

## The Life History of *Hemileuca magnifica* (Saturniidae) With Notes on *Hemileuca hera marcata*

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**Abstract.** *Hemileuca magnifica* is a diurnal saturniid inhabiting Climax Sagebrush Associations in southern Colorado and northern New Mexico. The larval host is exclusively *Artemisia tridentata* in Costilla County, Colorado and northern Taos County, New Mexico. The Albuquerque, Bernalillo County, New Mexico colony is found on *A. filifolia*. The species has a two-year life cycle, overwintering first as ova and the second winter as pupae. The ova are deposited in rings typical of *Hemileuca* species. The young larvae feed gregariously and as they mature, disperse widely. Observations of insect parasitism and avian predation are reported.

### Introduction

Until recently, *Hemileuca magnifica* (Rotger) (Saturniidae) was represented in private and museum collections by very few specimens (Ferguson 1971) and virtually nothing was known of its life history. The present paper provides new information on habitat, behavior, and biology. *Hemileuca magnifica* was considered a subspecies of *H. hera* by the original author and Ferguson (1971), but more recently the moth was given full specific rank (Ferguson 1983).

### Discussion

### Habitat

*Hemileuca magnifica* is a cryptically colored black, white and orange saturniid of moderate size inhabiting the Upper Sonoran Life Zone in

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southern Colorado and northern New Mexico. The Upper Sonoran Life Zone, which includes the Sagebrush-Pinyon-Juniper Belt, extends from at least Colorado and Utah south to central Arizona and New Mexico. The altitudinal range of this zone is from about 1,370 to 2,280 m and its limits vary with and are influenced by differences in exposure, soil, and moisture conditions (Gregg 1963, Patraw and Janish 1977).

Sagebrush, (*Artemisia tridentata* Nuttall: Compositae) is found at elevations between 1,820 and 2,500 m and ranges through western North America from South Dakota to British Columbia and south to New Mexico, northern Arizona and Baja California and is, therefore, not restricted to the Upper Sonoran Life Zone. The plant can cover vast areas to the almost total exclusion of other plant species and can grow well over two m in height in conditions of favorable soils and abundant precipitation, but one m or less is normal (Coyle and Roberts 1975, Elmore and Janish 1976, Gregg 1963, Kearney and Peebles 1942, Patraw and Janish 1977, Rydberg 1906, Tidestrom 1925, Wiggins 1980, Wootton and Standley 1915).

*Artemisia tridentata* is the dominant shrub of the Climax Sagebrush Association southern San Luis Valley, Costilla County, Colorado where most of the work reported in this study took place. Occasional associated plant species within this study area include rabbitbrush (*Chrysothamnus* sp.: Compositae) and saltbush (*Atriplex* sp.: Chenopodiaceae) (Lamb 1975). The Climax Sagebrush Association at Albuquerque, New Mexico is dominated by *Artemisia filifolia* Torrington.

Seasonal temperatures in the study area range from 35°C during July and August to extremes of -35°C and lower in December and January. Annual precipitation averages less than 20 cm (Colorado Climate Center, pers. comm.) with occasional summer thunderstorms. The majority of moisture, however, is received as winter snows.

## Range

*Hemileuca magnifica* is associated with Climax Sagebrush Associations (Fig. 1) at elevations between 2,000 and 2,500 m. In Costilla County, Colorado the known range of *H. magnifica* extends from just north of Fort Garland south through Mesita (type-locality) and Jaroso. It extends further south in New Mexico through Taos County to Albuquerque, Bernalillo County and then west to just northeast of Pintado, McKinley County (Jim Coleman, pers. comm., and Ferguson 1971). Thus, *H. magnifica* inhabits a limited, roughly triangular area on the border of northern and northwestern New Mexico and south central Colorado. However, Townsend (1893) stated that on 25.VII. 1892 he observed a number of large brownish and blackish *Hemileuca* larvae feeding on *A. filifolia* east of Navajo Springs, Arizona. It is reasonable to believe the species Townsend observed were *H. hera hera* (Harris) or *H. magnifica*. Navajo Springs, Apache County, Arizona shares the same Great Basin influence as Pintado, McKinley County, New Mexico (Martin and Hutchins 1980), which is the westernmost known locality



Fig. 1. Typical climax Sagebrush habitat which supports *Hemileuca magnifica*.

for *H. magnifica*. As discussed below, populations of *H. magnifica* and *H. h. hera* are not known to be sympatric nor parapatric.

