

HYBRIDS BETWEEN *CALLOSAMIA* AND *SAMIA* (SATURNIIDAE)

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ABSTRACT. Several crosses between *Callosamia promethea* and *Samia cynthia* were made between 1900 and 1910, and the hybrid specimens are now in museums. Recently, the cross *C. angulifera* ♂ × *S. cynthia* ♀ was made, yielding four F₁ adult males. Egg hatching rate was high in this cross. The hybrid larvae, cocoons, adults, and male genitalia all were intermediate between those of the parent species. Other intergeneric crosses involving these moths produced no adults, but limited information was obtained from such attempts. The Nearctic *Callosamia* is closely related to the Asiatic *Samia*, perhaps even more closely than to the Nearctic *Hyalophora*. The chromosome numbers in these genera are all quite different; thus, crosses rarely produce ova which hatch. Ecological and morphological differences between the genera suggest that they do not cross in nature.

Between 1900 and 1910 a few lepidopterists succeeded in rearing crosses between *Callosamia promethea* (Drury) and *Samia cynthia* (Drury). Miss C. G. Soule published her results several times (Soule, 1902, 1906, and 1907) as did Joutel (1907). Some of the hybrid larvae reared by Soule were figured by Packard (1914) but apparently Ferguson (1972) was first to illustrate one of the impressively intermediate adults of such crosses. Packard (1914) also cited unpublished remarks from Herman Strecker stating that these hybrids occur in nature. However, considering that Strecker's scant descriptions do not coincide with the artificial hybrids, these remarks should perhaps be discounted. Furthermore, I indicate later in this paper why such crosses are not likely to occur in nature.

I have seen hybrids from these early workers in the United States National Museum and the American Museum of Natural History. Most of these are obviously true hybrids such as the male of the cross *S. cynthia* ♂ × *C. promethea* ♀ figured in color by Ferguson (1972). However, others appear to be pure *S. cynthia* such as the other "hybrid" which Ferguson illustrates (a female stated to be of the cross *C. promethea* ♂ × *S. cynthia* ♀). I believe these latter specimens are pure *S. cynthia* because it is unlikely that progeny of an intergeneric cross could look so much like one parent species (in larval, cocoon, and adult traits) and bear no resemblance to the other. Indeed, Joutel (1907) and Soule (1906) reveal that they sometimes remated females to males of their own species in order to initiate oviposition. Future workers who find this practice

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necessary might try remating females to males which have been artificially sterilized beforehand. The purpose of this paper is to report results of similar intergeneric crosses not previously published.

Callosamia angulifera ♂ × *Samia cynthia* ♀

Using hand-pairing and rearing methods which I have described in an earlier paper (Peigler, 1977), I obtained two fertile matings of this cross and adults from one of these crosses. The females oviposited freely so that remating to males of *S. cynthia* was unnecessary. One of these crosses employed a male *C. angulifera* (Walker) from Clemson, South Carolina and a female *S. cynthia* from Brooklyn, New York. Of 248 ova laid, only four larvae eclosed and these died during the first day.

Another male *C. angulifera* from Clemson was mated to a female *S. cynthia* from New Haven, Connecticut. This time the percent hatch was very high and the larvae were reared on tuliptree (*Liriodendron tulipifera* L.), the food of the father species. Mature larvae were offered ailanthus (*Ailanthus altissima* (Mill.) Swingle), the food of the mother species, and refused it completely. All the larvae were intermediate and exhibited very little variation, but Soule (1902) reported a "cynthia form" and a "promethea form" in one of her broods. Although disease killed many larvae throughout the rearing, 14 cocoons were obtained. Of the 14 cocoons, ten pupated, and ultimately four adult males were secured, the others dying as pupae. Physiological problems were noted with the pupal stage. Two individuals remained green contracted larvae (pre-pupae) in cocoons for over 13 days before finally pupating. Three males emerged in the autumn, a full year after pupation, and the fourth in the spring after the second winter. In late May after the second winter, the two remaining pupae were injected with 12 μg of α -ecdysone in an attempt to break diapause but they died shortly afterwards.

