, even on the crochets. We give here the specific parasites observed.

Tachinidae. *Leschenaultia fulvipes* (Bigot), 21 mm wing expanse, brownish black puparium; Bexar and Eastland counties. Arnaud (1978) cited other Lepidoptera hosts as: *Malacosoma californicum* (Packard), *M. californicum fragile* (Stretch), *M. incurvum incurvum* (Hy. Edwards); *Hemileuca lucina* Hy. Edwards, and *H. maia* (Drury). *Exorista mella* (Walker), 20–24 mm wing expanse, blackish puparium, one to several per host larva; Brown, Eastland, and Motley counties. Watts & Everett (1976) recorded *H. oliviae* as a host. Arnaud (1978) cited many other Lepidoptera species in some 10 different families

that are hosts for this parasite. *Spoggosia* sp., 10 mm wing expanse with a red-brown puparium, 1 or 2 per host larva; Mills Co. Arnaud (1978) cited only *Spoggosia gelida* (Coquillett); it probably parasitizes the pupa of *Dasychira* spp. These 3 Tachinidae were determined by C. W. Sabrosky, Systematic Entomology Laboratory, United States Department of Agriculture.

Phoridae. *Megaselia* sp., this very small fly was found infesting diapausing pupae from Eastland Co. in the lab at San Antonio, Bexar Co. Determination was by W. W. Wirth, Systematic Entomology Laboratory, United States Department of Agriculture.

Predators

Undoubtedly the larvae and pupae of *H. grotei* are preyed upon by many different insects (especially wasps), spiders, birds, and mammals, but we are aware of but 2 at this time: 1) a large brown stinkbug *Apateticus cynicus* (Say), Pentatomidae (both nymphs and adults), determined by Joe E. Eger, Texas A&M University; and 2) the well known *Calosoma scrutator* Fabricius, Carabidae, which is well established over much of the range of *H. grotei* (Both the larva and adult beetle are predaceous on caterpillars.).

Disease

Mutually independent field trips made by us on 7, 8, 16, and 18 April 1979 disclosed larvae of *H. grotei* in abundance at both new and previously visited sites. Although several hundred larvae were collected by us over a wide area (11 counties), few survived. Most larvae appeared to have died of an unidentified virus or bacterium. Some larvae would become limp and then simply "melt" away. Other larvae would first become rigid and then become covered with a mold-like fungus, the "spores" spreading to nearby leaves covering them with a greyish powder. From ca. 150 larvae collected in 4 counties by Kendall, and reared under conditions which had proven most successful previously, 3 pupated, 3 died of parasitism, and the remainder seemingly died of a virus or bacterium. These organisms appear to have affected larvae of other Lepidoptera in the same way. Many geometrid larvae were collected with the result that all but 2 died before pupating. It was significant to note that most of the larvae collected by Kendall were either on the ground or resting on groundcover vegetation. Few were feeding in nature, and very little feeding occurred in the lab. Although no dead larvae were found in the field, several larvae were rejected because they were unusually limp when handled. Later, several noctuid larvae feeding in the wild (in the lab

garden) were found dead and disintegrating, but still clinging to vegetation.

We are inclined to attribute the disease to unusually humid conditions early in 1979; high humidity which persisted for a long time, and extended over much of the Edwards Plateau. Rainfall at San Antonio, for example, was ca. 35 cm by 1 May as compared to a normal of 20 cm. We have found the larvae of certain other saturniids very sensitive to humidity. If the larvae of *Hemileuca chinatiensis* (Tinkham), *H. oliviae*, or *Agapema galbina* (Clemens) are moved from their naturally arid habitat to San Antonio, Texas, where the humidity is low by most standards but high compared to that of the natural habitat of these species, most if not all will soon die of this undetermined disease; we have experienced such results even when the larvae were reared in an outdoor environment.