### Biology

The *Hemileuca hera* group is composed of three taxa, *H. h. hera*, *H. h. marcata* (Neumoegen), and *H. magnifica*, which have long been associated with sagebrush communities (Holland 1903, McFarland 1974, Packard 1914, Ferguson 1971, Furniss and Carolin 1977). Recently, *H. h. hera* in California has been shown to prefer *A. tridentata* as host, although when larval populations are dense, various species of *Lupinus* (Mimosoideae) and *Eriogonum* (Polygonaceae) are also used (Tuskes 1984). The population of *H. magnifica* in the vicinity of Albuquerque, New Mexico feeds only on *A. filifolia* (Jim Coleman, pers. comm.) while those of Taos County, New Mexico and Costilla County, Colorado feed exclusively on *A. tridentata* as does the colony of *H. h. marcata* in Klamath County, Oregon (Melvin Parker, pers. comm.).

It is noteworthy that *H. magnifica* is not distributed uniformly throughout all suitable range, but seems to be highly localized in concentrated populations, as is *H. h. hera* in California (Tuskes, pers. comm.). The preferred habitat seems to be areas where the host is growing in sandy-loamy-clay soils and is fairly tall, dense and lush. Coarse gravelly areas, where the host plant is shorter and less fully developed, do not appear to support populations of *H. magnifica*. Even where lush and stunted sagebrush communities are adjacent, the stunted areas are devoid of *H. magnifica*. Patrolling (mate seeking)

males stay within the more lush habitats and larvae are found only in such areas.

Adults in Jaroso are on the wing from early August to late September with the main flight in late August. Males fly from approximately 1100 to 1500 hours (Mountain Daylight Time). Ovipositing females may be on the wing until 1800 hours. Adults hatch from 0900 to 1200 hours emerging from the pupa and climbing a short way into nearby vegetation, usually *A. tridentata*, where they expand and harden their wings which takes about an hour. As soon as males harden their wings they fly off in search of a mate. It is to the advantage of male saturniids to cover as much suitable habitat as quickly as possible in their search for potential mates, which is why they are such wide ranging and active fliers (Janzen 1984). It would appear males flying in late afternoon are those that have been unsuccessful in locating a virgin female earlier in the day and are still actively seeking a mate, or have mated earlier in the day and are seeking another mate.

Females start emitting pheromone as soon as their wings are hardened and usually do not fly until after copulation. As discussed by Tuskes (1984) for *Hemileuca* in general, newly emerged females usually remain on lower stems of the plant while emitting pheromone. Mating requires one to three hours. After separation, the females seldom fly to deposit the first egg ring but, instead, crawl up the plant to form a ring of cream colored eggs on an apical shoot of the host. The rings are typical of the genus *Hemileuca*. The first ring contains ca. 50 to 75 ova. During the next few days, the female deposits several additional egg rings, but each contains a smaller number of 30 to 35 ova. The female may deposit 100 to 200 ova during her life of five to seven days. Ova normally overwinter the first year.

Although theoretically equal in numbers to males, females are uncommonly encountered. It would appear that females which have mated need not range far seeking suitable hosts for oviposition. After ovipositing, which takes anywhere from 30 minutes to more than an hour, the female may or may not immediately fly again in search for another host. Our observations indicate the female may perch and rest for several hours or until the next day depending on her burden of ova, age, strength and condition.

Females mate once, males may mate several times as opportunity provides. Males searching for pheromone plumes emitted by virgin females search exactly as described by Collins and Tuskes (1979), Collins and Weast (1961), and Janzen (1984). The males fly crosswind at rapid speed searching for pheromone plumes emitted by females. Upon encountering a plume they follow it upwind to the female by an ever decreasing series of lateral oscillations. When males are from one to two m from the female, flight slows and is more direct. When males are less than one m from the female, they fly very slowly and frequently hover within a few cm of the female before landing.

Our observations indicate the male crosswind flight often exceeds



Fig. 2. Adult male *H. magnifica* perched for the night on *Artamisia. P.*

400 m. If no plume is encountered the male drops downwind several hundred m and begins another crosswind search pattern. Patrolling males generally cruise widely just over the tops of the sagebrush and seem to prefer draws, washes and saddles, perhaps using these topographic features as natural flyways. A single caged pheromone-emitting female may attract hundreds of males within a few hours.

