

NOTES ON THE BEHAVIOR OF *ASTEROCAMPA LEILIA*  
(NYMPHALIDAE) IN SOUTHERN ARIZONA

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While conducting studies on the Santa Rita Experimental Range, Pima Co., Arizona, in 1970 and 1971, I obtained data on the behavior of *Asterocampa leilia* Edwards, especially with regard to temperature and territoriality. Although these data are largely incomplete, they are reported now because my studies in southern Arizona are not being continued and these aspects of life history are unknown for this species and poorly known for butterflies in general.

METHODS

Relative abundance was determined by counting all butterflies as they were encountered within 5 m of me as I walked through the study area. Time budget studies were made over stopwatch-timed intervals on ca. 10 individuals. Concurrent air shade temperatures ( $T_a$ ) were obtained. Microhabitats were distinguished as full sun, partial shade with an interspersed of sun and shade, and full shade. Posture was expressed as wings fully spread at  $180^\circ$ , wings partially spread, or wings closed tightly together. Orientation with respect to the sun was also noted. Too few data were obtained to ascertain any diurnal changes in behavior patterns that may have been present. Most data on interactions with other fauna were gathered during time budget observations. Data were collected on clear, windless days. Additional miscellaneous life history data were obtained incidentally.

Study Area

The study area was located on the western slope of the Santa Rita Mountains, ca. 10 km SE of Sahuarita, at an elevation of 1150 m. The area was relatively flat, sloped slightly to the northwest, and was dissected by a maze of small and large desert washes. The community, including the study area, was described as desert-grassland (Lowe, 1964) which has been invaded by considerable woody growth mainly as a result of protection from fire (Humphrey, 1958). No grazing has occurred in much of the area for the last several years. The dominant vegetation included mesquite (*Prosopis glandulosa*), paloverde (*Cercidium microphyllum*), hackberry (*Celtis pallida*), and cholla cacti

(*Opuntia fulgida* and *O. spinesior*), with an understory of several grass species, some small woody bushes, succulents, and herbs. Photographs of the area were published by Anderson & Anderson (1973).

Rainfall and temperature were typical for this part of Arizona. Rain fell principally in winter (December–February) and summer (July–August). Daytime temperatures during midsummer commonly exceeded 35°C whereas morning lows were often near 20°C.

### Territoriality

Males of *A. leilia* flew at and chased nearly anything that came close to them. I have records of 179 attacks by males, of which 64 were intra-specific, 78 were directed at other butterfly species that ranged in size from *Microtia dymas* Edwards to *Battus philenor* (L.), one was directed at the moth *Celerio lineata* (Fabricius), 24 at Odonata, 11 at Hymenoptera, including one at an ant, and one at a lizard (*Cnemidophorus* sp.). I never saw one fly directly at a bird, although perched *A. leilia* usually flew when a bird passed overhead.

No butterflies were marked, but three males I studied were recognizable by distinctive tears in their wings. These three were apparently resident for at least 8, 14, and 17 days after I first saw them. Additionally, males which were observed at various times throughout the course of a day remained within a definite area at all times. These used very few perch sites, of which one or two seemed preferred and were returned to time after time following flights. Favored perch sites were on the ground, in a wash, and usually near the center of the area used by the individual.

The majority (63%) of flights were initiated by disturbance caused by another organism passing over or near a perched individual. Many of these flights terminated in a patrol within a well-defined area that did not change diurnally or over several days. Furthermore, many flights were initiated without any obvious stimulus when the butterfly would similarly patrol this area. The patrolled areas of neighboring individuals overlapped little. Many intraspecific interactions occurred near the boundaries of the patrolled areas when one male entered the area occupied by another. Invariably, the intruding individual was chased by the resident male. Nearly all of these areas were along washes.

This strong site tenacity and associated behavior indicate true territoriality. The occurrence of territoriality in butterflies has been the subject of some debate. Considerable evidence for territoriality in males of two Nymphalids was presented by Baker (1972). Scott (1974), however, argued that territoriality was absent or rare among butterflies.

TABLE 1. Average length of intraspecific and interspecific interactions by *Asterocampa leilia* males.