Descriptions below are based on larvae and pupae preserved in ethyl alcohol of the hybrids and pure species except the description of the mature larva which was written with living specimens before me of the hybrids and mature larvae of *S. cynthia* and *C. angulifera*.

First instar. Head like *C. angulifera* with a light frontal band. Markings on integument of thoracic and abdominal segments like *S. cynthia* but weaker. No stripes as in *C. angulifera*. Scoli on all segments basically intermediate, tending toward *S. cynthia*. Lateral dark patches on all prolegs intermediate.

Second instar. Color deep yellow as in both parent species. Evidence of both the striping as in *C. angulifera* and the mottling in *S. cynthia*. Scoli dark and more like *S. cynthia*.

Third instar. Greenish-yellow with darker yellow head and prolegs. Still more like *S. cynthia* with mottled integument. Frontal band no longer present, which would be in pure *C. angulifera* of the same instar.

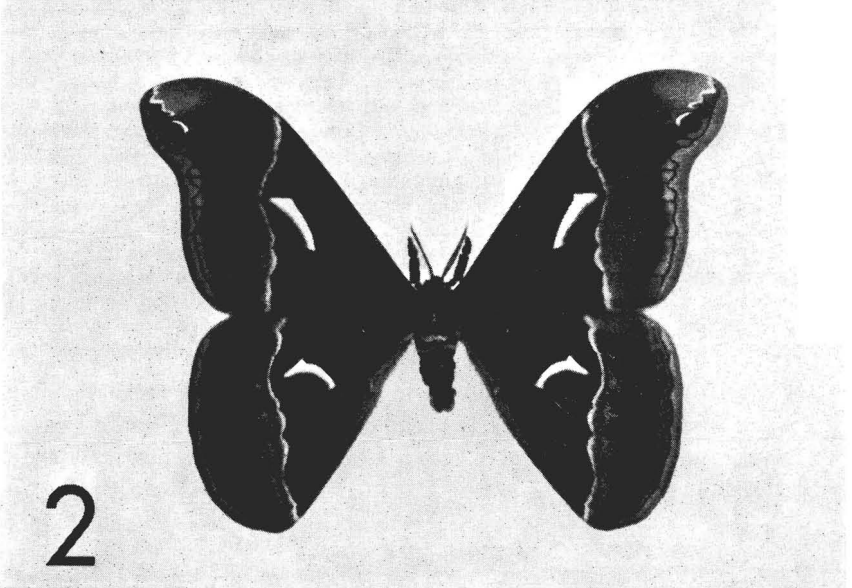
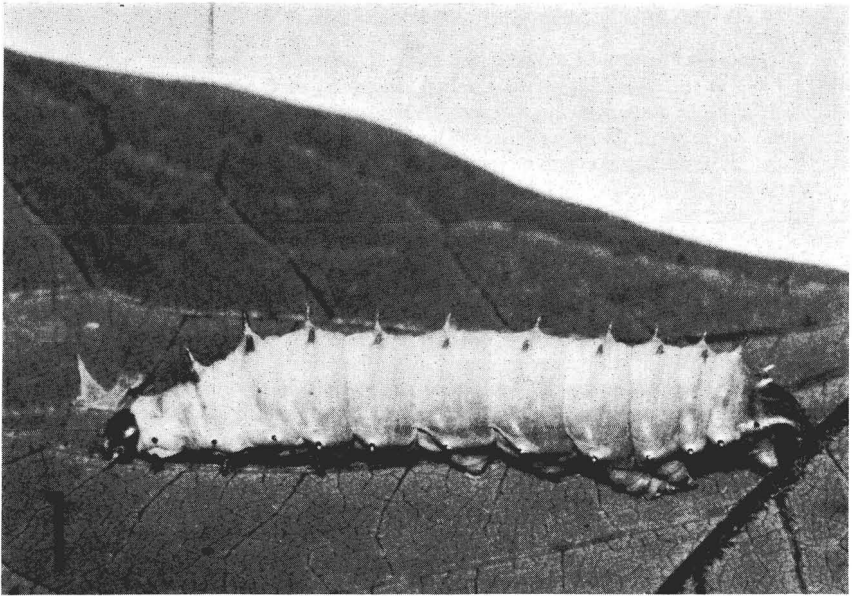