After the daily flight is over, adults, especially males, tend to perch on the high exposed tips of plants where they spend the night (Fig. 2). Tuskes (pers. comm.) observed similar behavior in populations of *H. eglanterina* (Boisduval), *H. nuttalli* (Strecker), and *H. h. hera* in east Sierra country in California. Approximately one hour after sunrise of the next morning they position themselves in an easterly, southeasterly or southern orientation with the dorsal surface fully exposed to the sun in order to sufficiently warm to begin the day's activities.

In Jaroso, Colorado ova hatch from mid to late June. In Albuquerque, New Mexico ova hatch from early to mid May (Jim Coleman, pers. comm.). Larvae bear urticating spines and are gregarious until mid to late third instar when they disperse widely. More mature larvae generally prefer apical, succulent growth. During the day these older larvae tend to gravitate to this exposed growth and are easily seen (Fig. 3). Larvae were also observed in shadier portions of the host, probably shifting between these two areas as a means of thermoregulation (see Capinera et al. 1980). During the night larvae retreat to the interior of the host where their color patterns provide excellent camouflage.



Fig. 3. Last instar larva of *H. magnifica* in a natural day-time feeding position.

Larvae reared indoors on cut host do poorly. Ferguson (1971) stated that *H. h. hera* larvae have successfully been reared in screened cylinders placed in sunlight for an hour or so each day. *Hemileuca magnifica* larvae can be reared indoors but require spacious airy conditions and the radiation of a "Gro-Light" (Tuskes, pers. comm.). They do best if reared outdoors on living hosts, but will mature indoors on cut food if it is fresh. The later instars cannot stand crowding and will die if crowded. These findings are consistent with those of McFarland (1974) and Smith (1974).

Pupation is a few cm under the soil surface without any kind of cocoon. The pupae normally overwinter for a single year, but individuals holding over for two or more years are known.

### Adult Coloration

The black, white and orange colors of *H. magnifica* adults are an excellent camouflage while they are perched deep inside sagebrush plants, especially during the most vulnerable time of expanding and hardening their wings. If the moths are distasteful to birds as Ferguson (1971) suggests, then moths of this genus would be interesting inasmuch as they are cryptic while resting yet aposematic in flight. The black and white of wings blend well with the light and shadows within the host and help to break up the adult outline. The orange tufts and rings on the body are a very close match to an orange lichen (*Xanthoria polycarpa* (Ehrh.) Olir.: Teloshistaceae) found commonly on sagebrush stem and trunk bark, especially in the Jaroso area. The evolution of

highly developed orange patches and rings on adult *H. magnifica* may be directly related to the lichen. While in repose within the sagebrush plant the orange color further helps to conceal the adults and may contribute to reduced predation pressure.

### Parasitoids and Predators

A group of 50 *H. magnifica* larvae ranging in age from 3rd instar to mature were collected on *A. tridentata* 24. VIII. 1985 at Jaroso, Colorado. The following parasitoids were found.

Diptera. *Exorista* sp. (Tachinidae); medium sized flies, of which several specimens were reared. *Chetogena* sp. (Tachinidae); smaller sized flies, of which several specimens were also obtained. The species are not presently identifiable, according to N. E. Woodley who determined them. Arnaud (1978) cited no parasitic tachinid records for *H. magnifica*.

Hymenoptera. *Microdontomerus fumipennis* Crawford (Torymidae), determined by E. E. Grissell. These small wasps with prominent ovipositors are known to attack several hosts (Krombein et al. 1979, Peigler 1985). Numerous wasps emerged from a single host.

*Cotesia electrae* (Viereck) (Braconidae), determined by P. M. Marsh, formerly classified in the genus *Apanteles*. (*Apanteles electrae* has been recorded as a parasitoid of a *Hemileuca* species in Texas [Peigler 1985], *Agapema galbina* [Collins and Weast 1961], *H. h. hera* and other saturniids, especially *Hemileucinae* [Krombein et al. 1979] in western North America.)

When the *C. electrae* larvae are mature, they exit the host and spin silken cocoons directly on the host body surface (Borror and DeLong 1970 [as *Apanteles*]). A population of 10 to 20 parasitic *C. electrae* larvae per parasitized *H. magnifica* larva host is common.

