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TWO INTERESTING ARTIFICIAL HYBRID CROSSES IN THE GENERA *HEMILEUCA* AND *ANISOTA* (SATURNIIDAE)

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ABSTRACT. Two crosses were reared to the adult stage with saturniid moths from different areas of the United States. These were *Hemileuca lucina* ♂ × *H. nevadensis* ♀ reared in Massachusetts and Texas on *Salix*, and *Anisota senatoria* ♂ × *A. oslari* ♀ reared in Connecticut on *Quercus coccinea*. Larvae and adults of both crosses were intermediate. Descriptions and figures of the hybrids are given. Several isolating mechanisms between the parent species were tested and are discussed.

Dozens of artificial crosses in the Saturniidae have been successfully reared since the previous century, but virtually all of these have involved species of the subfamily Saturniinae. This paper deals with two remarkable crosses obtained by the junior author utilizing small saturniid moths belonging to the subfamilies Hemileucinae and Ceratocampinae.[2] In both crosses, species native to the Southwest were reared in the Northeast and females from those rearings attracted congeneric diurnal males native to the Northeast. The species involved were *Hemileuca lucina* Henry Edwards, *H. nevadensis* Stretch, *Anisota senatoria* (J. E. Smith) and *A. oslari* W. Rothschild. For information on the adult morphology, wing pattern, immature stages, hostplants, reproductive behavior, and geographical distributions of these four parent species, the reader is referred to works by Ferguson (1971) and Riotte and Peigler (1981).

Hemileuca lucina ♂ × *H. nevadensis* ♀

In mid-September 1977 two virgin females of *H. nevadensis* (stock from Escondido, San Diego Co., California) were placed on twigs of *Salix gracilis* Anderess at the edge of a wet meadow in Groton, Middlesex Co., Massachusetts, which supports a sizable population of *H. lucina*. The emergence time of the reared *H. nevadensis* in Groton coincides with the flight time of *H. lucina*, i.e., mid-September through early October. The females emitted pheromone, and males of *H. lucina* were attracted. We assumed that pheromone from wild females

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of *H. lucina* was also present in the air, and therefore we concluded that males of *H. lucina* may not discriminate between pheromones of the two species. No behavioral isolation was observed as is often the case in achieving cross-matings of Saturniidae; there was no hesitation by the males nor resistance to them by the females.

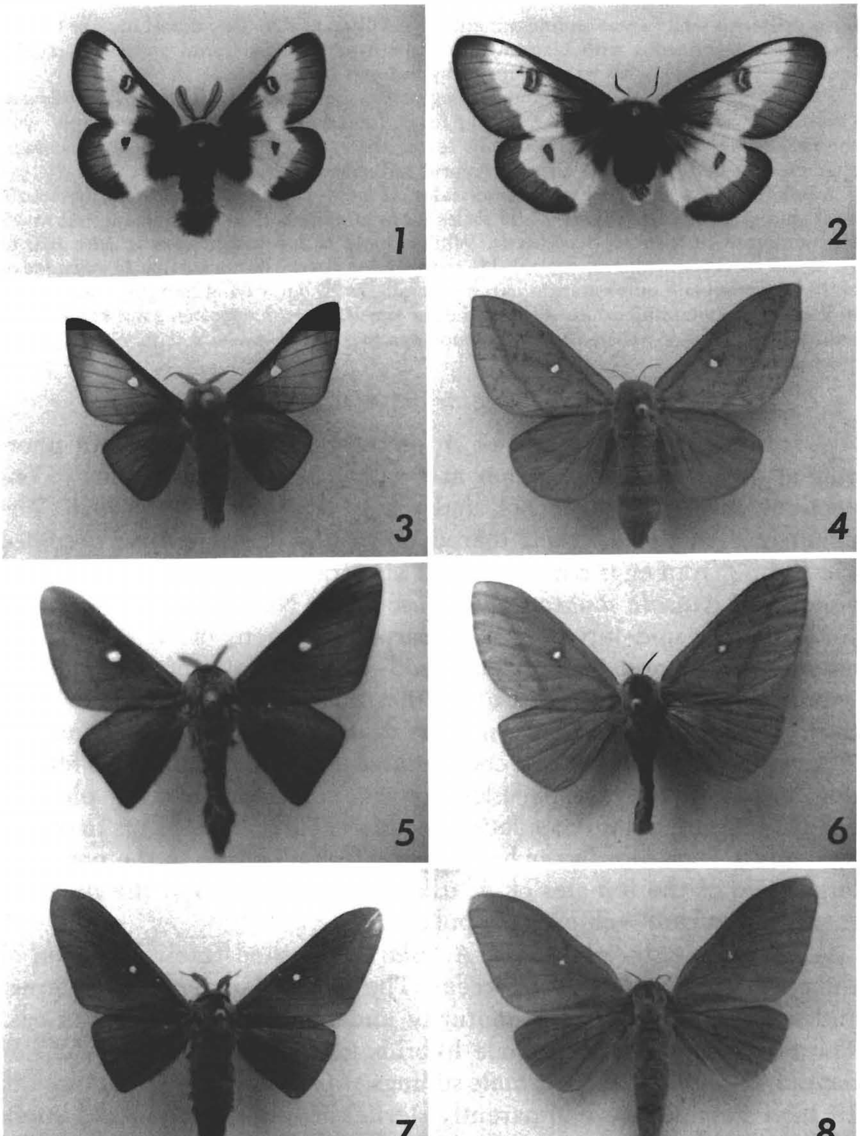
Each female produced an egg ring around a twig, each ring consisting of ca. 100 eggs. The egg is the overwintering stage in most species of this genus. One egg ring was sent to the senior author. The following spring eclosion of both egg rings was near 100 percent, and both authors reared broods successfully to the adult stage. In Groton the larvae were reared on *Salix gracilis* under a cloth bag, surviving an unseasonal 25 cm snowfall on 10 May while in the second instar. In Brazos County, Texas, the senior author reared his brood on *Salix* sp. (probably *nigra* Marshall) under cloth bags. Adult emergence in 1978 in Texas and Massachusetts differed, probably as a result of differences in photoperiod between the two regions where the pupae were kept. In Texas males emerged 21 July through 24 August peaking in the middle of August; females appeared during the second half of August and early September. The hybrid brood in Massachusetts yielded males from 6 September to 8 October and females mostly during the second week of October. A brood of pure *H. nevadensis* (Escondido, California) reared alongside the hybrids in Texas produced adults of both sexes in September, too late to permit attempts to backcross the hybrids, but coinciding with the emergence pattern of pure *H. nevadensis* in Massachusetts as mentioned above.

