A FURTHER STUDY OF INTERSPECIFIC HYBRIDS IN BLACK SWALLOWTAILS IN JAPAN

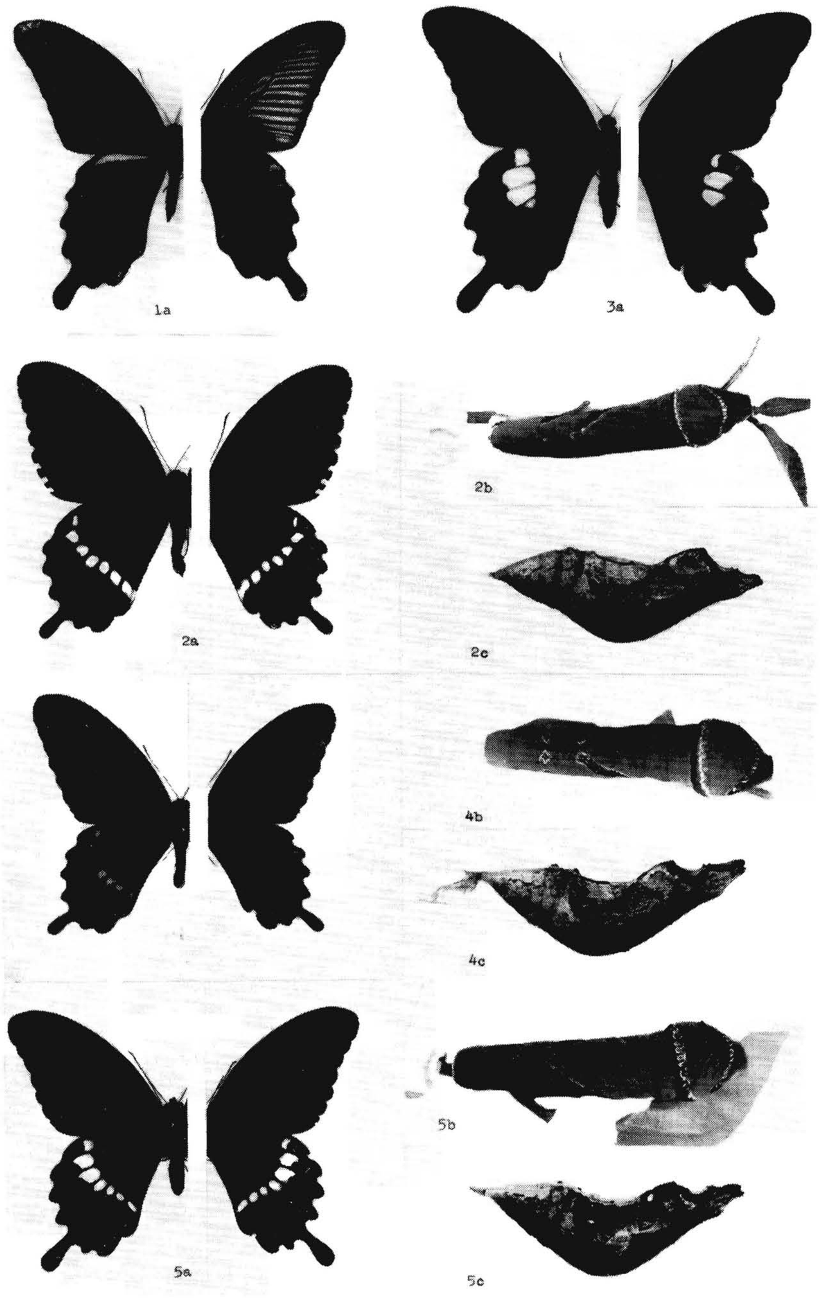
by Shigeru A. Ae

There are five species of black swallowtails in Japan which have "orange dog" type 5th instar larvae. They are *Papilio protenor demetrius* Cramer, *P. macilentus* Janson, *P. helenus nicconicolens* Butler, *P. polytes polycles* Fruhstorfer, and *P. memnon thunbergii* von Siebold. Their larvae feed on Rutaceae and their pupae also resemble each other, although their adults are easily distinguishable.

The writer has been working in interspecific hybridizations of the above black swallowtails at Nanzan University, Nagoya, Japan, since 1959 and has obtained some positive data. Some of them were previously published (Ae, 1962a, 1962b), and this paper presents the data on hybrids between *P. protenor* (Fig. 1a) and *P. polytes* (Fig. 2a), between *P. helenus* (Fig. 3a) and *P. polytes*, and between *P. helenus* and *P. protenor*.