Voucher material of *Chetogena* and *Microdontomerus* were deposited in the U. S. National Museum of Natural History, and *Exorista* and *Cotesia* in the Los Angeles County Museum of Natural History.

Jim Coleman (pers. comm.) has reported robins (*Turdus migratorius* Ridgeway) occasionally feeding on mature *H. magnifica* larvae in the Albuquerque colony.

### Larva Description

A description of a mature *H. magnifica* larva (Fig. 4) follows based on living material from Jaroso, Colorado. There usually are six instars although seven is not uncommon (see Lemaire 1979: 231, footnote).

#### DESCRIPTION OF MATURE LARVA OF *HEMILEUCA MAGNIFICA*

**HEAD:** Lustrous black to reddish brown with abundant white secondary setae; diameter 4.5-5.0 mm. **BODY:** Length (including head) 60.0-72.0 mm; width 9.0-11.0 mm. Ground color dark brown approaching black, rarely tan to light brown. Body with four pairs of off-white lines which may be reduced to a series of inconspicuous dashes. Subspiracular line most developed, broad, and quite pronounced, running through subspiracular and subdorsal scoli and

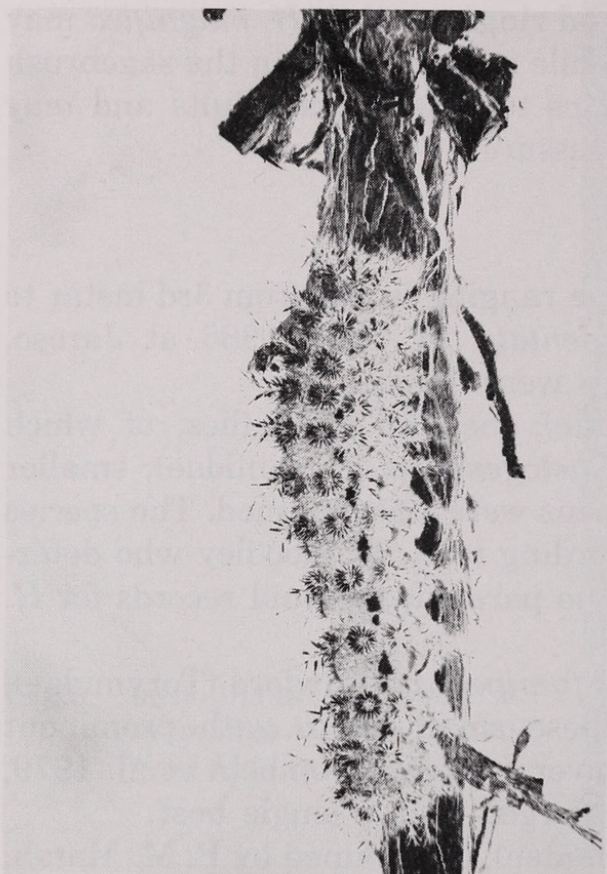


Fig. 4. Last instar larva of *H. magnifica*.

variably developed, but always less than subspiracular line. Subdorsal line between subdorsal and dorsal scoli, and significantly reduced or absent. Dorsal line between dorsal (rosette) scoli, reduced to narrow white dashes or dots, if present. Ventral scoli present on pro-, meso-, and metathorax and abdominal segments one, two, seven and nine. Dorsal scoli present as two rows of short dull yellow rosettes with black tips, on metathorax and next seven abdominal segments; on abdominal segment eight a median rosette; on pro- and mesothoracic segments rosettes containing larger black scoli resembling subdorsal and spiracular ones. Subdorsal and lateral scoli long, black, and yellow tips on branches. Numerous white secondary setae over entire body surface. True and prolegs black, feet white on inner side. Spiracles black. Abdominal and especially thoracic segments with white dots or markings ventrally, anterior to each proleg or true leg.

Since no descriptions of the early stages of *H. hera marcata* have been published, we offer the following description based on a mature larva in alcohol. The specimen was collected as a first instar larva on *A. tridentata* at Klamath Falls, Klamath County, Oregon by Melvin Parker and reared to maturity on *A. tridentata* by Dean Swift in Jaroso, Costilla County, Colorado.