Fig. 1. Mature larva of *C. angulifera* ♂ × *S. cynthia* ♀ on tuliptree. (Photo by G. R. Carner.)

Fig. 2. Adult male of *C. angulifera* ♂ × *S. cynthia* ♀. (Photo by E. V. Gage.)

Fourth instar. Very similar to the fifth instar but with whitish powder covering integument.

Fifth instar (Fig. 1). Color lighter than *C. angulifera* but waxy white powder minimal or absent. Head like both parents; the heads of *C. angulifera* and *S. cynthia* are much alike in size, color and shape. Yellow on top of prothoracic segment as in *S. cynthia* (absent in *C. angulifera*). Thoracic legs darker green-yellow than in *C. angulifera*. Lateral stripe concolorous with body (like *S. cynthia*) or slightly yellowish (very yellow in *C. angulifera*). No black spots on the integument as in *S. cynthia* but never in *Callosamia*. Spiracles light blue. Prolegs mostly like *C. angulifera* but with some yellow as in *S. cynthia*. Anal claspers without blue of *S. cynthia*; the black ring of *C. angulifera* reduced to a posterior black stripe. Anal plate with two lateral black spots of some *C. angulifera* but lacking the black streak between. Dorsal scoli (tubercles) of meso- and metathoracic segments orange with yellow-green base, longer than in *C. angulifera*. Dorsal scoli on first abdominal segment orange or yellowish-orange on tip, higher yellow-green base. All other dorsal scoli yellow, one greenish larger one on eleventh segment. Subdorsal scoli small, raised, pointed blue tubercles; in some individuals the ones on third and fourth segments with black at base. Subspiracular tubercles all small and blue with black bases; the one on first segment a black dot as in *C. angulifera*. Thoracic segments each with a subventral black button as in both parent species.

Pupa. Anal angles of forewings lying on fourth abdominal segment as in *Callosamia*. The maxillary area between antennal covers much more like *S. cynthia* (see Mosher, 1916).

Cocoon. About two-thirds with attachments to stem. Intermediate, but variable shapes tending to *S. cynthia* and dark brown coloration quite like *C. angulifera*.

Male (Fig. 2). Antennae and frons like *C. angulifera* in size and coloration. Scaling on body intermediate in color. No dorsal white tufts on abdomen but lighter scaling in first two abdominal tergites as in *S. cynthia*. Legs without white scaling. Antemedian line intermediate. Postmedian line with maroon replacing light pink in *S. cynthia* and golden suffusion in *C. angulifera*. Ground color and submarginal ornamentation of forewing and hindwing all intermediate. Apical black patch larger like *C. angulifera*. Discal mark in each wing more like *S. cynthia* but with an anterior tooth suggesting *C. angulifera*. Overall coloration of underside much closer to *C. angulifera*.

Male genitalia (Fig. 3). Intermediate in general but more like *C. angulifera*. Uncus larger as in *S. cynthia*, and saccular lobe of valve less produced as in *S. cynthia*. Median lobe like *S. cynthia* but wide costal lobe like *C. angulifera*, with no evidence of the indentation which *S. cynthia* so clearly has in the costal lobe. Anellus more like *S. cynthia* but transtilla (gnathos) weaker as in *C. angulifera*. Aedeagus shorter than either parent species and intermediate in width. Only one hybrid dissection studied.