The Cross ♀ *P. polytes* × ♂ *P. protenor*

P. protenor is common in most parts of Japan, and *P. polytes* is distributed only in a few islands of the south of Kyushu in Japan. Mr. Suguru Igarashi provided the writer many eggs and larvae of *P. polytes* in June 1960. They were the progeny of females which he collected at Kikaigajima, one of the above islands. The writer obtained 7 females and 10 males from them. They emerged in July, except 2 males which emerged in September, and were used for inter- and intraspecific matings. One of these females, O-1, which emerged on July 10, was hand-paired on July 11 to a *P. protenor* male, R-51, which was collected in Nagoya on July 9 by the writer. The duration of the copulation was about 1 hour. This female laid 20 eggs on July 12 and 13, and 19 of them hatched on July 15 and 16 at room temperature. One was killed for preservation in the 1st instar. Three were reared on Karatachi (*Poncirus trifoliata* Rafin.) and others were reared on Natsumikan (*Citrus Natsudaidai* Hayata) at the window side of the laboratory. Seven reached the 5th instar, and four pupae were obtained from them. Three of four were reared on Natsumikan and one was reared on Karatachi. All of these pupae hatched and all four adults were males. Developmental rates of the hybrids were approximately the same as with the parental species, both of which are very similar in developmental rate. The two different food plants seemed to produce no notable difference in developmental rate.


1a
3a
2b
2a
2c
4b
4c
5b
5a
5c

Larval differences between the parental species are very scant in all stages. There are distinguishable differences only in the 5th instar (Fig. 2b; Ae, 1962a, Plate 1). The stripe on the 4th and 5th abdominal segments is discontinuous at one point and the stripe on the 6th abdominal segment is discontinuous at three points in *P. polytes;* these two stripes are continuous in *P. protenor.* The stripes on the 4th and 5th segments of three of the seven hybrid larvae were discontinuous at one point, and these stripes on the other hybrid larvae were continuous (Fig. 4b). The stripes on the 6th segment of all of 7 hybrid larvae were discontinuous at the three points. The color of those stripes is brown in *P. protenor,* yellowish brown in *P. polytes,* and was brown in the hybrids.

The pupae of *P. protenor* are slenderer in general than those of *P. polytes* (Fig. 2c; Ae, 1962a, Plate 1), but they are variable. Hybrid pupae resemble *P. polytes* (Fig. 4c) and are smaller than those of *P. protenor,* but not necessarily than those of laboratory-reared *P. polytes.*

The four hybrid adults emerged from August 5 through 9. The general shapes of the wings are easily distinguishable between the species, and in shape the hybrids resemble *P. polytes.* The band which consists of 7 white patches of both sides of the hind-wing is the most prominent character of *P. polytes. P. protenor* lacks this band, but in the male it has a large slender white patch on the upper side of cell $Sc\text{-}R_1$ of the hindwing. In the hybrids these two characters are both expressed, although their expression is very scant, especially at the position of the patch of *P. protenor* and the cells Rs and M_1. All hybrids have more or less red scales on the basal parts of the white patches on the under side of the hindwing. These red scales are seen neither on *P. polytes* nor *P. protenor.* The white spots on the outer margin of the forwing of *P. polytes* are not present on the hybrids (Figs. 1, 2a & 3a).

The Cross ♀ *P. polytes* × ♂ *P. helenus*

P. helenus is found in many places in the central and southern parts of Japan, but it is not so common as *P. protenor.* Two females of *P. polytes,* O-5 and O-7, which emerged on July 17 and 18 respectively, were hand-

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Explanation of Plate:

Papilio protenor: 1) adult male (underside at right).
P. polytes: 2a) adult ♂ (underside at right); 2b) mature larva, dorsal; 2c) pupa, lateral.
P. helenus: 3a) adult male (underside at right).
F_1 hybrid (♀ *polytes* × ♂ *protenor*): 4a) [2nd from bottom at left] adult ♂ (underside at right); 4b) mature larva, dorsal; 4c) pupa, lateral.
F_1 hybrid (♀ *polytes* × ♂ *helenus*): 5a) adult ♂ (underside at right); 5b) mature larva, dorsal; 5c) pupa, lateral.