Hybrid females of both broods were sterile, based on the fact that their abdomens appeared to contain few or no ova. In both broods most adults expanded their wings normally after emerging, but some specimens, especially among females, failed to spread their wings partially or totally. This problem is encountered in several species of the genus with reared material and is not considered to indicate reduced viability resulting from hybridization.

Only the final instar larva is described, this one showing greatest divergence from parent species, but *H. nevadensis* and *H. lucina* hardly differ structurally. Pupal differences were difficult to find between the parent species also, so that those given below may not be reliable. Adults of this group do not exhibit sexual dimorphism; thus, the sexes are not described separately.

Description

Mature larva. Integument intermediate: black with numerous dull white oval flecks,[3] many converging but all individually distinct except around spiracles; in *H. lucina* flecks smaller and more widely separated; in *H. nevadensis* flecks larger and converging to



FIGS. 1–8. **1 & 2,** hybrid pair of *Hemileuca lucina* ♂ × *H. nevadensis* ♀; **3 & 4,** pair of *Anisota senatoria* from Pomfret, Connecticut; **5 & 6,** hybrid pair of *Anisota senatoria* ♂ × *A. oslari* ♀; **7 & 8,** pair of *Anisota oslari* from Santa Cruz Co., Arizona.

form yellowish white areas on integument, especially dorsally. Two dorsal rows of tufted-spine scoli stramineous with black tips as in both parents. Subdorsal and subspiracular branched scoli black with whitish tips in hybrid and both species.

Pupa. Anterior rim of each abdominal segment wider as apparently for *H. nevadensis*. Cremaster with stouter curved spines as in *H. lucina*; *H. nevadensis* apparently with thinner, straighter spines, and possibly fewer than in *H. lucina*. Head and thoracic characters of both parent species and hybrid indistinguishable.

Adult (Figs. 1 & 2). Elongated white scales on meso- and metathorax sparsely distributed among black scales, these white scales more numerous than in *H. lucina* but much less numerous than in *H. nevadensis*. Whitish band of forewing agreeing with that of *H. lucina* by being wider on ventral side than on dorsal side, but more like *H. nevadensis* by having crenulate outer margin curving parallel with outer wing margin. Discal mark in hindwing containing white slit as in father species, this mark often solid black in *H. nevadensis*. Black portions of wings more opaque and coal-black than either parent species.