Texas Specific Field and Lab Records

Some of the specimens cited remain in the collections of the authors, but most of them are in various natural history museums, and private collections throughout the United States, and in Europe.

Bandera Co., nr. Bandera: 25 November 1978 (1 ♂), Edward V. Gage. Bexar Co., nr. Helotes: 17 November 1962 (1 ♂), 19 November 1962 (1 ♂), 1 November 1963 (1 ♂), 16 November 1963 (1 ♀), all *ex larvis*, found on *Quercus fusiformis* and reared on *Q. shumardii* Buckley, Roy W. and Ellen S. Quillin; 17 November 1963 (18 ♂, 2 ♀) Roy O. and C. A. Kendall; 11 November 1964 (2 ♂, 1 ♀), 12 November 1964 (1 ♀), 13 November 1964 (1 ♂), 14 November 1964 (3 ♀), 15 November 1964 (2 ♂, 1 ♀), 16 November 1964 (1 ♀), 17 November 1964 (2 ♀), 24 November 1964 (2 ♀), 12 November 1965 (1 ♂), 19 November 1965 (1 ♂), 20 November 1965 (1 ♀), 26 November 1965 (1 ♀), all *ex ovis*, *Q. fusiformis*, Roy O. and C. A. Kendall (4 of these did not emerge until the year following pupation); San Antonio (Kendall lab garden): 19 April 1979, 3 larvae, *Q. fusiformis*, all seem to have succumbed to disease.

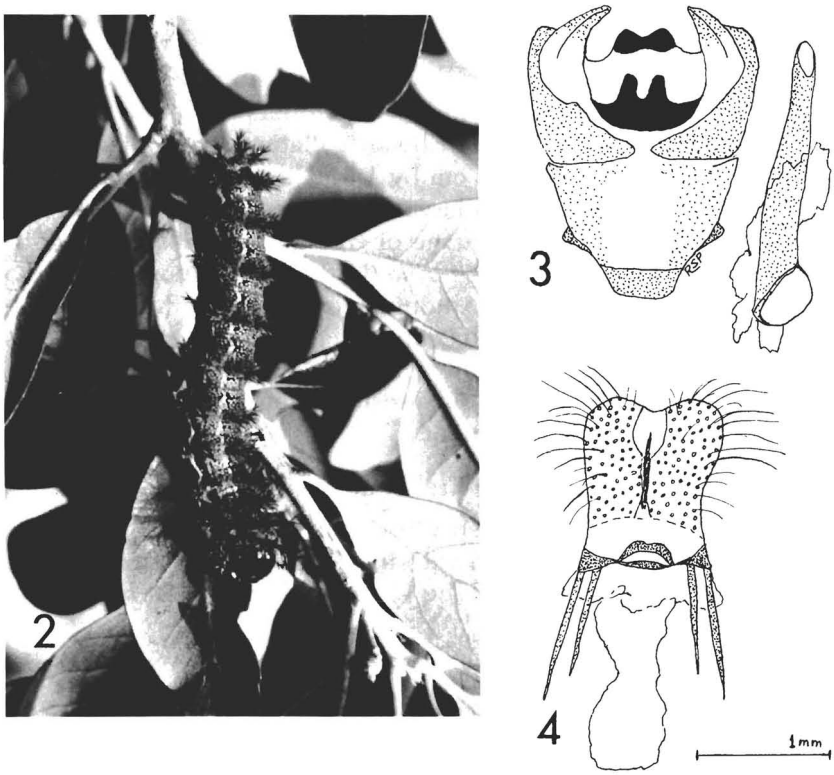
Blanco Co., Pedernales Falls State Park: 8 April 1979, few disbursed larvae on *Q. fusiformis*, R. S. Peigler; Hwy 281, ca. 10 km S of Johnson City: 18 April 1979, 11 larvae, *Q. fusiformis*, all seem to have succumbed to disease, Roy O. and C. A. Kendall.