paired with wild males of *P. helenus*, N-25 and N-27, on July 18 and 19 respectively. The durations of copulation were both more than 1 hour. These *P. helenus* males were collected on July 6 and 18 respectively both at Ryusozan, Shizuoka Prefecture. Female O-7 did not oviposit. Female O-5 laid 86 eggs in a few days, beginning July 20. Of these 86, 67 started to develop, and embryos were well formed within 62. Larvae started to hatch July 23 at room temperature; In all, 56 1st instar larvae were obtained. Three were killed for preservation in the 1st instar. Of the remaining 53, 30 were fed on Natsumikan and 23 on Kihada (*Phellodendron amurense* Rupr.) at the window side of the laboratory. Hybrid larvae survived better on Natsumikan than on Kihada, although their developmental rates were approximately the same on both plants. Their developmental rates seem not different from the developmental rates of the parental species. Adult butterflies emerged from August 14 through 31. Sixteen adults were obtained from the larvae reared on Natsumikan and two from the larvae reared on Kihada; all eighteen were males.

Larval differences between the two parental species are very slight, as with *P. protenor* and *P. polytes* (Fig. 2b; Ae, 1962a, Plate 1). The stripe on the 4th and 5th abdominal segments in the 5th instar larva of *P. helenus* are either continuous, or discontinuous at one point; that on the 6th segment is discontinuous at three points. These discontinuous parts are narrower than on *P. polytes*. The hybrids are *helenus*-like, but the discontinuous parts show somewhat intermediate expression (Fig. 5b). The color of these stripes is dark brown in the hybrids, apparently intermediate between the deep purple of *P. helenus* and the yellowish brown of *P. polytes*.

The angle of the mid-ventral bent of the pupa of *P. helenus* is generally sharper than that of *P. polytes* (Fig. 2c; Ae, 1962, Plate 1). However, this character is variable in both species and may overlap in some individuals. The hybrids seem to be intermediate in this character (Fig. 5c). The size of the hybrid pupae was smaller than that of *P. helenus*, but not necessarily smaller than that of *P. polytes*.

In the adults of *P. polytes* and *P. helenus* the shape of the white patches of the hindwings is quite different. *P. polytes* has seven patches of almost the same size, and they are not contiguous in the Japanese subspecies. *P. helenus* has three large continuous patches on cells Sc-R_1, R_2, and M_1 and three more small continuous ones on the cell M_2, M_3, and M_4 in some individuals. Therefore, a total of 6 patches are known in *P. helenus*, and the white patch in cell Cu_2 which exists in *P. polytes* is always absent in *P. helenus* (Figs. 2a,3a). The white patches of the hybrids resemble the *P. polytes* in general, and they are very clear. However, the patches in cells R_2 and M_1 are larger than on *P. polytes* and the intervals between patches are smaller than on *P. polytes*, Therefore, the white patches of the hybrids seem to express the character of *P. polytes*, with influence from *P. helenus* (Fig. 5a).

New Notes on Hybrids between ♀ *P. protenor* × ♂ *P. helenus*

The writer obtained 15 male hybrids between *P. protenor* and *P. helenus* in 1959 (Ae, 1962a, 1962b). In 1961, the writer obtained one more crossing by hand-pairing. On August 24 a female *P. protenor*, R-54-43 (progeny of a female collected at Midoridani, Neo-mura, Motosu-gun, Gifu Prefecture), copulated for 55 minutes with a wild *P. helenus* male, N-37, collected August 24 at the same place. This female laid many eggs, most of which hatched, and hybrid larvae were reared on Natsumikan in the screened chamber at the writer's house near Nanzan University. The first larvae pupated on September 13. Thirteen pupae were obtained within a few days. They were brown and their average length was 30.4 mm, the largest being 34.0 mm. However, several larvae continued to grow and started to pupate about one week after the pupations of the above 13 pupae. Three reached the prepupal stage but did not produce the silk girdles around their thorax. Only one succeeded in pupating. Its color was green and the length was 34.0 mm. Nine males emerged from September 24 to 27 from the thirteen brown pupae, and they were the same as the fifteen hybrids which the writer obtained in 1959. The adult body was formed within the pupal case of the green pupa on October 14. However, it failed to emerge and died. The writer broke the pupal case on October 16. Its sex was female and no white pigment was found, although the unexpanded fore and hind wings had black and red pigments.

Backcross Attempts

Most of the males of the above three kinds of hybrids looked strong. However, backcross attempts to the females of the parental species were not successful, probably because the writer had available only a few weak females of *P. protenor* and *P. helenus*.