#### DESCRIPTION OF MATURE LARVA OF *HEMILEUCA HERA MARCATA*

**HEAD:** Lustrous black with abundant white secondary setae; diameter 4.0 mm. **BODY:** Length (including head) 55.0 mm; width 7.0-9.0 mm. Ground color purplish brown. Body with four pairs of off-white lines. Subspiracular line most developed, broad, running through subspiracular scoli, with dark evaginations from ventral edge. Lateral line between subspiracular and subdorsal scoli, closer to latter, prominent and unbroken, but only half as thick as subspiracular line. Subdorsal line between two aforementioned lines

in thickness, unbroken. Dorsal line barely visible, except on thoracic segments, running between dorsal scoli. Ventral scoli present on pro-, meso-, and metathorax and abdominal segments one, two, seven and nine. Dorsal scoli present as two rows of short dull yellow rosettes with black tips, on metathorax and next seven abdominal segments; on abdominal segment eight a median rosette; on pro- and mesothoracic segments (and three on abdominal segment nine) rosettes containing larger black scoli resembling subdorsal and lateral ones. Subdorsal and lateral scoli long, black, with yellow tips on branches. Numerous white secondary setae over entire body surface. True legs black, prolegs white with dark patches on outer sides. Spiracles black. Ventral surface predominantly off-white, with a few small dark median patches on each segment.

Preserved mature larvae of *H. magnifica* and *H. h. marcata* have been deposited in the Los Angeles County Museum of Natural History.

### Diagnosis

Based on our above observations of mature larvae of *H. magnifica* and *H. h. marcata* and the description of *H. h. hera* by Tuskes (1984) plus a color slide of *H. h. hera* which he kindly sent to us, we are able to make the following brief comparisons. The larva of *H. h. hera* has a slender yet conspicuous subspiracular stripe, but less developed than the lateral one; in *H. h. marcata* and *H. magnifica* this ventralmost stripe seems to be widest and the most conspicuous. The dorsal rosette scoli of *H. h. hera* appear to be dull yellow, like the ones in *H. magnifica* and *H. h. marcata*. The ventral surfaces of *H. h. hera* and *H. magnifica* are predominantly blackish, whereas *H. h. marcata* is mainly whitish throughout the ventral area. As would be expected due to the size of the imagines, the larva of *H. magnifica* is larger than those of the other two.

Comparison of *H. h. hera*, *H. h. marcata* and *H. magnifica* convinces us that these three taxa form a compact group, or a subgroup within the *eglanterina* group of Tuskes (1984, Table 1). The adults of these three differ from their nearest relatives (viz *H. nuttalli* and *H. eglanterina*) by lacking yellow or orange scales on the wings. The *hera* subgroup also differs from the other members of the *eglanterina* group by being almost exclusively feeders on sagebrush.

As mentioned above, Ferguson (1983) elevated *H. magnifica* to full specific status; the same author (Ferguson 1971) earlier speculated that both *H. magnifica* and *H. h. marcata* could be full species distinct from *H. h. hera*. Since subspecies by definition should have ranges that overlap or at least are in contact, and show blending of characters, we consider it significant that no such zones are known for *H. h. hera* and *H. magnifica*. These two species are allopatric as far as known. Any pair of full species could be either allopatric or sympatric, but if two taxa are subspecies, they should show blending in a parapatric pattern. As discussed earlier, the status of *H. h. hera* and *H. h. marcata* is less certain.

Presently the response of each species males to calling females of the other taxon is unknown. Tuskes (1984) discussed a blend zone of *H. h.*

*hera* and *H. h. marcata* and described what appears to be intergrade adults. He referred to *H. h. marcata* as a "form" but did not state whether the *H. h. hera* population in California contacts the *H. h. marcata* in Oregon, or if the two populations are disjunct. The "*H. h. marcata* population in Oregon, or if the two populations are disjunct. The "*H. h. marcata*" he figured from California is not as extreme in reduction of black markings as in specimens of true *H. h. marcata*. backcrosses and sibmatings could be reared. Such hybrid work may answer such questions as the nature and degree of phenotypic variation of hybrid individuals, ova fertility and fecundity, survival and viability of hybrid individuals throughout development (which is directly related to phylogenetic divergence), and isolating mechanisms (see Peigler and Williams 1984).

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