Interaction with	Mean number of seconds		Total
	T <sub>a</sub> < 30°C	T <sub>a</sub> > 30°C	
<i>Asterocampa leilia</i>	18.0 <sup>1</sup> ( 9) <sup>2</sup>	15.6 (14)	16.8 (23)
Other butterflies	6.5 (26)	5.1 (21)	5.9 (47)
Other insects	—	—	5.9 (26)

<sup>1</sup> Seconds.<sup>2</sup> Number of flights.

He claimed that site tenacity was poor and that the apparent pugnacity of perched males was in reality a mate-seeking behavior.

My data on *A. leilia* indicate that although males were disturbed by nearly any passing object, a distinct difference existed between responses to and contacts with intraspecific and interspecific objects. Intraspecific interactions averaged nearly three times longer than interspecific interactions (Table 1). Thus, males were able to quickly distinguish a conspecific. Initially, all contacts were investigative. If the individual was not an *A. leilia*, it was on occasion chased briefly, but usually not out of the defined area. Conspecific males were pursued to the boundaries of the area. Four contacts with known female *A. leilia* lasted an average of 35 s. The results of these contacts were unknown, but after one, the male could not be found within his known territory, although he was present later in the day. The pair may have disappeared into the vegetation. On one occasion, I found a male and female perched near each other in the middle of a *Celtis pallida*.

Fourteen territories were examined in some detail. All except one were along washes. They contained an average of 5.7 (range 4–10) shrubs and small trees of which an average of 1.6 (range 1–3) were *C. pallida*. This tree was the only one common to all territories. The defended area averaged 0.07 ha. (range 0.03–0.13 ha).

The territorial behavior of *A. leilia* shows both similarities and differences to that of two other Nymphalids (Baker, 1972). *A. leilia* is similar to *Aglais urticae* (L.) in that the male defended an area which included an oviposition site, whereas *Inachis io* (L.) males defended areas along female flight paths on route to oviposition sites. *Asterocampa leilia*, however, was similar to *Inachis io* in that there was but one male per territory. In *Aglais urticae*, territories were often occupied by several males. *Asterocampa leilia* apparently defended territories for much of the day compared with only ca. 4 h per day by *Inachis io* and 1.5 h per day by *Aglais urticae*. The latter two species

TABLE 2. Time budget and number and length of flights for male *Asterocampa leilia* as a function of ambient temperature.

	Ambient Temperature (°C)			
	20-25	25-30	30-35	35-40
% time perched	92.6	91.8	81.0	98.6
% time flying	7.4	8.2	19.0	1.4
Total time (s)	2181	15426	10812	3636
Mean number of flights per hour	3.2	25.2	39.0	2.2
Mean length of flights (s)	81.0	11.1	17.6	25.5

spent much of the morning feeding; I have observed feeding by adult *Asterocampa leilia* but once (on Coyote, *Canis latrans*, feces containing much *Opuntia* fruit).

#### Temperature-related Behavior

Behavior of *Asterocampa* was greatly affected by temperature. Amount of time spent flying was ca. 8% at low  $T_a$ , increased to 19% at moderate  $T_a$  and decreased to less than 2% at high  $T_a$  (Table 2). At a  $T_a$  of 20-25°C, few flights were made (Table 2), but these were long in duration and usually very fast and erratic. These were usually the first flights of the day. Later and at warmer  $T_a$ , flights were more frequent and of shorter duration. These were usually the slower stroke-glide type of flight characteristic of the species. At high  $T_a$ , flights were again infrequent and of relatively short duration (Table 2). Pursuits also apparently decreased in length with increasing  $T_a$  as shown in Table 1, although the sample size is small.

As temperatures increased, there was a gradual shift in use of perch sites from those completely exposed to the sun at low  $T_a$  to those completely shaded at high  $T_a$  (Table 3). The positioning of the wings also varied overall and within the three microhabitats used for perching, with  $T_a$ . At low  $T_a$ , the wings were nearly always spread when the butterflies were perched; above 30°C, the wings were nearly always

TABLE 3. Microhabitat usage by male *Asterocampa leilia* as a function of ambient temperature.