Unfortunately, no attempt was made to test fertility of these F_1 males. Of the four males obtained, one is in the collection of Dr. Claude Lemaire of France, another in the Los Angeles County Museum, and two are in my collection.

Additional Crosses

Limited information is available on other intergeneric crosses and it seems appropriate to report it here. These include *Callosamia securifera* (Maassen) ♂ × *Samia cynthia* ♀ and *Callosamia promethea* ♂ × *Hyalophora cecropia* (L.) ♀. None of these resulted in adult imagines.

Using a male of *C. securifera* from Berkeley County, South Carolina

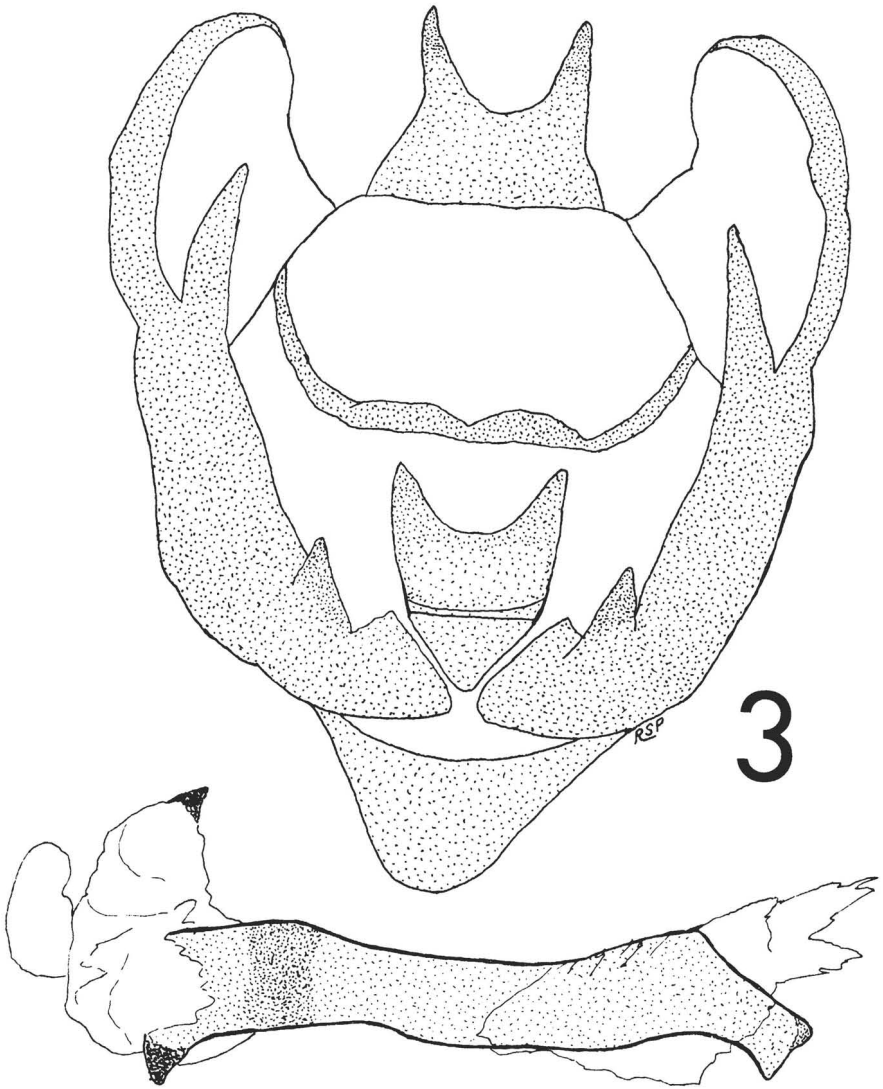


Fig. 3. Male genitalia of *C. angulifera* ♂ × *S. cynthia* ♀.

and a female of *S. cynthia* from Paris, 58 ova were secured. Only six ova hatched but most other embryos reached full development even though they failed to hatch. This became apparent when viewing the batch of ova after they had been stored in ethyl alcohol. The six larvae were offered tuliptree but were very weak and expired within a few hours.