Brown Co., Lake Brownwood State Park: 9 April 1964 (3rd instar larvae, *Q. fusiformis*), adults emerged 18 November 1964 (1 ♀), ca. 25 December 1964 (1 ♂); 11 April 1978 (larvae, *Q. fusiformis*), pupated 15–26 May 1978, adults emerged 16 October 1978 (1 ♀), 17 October 1978 (2 ♀), 20 October 1978 (1 ♂), 21 October 1978 (1 ♂), 22 October 1978 (1 ♂), 23 October 1978 (1 ♂), 22 January 1979 (1 ♂), 19 October 1979 (2 ♀), 25 October 1979 (1 ♀), 26 October 1979 (1 ♀), 27 October 1979 (1 ♂, 2 ♀), 31 October 1979 (1 ♂), 1 November 1979 (1 ♂) (10 emerged the year following pupation), all Roy O. and C. A. Kendall.

Burnet Co., Inks Lake State Park: 7 April 1979, larvae abundant on *Q. fusiformis* (collected many); Hwy 281, ca. 4 km S of Burnet: 8 April 1979, few larvae on *Q. fusiformis;* Inks Lake State Park: 18 April 1979, ca. 200 mature larvae, 3 larvae on *Q. stellata*, the remainder on *Q. fusiformis*, all R. S. Peigler.

Comal Co., Hwy 281, nr. Spring Branch: 18 April 1979, 3 larvae on *Q. fusiformis*, all seem to have succumbed to disease, Roy O. and C. A. Kendall.

Coryell Co., Hwy 84, ca. 5 km W of Purmela: 18 April 1979, 5 larvae on *Q. fusiformis*, R. S. Peigler.



FIGS. 2–4. *Hemileuca grotei*. **2,** Mature larva; **3,** Male genitalia; **4,** Female genitalia.

Eastland Co., nr. Eastland: 13 May 1973 (numerous last instar larvae, *Q. fusiformis*), larvae pupated 18–25 May 1973 and adults emerged 26 October 1973 (4 ♂), 29 October 1973 (2 ♀), 30 October 1973 (1 ♂), 22 October 1974 (2 ♀), 23 October 1974 (1 ♂), 31 October 1975 (1 ♀) (3 emerged 1 year and one 2 years following pupation), Roy O. and C. A. Kendall.

Hamilton Co., Hwy 84 at Lampasas River: 18 April 1979, larvae on *Q. fusiformis*, R. S. Peigler.

Kerr Co., Kerr Wildlife Management Area nr. Hunt: 17 April 1965 (few larvae, *Q. fusiformis*), 1 pupated ca. 13 May 1975 and a ♀ emerged 5 November 1965, Roy O. and C. A. Kendall; ca. 11 km SW of Kerrville: 5 November 1902 (1 or more), 7 November 1902 (1 ♀), 9 October 1904 (1 ♀), the last 2 *ex larva*, Howard G. Lacey (Kendall & Kendall, 1971).

Kimble Co., Hwy 290, ca. 11 km W of Harper: 27 April 1979, few larvae, *Q. fusiformis*, Joe E. Eger.

Lampasas Co., nr. Lometa: 17 April 1975 (few larvae, *Q. marilandica*), 4 pupated before 10 May 1975, adults emerged 23 October 1975 (1 ♂), 4 November 1975 (1 ♀), 22 November 1976 (1 ♀) (1 emerged the year following pupation), Roy O. and C. A. Kendall.

Llano Co., Enchanted Rock Park, ca. 32 km N of Fredericksburg: 7 April 1979, few larvae on *Q. fusiformis*, R. S. Peigler; Hwy 71 rest area, ca. 16 air km S of Kingsland:

18 April 1979, ca. 60 larvae (mostly on ground beneath *Q. fusiformis*), 2 were parasitized, 3 others pupated 24 April 1979 (2), 26 April 1979 (1), the remainder died, probably of a virus, a ♂ emerged 1 November 1979, and 2 pupae remained in diapause as of 18 January 1980, Roy O. and C. A. Kendall.