Microhabitat	Usage (% Total Time)			
	20-25°C	25-30°C	30-35°C	35-40°C
Sun	100.0	74.1	25.7	0.0
Partial shade	0.0	24.2	32.7	0.0
Shade	0.0	1.5	41.5	100.0

TABLE 4. Wing position by male *Asterocampa leilia* as a function of ambient temperature.

Position	% Total Time			
	20-25°C	25-30°C	30-35°C	35-40°C
Spread	99.2	51.6	3.9	0.0
Partially spread	0.0	25.3	4.6	0.0
Folded	0.8	23.1	91.5	100.0

folded dorsally (Table 4). At moderate  $T_a$ , the wings were spread more when perched in full shade than when perched in partial shade or in full sun (Table 5).

At each  $T_a$ , even when perched in the shade, the males nearly always perched with the head facing away from the sun. This was usually the orientation at which they alighted following a flight. If not, they so aligned themselves almost immediately.

There are few other quantitative data that illustrate the various aspects of behavioral thermoregulation by butterflies as outlined by Clench (1966). *Asterocampa leilia* reacted behaviorally to temperature in a manner similar to that described for the nymphalids *Argynnis paphia* (L.) by Vielmetter (1958) and *Precis villida* (Fabricius) by Heinrich (1972).

*Asterocampa leilia* is a dorsal basker as is typical for nymphalids in general (Clench, 1966). This species showed all the characteristic behavioral patterns of dorsal baskers. At cool  $T_a$ , the wings were opened fully so that they were maximally exposed to the sun. With increasing  $T_a$ , the degree of opening was varied to adjust the amount of heat gain. This was concurrently augmented by selection of an appropriate microhabitat to further control the rate of heat gain. Still additional control was attained by slowly opening and closing the wings while perched. This behavior was noted 0.8% and 2.2% of the total perching time at a  $T_a$  of 25-30°C and 30-35°C, respectively, but not at any other  $T_a$ . Heat loss or reduction of solar heat gain at high  $T_a$  was facilitated by selecting the coolest microhabitat and reducing activity to a minimum.

TABLE 5. Percent of time wings are folded by male *Asterocampa leilia* in three microhabitats as a function of ambient temperature.

Microhabitat	% Time Folded			
	20-25°C	25-30°C	30-35°C	35-40°C
Sun	0.8	22.3	100.0	-
Partial shade	-	27.0	91.8	-
Shade	-	0.0	87.1	100.0

TABLE 6. Percent of *Asterocampa leilia* in counts of butterflies on the Santa Rita Experimental Range.

Year	<i>Asterocampa leilia</i> (%)						
	May	June	July	Aug.	Sept.	Oct.	Nov.
1970	8.9	15.2	26.3	25.2	23.2	0.0	—
1971	7.7	5.0	51.6	29.1	41.1	—	38.1

Normal activity in *A. leilia* occurred in the  $T_a$  range of 25–35°C, slightly higher than the generalized range given by Clench (1966) and that for an alpine species (*Erebia epipsodea* Butler) by Brussard & Ehrlich (1970). *Asterocampa leilia* was actually active in a temperature niche considerably warmer than this for much of the day, since the temperatures given herein were obtained in the shade. Exposed air temperature taken with a silver-bulbed mercury thermometer average ca. 5°C greater than shade  $T_a$ . The radiational heat load on a relatively dark-colored insect would be even greater. Considerable interspecific differences have been shown in the active thoracic temperatures of butterflies (Heinrich, 1972). *A. leilia* apparently flies with and is able to tolerate high thoracic temperatures, which is of definite adaptive value in the southwestern deserts.

#### General Life History

On the Santa Rita Experimental Range, adult *A. leilia* were active from early May–mid-November. Fresh individuals were noted throughout the flight period. Peak abundance (both actual and relative) was from early July–September (Table 6). The daily flight period was long. The first flying individuals undisturbed by me were observed as early as 30 min. after sunrise but more usually 90 min. after sunrise. These early morning flights, as noted above, were usually very fast and erratic. The last active individuals were noted just before sunset.