Discusson

F_1 hybrids between *P. polytes* and *P. protenor*, between *P. polytes* and *P. helenus*, and between *P. protenor* and *P. helenus* are predominatly males. Therefore, Haldane's Rule applies to these cases, since in butterflies the female is heterogametic. However, the data for the first crossing are too scant for a positive conclusion. These results also indicate that the above three species are not so closly related to each other as the members of the *Papilio polyxenes-machaon* group, in which almost the same numbers of females as males are produced in interspecific crossings (Clarke & Sheppard, 1953, 1955a, 1955b; Remington, 1958; Ae, 1962b).

All of the three species have white patches on their hindwings. However, the positions are different, and *P. protenor* has it only in males. The white patches of F_1 hybrids between *P. polytes* and *P. helenus* are very clear, but them of between *P. protenor* and *P. polytes* and between *P. protenor* and *P. helenus* are not clear. Therefore, white patches of *P. helenus* and *P. polytes* may be controlled by the same gene(s) with different modifiers which controlled the shapes of patches.

The fact that the F_1 hybrid female between *P. protenor* and *P. helenus* has no white pigment may indicate that the gene(s) which suppress the expression of white patch in *P. protenor* females has the same effect on the expression of white patches of *P. helenus* in the hybrids.

SUMMARY

1. One fertile mating was obtained of each of the following crosses: ♀*P. polytes* × ♂*P. helenus*, and ♀*P. protenor* × ♂*P. helenus*, and ♀*P. protenor* × ♂*P. helenus*, using the technique of hand-paring.

2. The egg fertility and hatchability of all the above crossings were high, and the resulting larvae developed well and with normal rates.

3. Four F_1 males from *polytes* × *protenor*, 18 F_1 males from *polytes* × *helenus*, and 9 F_1 males from *protenor* × *helenus* were obtained. No female emerged from any of the above crossings, but one female adult body was formed in its pupal case in *protenor* × *helenus*. Therefore, Haldane's Rule applies to the above three crossings.

4. Larvae and pupae of these three species resemble each other closely, and the hybrids usually show intermediate characters.

5. Sizes of the three kinds of hybrids are usually smaller than their parental species.

6. The hybrid adults also show intermediate characters between the parental species in general.

7. White patches of the hindwings of *P. polytes* and *P. helenus* may be controlled by the same gene(s) with different modifiers.

ACKNOWLEDGEMENTS

The writer wishes to express his sincere gratitude to Dr. CHARLES L. REMINGTON, Department of Biology, Yale University, for reading this paper in manuscript. He is also grateful to Mr. SUGURU IGARASHI for providing the *P. polytes* livestock.

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Biological Laboratory, Nanzan University, Nagoya, JAPAN

A NEW NAME FOR THE PREOCCUPIED NAME *THECOPHORA* LEDERER, 1857 (NOCTUIDAE)

by JOSEF MOUCHA and MILAN CHVALA

We have found in the course of joint work on the orders Lepidoptera and Diptera that the generic name *Thecophora* Rondani, 1845 (Diptera, Conopidae) is an older homonym of LEDERER'S generic name in the family Noctuidae. The name *Thecophora* Lederer, 1857, has as far as we know no younger synonym, so, in accordance with Article 60b of the "Code", it must be substituted by a new name. We propose therefore in accordance with Article 60 of the International Code of Zoological Nomenclature, adopted by the XV International Congress of Zoology, a new name for the noctuid genus: *RILEYIANA* Moucha & Chvála, *nomen novum.* The genus is named in honor of Mr. N. D. RILEY of the British Museum of Natural History, a well known specialist in the Lepidoptera.

Ver. Naturkunde 61: 79 - 80. (Placed in synonymy of *N. semialbata* by Covell, 1963.)

4. *C. salapia* (Druce), NEW COMBINATION. Colombia.
   Hasodima salapia Druce, 1900, *Annals & mag. nat. hist.*, ser. 7, vol.5: 522.
5. *C. arana* (Dognin), NEW COMBINATION. Colombia, Peru, Bolivia, Argentina.
   Caripeta arana Dognin, 1896, *Ann. soc. ent. Belgique* 39: 117.
   Erilophodes arana (Dognin), Warren, 1909, *Nov. zool.* 16: 109.
   Neodesmodes arana (Dognin), Covell, 1963.
6. *C. muscosa* (Dognin), NEW COMBINATION. Colombia.
   Neodesmodes muscosa Dognin, 1911, *Hétérocères nouv. Amér. Sud*, fasc.III: 38.
7. *C. pruna* (Dognin), NEW COMBINATION. Colombia, Ecuador, Peru, Bolivia.
   Bryoptera pruna Dognin, 1892, *Le Naturaliste*, 1 March 1892: p.59.
   Hasodima puta Druce, 1900, *Annals & mag. nat. hist., ser.* 7, vol.5: 522. NEW SYNONYMY.
8. *C. dardania* (Druce), NEW COMBINATION. Colombia.
   Hasodima dardania Druce, 1900, *Annals & mag. nat. hist.*, ser. 7, vol.5: 521.