Mills Co., ca. 13 km S of Goldthwaite: 17 April 1975 (larvae, *Q. fusiformis*), pupated 10–14 May 1975, adults emerged 17 October 1975 (1 ♂), 28 October 1975 (1 ♀), 1 November 1975 (1 ♀), 8 November 1975 (1 ♀), Roy O. and C. A. Kendall; nr. Goldthwaite: ? May 1977, 31 larvae feeding singly on *Q. havardii* × *stellata*, *Q. texana*, and *Q. fusiformis*, R. S. Peigler; 8 km W of Goldthwaite: 18 April 1979, few larvae on *Q. havardii* × *stellata*, R. S. Peigler.

Motley Co., ca. 10 km W of Roaring Springs: 14 May 1977 (1 last instar larva, *Q. havardii* × *Q. stellata*), parasitized, Roy O. and C. A. Kendall.

San Saba Co., Hwy 16 nr. San Saba: 18 April 1979, 1 parasitized larva on *Q. fusiformis*, R. S. Peigler.

Taylor Co., ca. 13 km S of Merkel: 3 November 1943 (1 ♂), 4 November 1943 (1 ♂, 1 ♀), Charles L. Remington.

Travis Co., Hwy 71 rest areas ca. 11 and 19 km WNW of Bee Cave: 16 April 1979, many larvae (ca. 60 collected) eating *Q. fusiformis* and *Q. texana*, all died, probably of a virus, Roy O. and C. A. Kendall.

Williamson Co., Hwy 29, vicinity of Liberty Hill: 18 April 1979, larvae abundant on highway, many killed by passing motorists, R. S. Peigler.

Morphological Descriptions

Apparently the larva and pupa of *H. grotei* have not been described previously. The pupal description utilizes work of Mosher (1914, 1916) with her descriptions and figures of pupae of other species of *Hemileuca*. Ferguson (1971) gave a good figure of the male genitalia; the female genitalia are figured here and described for the first time. The descriptions below are compared to *H. maia* from Baton Rouge, Louisiana. The male antennae of *H. grotei* have ca. 36 segments; those of *H. maia* have ca. 44 segments. (These counts are based on one male of each species.)

Mature larva (Fig. 2). Head 4.5 mm wide, rusty brown with numerous blackish mottles and sparse white setae. Thoracic legs stramineous. A lateral whitish stripe connecting subspiracular scoli. Integument maroon with numerous oval cream-colored flecks. Ventrum, prolegs, and intersegmental areas dull orange. Scoli all about equally developed, unlike *H. maia* in which the 2 dorsal rows of scoli are shorter, rust-colored tufts; black stalks with whitish branches which are distally darkened. Spiracles cream-colored. Overall aspect more like *H. burnsi* Watson than *H. maia*. Length 49 mm.

Pupa. Color black-brown as in *H. maia*. Cremaster with 6 spikes, same as *H. maia*. (These counts made from 19 *grotei* and 17 *maia* pupae.) Pro- and mesothoracic legs longer and narrower on pupal shell than *H. maia*. Otherwise very closely resembling *H. maia*. Length 22 mm.

Male genitalia (Fig. 3). Overall structure roughly half as large as *H. maia*. The costal lobe of the valve is more slender and less sclerotized than that of *H. maia*. Gnathos heavily chitinized and more strongly bifid than in *H. maia*. Uncus with less-produced lobes. Anellus membranous (sclerotized in *H. maia*). Aedeagus two-thirds the size of that of *H. maia*.

Female genitalia (Fig. 4). Genital plaque more chitinized than in *H. maia*. Proctiger slightly longer but only half as wide as in *H. maia*. Numerous long setae on proctiger each with a basal button. Apodemes tapering to a sharp point. Posterior apodemes long; anterior pair shorter.

ACKNOWLEDGMENTS

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