The general behavior of males was described in detail above. Females were observed infrequently. They appeared to fly along washes until intercepted by a male. Females were usually encountered by examining *Celtis pallida* bushes, where they were found perched in the shade on the lower sides of branches. In most cases, they remained in this position for considerable periods, up to at least 2 h.

Oviposition was noted four times, all on *C. pallida* and between 0930 and 1200. Eggs were laid in clusters of 10, 11, 13, and 15. Three clusters were on the upper side of leaves, and one was on the lower side. In each case, hatching took place on the seventh day following oviposition.

Thirty-six of the 49 eggs hatched; the remaining eggs showed no signs of development. On one occasion, I found a female perched in a *C. pallida*. She perched for 82 s, flew slowly with a male among the branches of the *C. pallida* for 16 s, then laid a cluster of 10 pale yellow eggs on the lower side of a leaf in 109 s. After this, she again perched for 455 s before flying out of sight.

The behavior of males perching with the head facing away from the sun, as noted earlier, may also function in quickly detecting the approach of an object from behind. Such an object would cast a shadow which passes by the perched individual before the object itself. Many times I noted males initiating flight in response to a shadow before the object itself was in view.

I never observed *A. leilia* visiting flowers or mud puddles. Other *Asterocampa* were reported to visit mud puddles (Klots, 1951).

#### SUMMARY

Territorial and temperature-related behavior of *A. leilia* were investigated in southern Arizona. Males appeared to be truly territorial. They investigated nearly all passing objects and chased conspecific males to the boundary of a well-defined area. These territories were described. Behavior by males was temperature dependent, with a shift from exposed to shaded microhabitats as temperature increased. Concurrent changes in other behavior patterns also occurred. Other miscellaneous life history notes were presented.

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#### UNIFORM GENITALIA AMONG WING COLOR MORPHS OF OLETHREUTID MOTHS

Most traits are said to be uniform among lepidopteran wing color morphs (Ford 1975, *Ecological Genetics*, ed. 4, 442 p., John Wiley & Sons, New York). This uniformity presumably includes structure, specifically genitalia. Important as they usually are taxonomically, genitalia are seldom mentioned in literature on wing color polymorphism (Robinson 1971, *Lepidoptera Genetics*, 687 p., Pergamon Press, New York). Because wing color polymorphism in well studied examples is controlled by only one or a few genes, structural uniformity is expected and hence not likely to be reported.

In olethreutids, wing color polymorphism and its genetics have been little studied. The occurrence of wing color morphs is problematic in many little known species in this family. Empirical evidence for genitalic uniformity among putative wing color morphs could be taxonomically helpful. From Opler's (1971, *J. Lepidop. Soc.* 25: 115-123) discussion of two species of *Epinotia* having wing color morphs, uniform genitalia can be inferred. I report here explicitly on this point in two additional species.

*Sciaphila duplex* (Walsingham) (subfamily Olethreutinae), feeding on *Populus tremuloides* (McGregor 1967, *J. Econ. Ent.* 60: 1213-1216), has two wing color morphs (Heinrich 1926, *U.S. Nat. Mus. Bull.* 132, 216 p.), one of which is melanic in both sexes. The melanic morph numbered 5 of 54 specimens from Michigan, Ontario, and Minnesota. Genitalia comparison between the morphs was based on 2 or more genitalia slide preparations of each sex (9 preparations in all).

*Epinotia solandriana* (Linnaeus) (subfamily Eucosminae), feeding chiefly on *Betula*, has 4 main wing color morphs (Lindquist and MacLeod 1967, *Can. Ent.* 99: 1110-1114), each in both sexes. These morphs may not be sharply discontinuous. Using specimens from Ontario, Wisconsin, and Michigan, I compared genitalia among these 4 morphs with 1-7 preparations of each sex (18 preparations in all). Comparisons were made under a light microscope at 60-90 $\times$ , magnifications normally used in genitalia study. There were no genitalic differences between color morphs in either sex of either species. This result confirms expectation and strengthens the usefulness of genitalia for ascertaining presence or absence of wing color polymorphism in olethreutids.

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