In addition to these species, others from Latin America may belong in *Cargolia*. The author hopes to carry on more detailed investigation of this genus and others closely related to it, studying the biology and ecology of species as well as morphology.

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The author is very grateful to Dr. E. L. Todd, A.R.S., U.S.D.A., for his advice during the course of this study. For the loan of material for study, the author wishes to thank Dr. J. F. G. Clarke (U. S. National Museum), Dr. F. H. Rindge (American Museum of Natural History), Mr. D. S. Fletcher (British Museum), Dr. J. G. Franclemont (Cornell University), Dr. C. D. MacNeill (California Academy of Science), and Mr. H. K. Clench (Carnegie Museum).

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CORRIGENDA FOR VOLUMES 16 AND 17

Vol. 16:

p. 106, left column – words in last two boxes should be reversed; thus, the lower left box should be "Habitat preference".

p. 119, in 3rd horizontal data row – "62", "3.75", "3.76", and "4.9583" should be "52", "3.71", "3.76", and "4.9585".
p. 123, 1st and 4th lines from bottom, and p. 124, 2nd line from top – "F_3" should be "F_1".
Vol. 17:
p. 109, bottom – line omitted just above mail address:
"9. *Adopaea lineola*: VI-10-59, Stevenson, Baltimore Co."
p. 168, 16th line from bottom – "♀ *P. protenor* × ♂ *P. helenus*" should be "♀ *P. polytes* × ♂ *P. helenus*".
p. 193, 3rd line from bottom – "Zucht *quercus*" should be "Zucht von *Marumba quercus*".
p. 195, 20th line from bottom – "524-629" should be "624-629".
p. 198, 20th line from bottom – "Yohrinori" should be "Yoshinori".

A MEXICAN SATYRID AT LIGHT

In view of the recent increased interest in Rhopalocera being attracted to light it is appropriate to note an addition to the body of information on this subject.

A large lepidopteron was taken at some time very near 9:00 pm, Pacific Standard Time, 14 November 1952, at San Blas, Nayarit, Mexico. It was sitting on the ceiling of an outdoor corridor about two feet from a yellow light of the insect-repelling type. The location was a hotel there (the only modern one at that time) on the south edge of town. The place the specimen was taken faced jungle which was about three hundred feet away. The Pacific Ocean was about two hundred feet in the opposite direction.

This specimen was recently identified, with the aid of Dr. C. L. Remington, as *Taygetis mermeria* Cramer, probably form *excavata*. Identification was based on figures in Seitz' *Macrolepidoptera of the World,* Volume 5. The specimen has been placed in the Peabody Museum of Natural History at Yale University.

ROBERT B. BUTLER, 15 Paulus Boulevard, New Brunswick, N. J., U. S. A.

BOOK NOTICE

The DYNAMICS OF EPIDEMIC SPRUCE BUDWORM POPULATIONS. Edited by R. F. Morris. Canadian Entomologist, Memoir 31, 332 pp., numerous textfigs., graphs, & halftone plates. May 21, 1963. Paper and cloth.

The spruce budworm, *Choristoneura fumiferana* (Clem.) (Tortricidae) pobably is the most intensively studied species of Lepidoptera in North America, if not in the world. Its tremdous outbreak capabilities and resultant economic importance to Canadian foresters precipitated a myriad of detailed studies on numerous aspects of its bionomics during the past 20 years.

This monograph is a series of closely related papers presenting the results of population studies on the spruce budworm. It is an attempt to ascertain and model mathematically where possible, the mode of action of the principal variables affecting density of the species. Major topics covered include general bionomics; development of outbreaks; analysis of survival and reproduction in both unsprayed and sprayed areas; a discussion of the major factors and processes affecting the bionomics, including dispersal, hosts and host conditions, parasites, predators, diseases, and insecticides. In all, twelve authors are contributors. – EDITOR