Anisota senatoria ♂ × *A. oslari* ♀

A freshly emerged female of *A. oslari* was permitted to emit pheromone in an exposed location at Pomfret, Windham County, Connecticut, during a clear, cool, and windy day in mid-July 1978. The undersized moth had been reared on scarlet oak (*Quercus coccinea* Muenchh.) from eggs received from Madera Canyon, Arizona the previous year. *Anisota senatoria* flies in southern New England from mid-June through mid-July, whereas reared specimens of *A. oslari* have emerged from mid-July through mid-August. Males of *A. senatoria* seek females from ca. 1130 to 1530 h EST, and the circadian flight time of *A. oslari* is also known to be during midday hours. A male of *A. senatoria* arrived but had considerable difficulty locating the female due to gusty wind. He persisted for ca. 1 h before making physical contact, at which time copulation readily occurred. Attempts to obtain this cross the previous year had apparently failed due to the normally larger size of the females of *A. oslari*, which prevented the males of *A. senatoria* from achieving copulation.

After mating, the female of *A. oslari* oviposited freely. Eclosion of the eggs was virtually 100 percent. The hybrid larvae were vigorous, and several were reared to maturity under cloth bags on scarlet oak. The following year the female hybrids emerged during the last few days of May, whereas their male siblings appeared from 9 June through 19 July. Females were apparently sterile, having shrunken abdomens as mentioned under the previous cross.

Description

Mature larva. Head brown with bold black markings on each side (head of *A. senatoria* solid black; head of *A. oslari* solid brown; the two-colored head of hybrids remarkable because all known species of *Anisota* have solid colored heads in all instars). Prothoracic tergite black as in *A. senatoria*. Body color black with bold orange stripes on sides and two broken orange stripes on top. Anal plate and anal prolegs orange with black markings (solid black in *A. senatoria*, solid brown in *A. oslari*). Pattern of spines on body more as in *A. senatoria* but size and arrangement of spines on anal plate intermediate between parent species. Median caudal spine long as in *A. oslari*.

Male (Fig. 5). Overall appearance strikingly intermediate. Wingshape as in *A. senatoria* but large size as in *A. oslari*. Ground color dark purplish brown, forewings having brownish orange overtones. Postmedian line weak; barely discernable transparent patch in forewing (absent in *A. oslari*, well-developed in *A. senatoria*). White discal mark large. Forewing with sparse sprinkling of dark spots. Outer margins of hindwings straight.

Female (Fig. 6). Intermediate in most characters. Wingshape closer to *A. oslari*. Ground color light brownish orange with pinkish suffusion in postmedian area as in father species and on hindwing as in mother species. Postmedian line weak in forewing, very faint in hindwing. White discal mark surrounded by purple as in *A. senatoria*. Forewing with a few dark spots.

DISCUSSION

Hybridization experiments such as these provide data on isolating mechanisms and degree of phylogenetic divergence. Aside from the obvious one of allopatry, other isolating mechanisms tested by these crosses include mechanical, behavioral, viability of immature stages, and fertility of adult hybrids. Remarks on each of these were given above for both crosses. The differing emergence times between the sexes of an individual hybrid brood were proposed by Peigler (1981) as an isolating mechanism, because this reduces frequency of F_2 or backcross matings when hybrid broods are produced in nature (when primary isolating mechanisms fail). This phenomenon, now widely recognized in hybrid Lepidoptera, is well illustrated in the two present crosses. We use the term "isolating mechanism" in the traditional sense as did Solignac (1981), notwithstanding the valid arguments put forth by Key (1981) that several independent principles are encompassed by the term.

Genetic compatibility between two taxa, which is to some extent correlated with phylogenetic divergence, falls along a continuum. The pairs of species in the present study are demonstrated to have an intermediate affinity when compared to the following two extremes. Minimal compatibility of parent species would be seen if eggs fail to eclose or larvae die in the first instar. This was demonstrated by the cross *Hemileuca nuttalli* (Strecker) ♂ × *H. eglanterina* (Boisduval) ♀ in the studies of Collins and Tuskes (1979), which might be expected because the parent species are sympatric. On the other hand, what appears to be total genetic compatibility in Saturniidae is illustrated by crosses (both reciprocals) between the Indian *Antheraea roylei* Moore and the Chinese *A. pernyi* (Guérin-Méneville). The parent species have chromosome numbers of $n = 30$ and $n = 49$ respectively, and the hybrid ($n = 30$) has been reared through more than 20 generations, maintaining its increased vigor over the parent species (Jolly, 1974, 1981). Most known crosses of Lepidoptera result in more or less vigorous F_1 hybrid adults with reduced fertility, especially in females.

It is our hope that this paper will encourage lepidopterists to exploit every opportunity to achieve interspecific matings of species that they rear. When fertile eggs and viable larvae result, records and descriptions should be kept, results published, and material deposited in museums.

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[2] Lemaire (1978:23) explained in detail why the name Ceratocampinae is to be used instead of Citheroniinae.

[3] Tuskes (1976) stated that these flecks are circular, but in all material we have seen, consisting of several species of the genus, these are distinctly oval.