They had banded heads and dorsal segmental stripes as in pure *C. securifera*, but the scoli were more like *S. cynthia*.

Mr. Laurence R. Rupert of Sardinia, New York very kindly provided information on a cross he made between a male *C. promethea* and a female *H. cecropia* over 60 years ago:

“. . . After holding the abdomens together for a time, I succeeded in inducing a mating. The *cecropia* produced a good number of eggs, but only 8 or 9 hatched. The young larvae at first resembled those of *cecropia*, but as time went on they grew more and more to resemble those of *promethea*. I fed them lilac [*Syringa vulgaris* L.] since I knew that was a favorite food of both parents.

Only two larvae survived to make cocoons, and the two cocoons were very different. One was quite hard, resembling in shape a very small *cecropia* cocoon of the hard non-puffy type. The other was irregular in shape with a strip of silk along a stem, like a *promethea* cocoon, but weaker. No moth emerged from either, and I never bothered to open the cocoons to see whether the larvae pupated.”

The same season during which I succeeded with the *C. angulifera* ♂ × *S. cynthia* ♀ hybrids, numerous other matings were made which resulted in no eclosion of ova. Adults of *Samia cynthia*, *S. canningii* (Hutton), *H. cecropia*, and hybrids and all three species of *Callosamia* were used in various combinations. In general, the male genitalia of *C. promethea* and *H. cecropia* are so large that females of other species are often killed by mating with them. The genitalia of other *Callosamia* males are very compatible with *Samia* females and such crosses should be tried whenever possible. I have been unable to accomplish hand-pairings in which the male was *S. cynthia*.

DISCUSSION

The value of hybridization as a tool in elucidating phylogeny has been well documented by Hubbs (1967). The fact that *Samia* is Asiatic and *Callosamia* is Nearctic may have caused earlier authors to overlook the affinities of the two groups. The close relationship based on morphological studies has been pointed out by Lemaire & Peigler (1978). Additionally, tuliptree, the main food of *Callosamia*, is an excellent food for pure *S. cynthia*, the larvae growing much faster than they would on other substitutes for their preferred host, ailanthus (pers. obs.). This becomes even more significant when one finds that larvae of the genus *Hyalophora*, considered closest to *Callosamia*, fail to survive on tuliptree (Scarborough et al., 1974). Intrageneric introgression sometimes proves to be advantageous to populations of organisms, but one can hardly see any possible advantage in intergeneric hybridization. Therefore, some specialized biochemical isolation mechanism may be in effect for the two sympatric genera of North America, not shared by the Asiatic *Samia*.

The chromosome number of *C. promethea* is 19, that of the species of *Hyalophora* is 31, and the various species of *Samia* is 13 and 14 (Robinson, 1971). Thus the pairing of sex chromosomes and autosomes possibly becomes critical when hybridizing these related genera, and this may explain several results such as lack of females (the heterogametic sex in Lepidoptera) in many hybrid broods, the rarity with which ova hatch in such crosses, and the different results sometimes obtained with reciprocal crosses (see Peigler, 1977).

The question arises as to whether such crosses ever occur in nature so that a collector might encounter such wild hybrids. The larger genitalia of *C. promethea* and its diurnal mating behavior argue against the possibility of this species mating with *S. cynthia*. The genitalia and mating times of *C. angulifera* and *S. cynthia* are much more compatible, but a pheromone difference exists wherein females are unlikely to attract males of the other species. Also, *S. cynthia* exists almost exclusively in large cities where *C. angulifera* populations are quite unlikely to occur with any regularity, if at all. Even after being in North America over 100 years, *S. cynthia* still appears to be predominantly on ailanthus in urban areas.

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