

HYBRIDS BETWEEN PAPILIO MEMNON AND P. HELENUS AND BETWEEN P. MEMNON AND P. PROTENOR

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PAPILIO MEMNON LINNE is found in the southern part in Japan only while *P. helenus* Linne and *P. protenor* Cramer are distributed throughout most parts of Japan. The form of *P. protenor* in the area of Japan is tailed. The writer obtained three male F₁ hybrid butterflies between *P. helenus* female and *P. Memnon* male (Fig. 1a) and one male F₁ hybrid butterfly between *P. memnon* female and *P. protenor* male (Fig. 2a) in 1962. These data are presented here with one record of a crossing between *P. protenor* female and *P. memnon* male in 1961.

MATERIAL

The adult females and eggs of *P. memnon thunbergii* von Siebold were sent to the writer from Kyushu, Japan in spring of 1962 by Mr. H. Fukuda, Mr. I. Otsuka and Mr. A. Tanaka. The larvae from the above eggs, and eggs obtained from the above females were reared on Natsumikan (*Citrus natsudaoidai* Hayata) and a large number of pupae were obtained. Many butterflies from these pupae were used for the experiments. The writer collected one *P. helenus nicconicolens* Butler at Ryusozan, Shizuoka-pref., Japan in May. The brood, N-40 from the above female, was reared on Kihada (*Phellodendron amurense* Rupr.) and many butterflies of this brood were used for the experiments. Some wild males of *P. protenor demetrius* Cramer collected in Nagoya by the writer were also used.

A few pupae and larvae of *P. memnon thunbergii* were sent to the writer from Kyushu by Dr. T. Shirozu in early summer of 1961. One male butterfly was obtained from the above larvae and used for the experiment. Brood R-54 of *P. protenor demetrius*, which originated from a female collected in Nagoya by the writer with the larvae reared on Inuzansho (*Fagara schinifolia* Engl.), was also used in 1961.

CROSSINGS

Three matings between *helenus* females and *memnon* males, 5 matings between *memnon* females and *helenus* males, and 3 matings between *memnon* females and *protenor* males were obtained by the method of hand-pairing in 1962. One mating between *protenor* fe-

male and *memnon* male was obtained by the same method in 1961. Eggs were obtained from 3 *helenus* females of the above first kind of mating, 3 *memnon* females of the second, one *memnon* female of the third and one *protenor* female of 1961. However, fertile eggs were only included among the eggs from three females of the first kind of mating, the female of the third and the female of 1961. Table 1 shows the egg fertility and hatchability of these matings and controls. An egg is yellowish white when laid, but if it starts to develop it becomes a mottled brown or a ring appears and either of these is used as an indication of fertilization. Therefore, if any embryo died at the very early age of development, the above indications may not appear. When an embryo is fully formed within an egg shell, the egg is always black. The egg fertility and hatchability of one mating between *helenus* and *memnon* were very high, although the same of other two matings of the same species were not so high. The low hatchability of one control mating of *helenus* may be the result of brother-sister mating.

REARINGS

Larvae of Brood N-40-1 (see Table 1) were reared on the following food plants: 24 on *Citrus* seedlings, 9 on Natsumikan, 11 on Kihada, and 14 on Karasuzansho (*Fagara ailanthoides* Engl.) All of the above plants are the natural food plants of *helenus* larvae. *P. memnon* larvae feed on *Citrus*, but they are not found on Kihada and Karasuzansho. The writer failed to rear *memnon* larvae on Kihada and Karasuzansho in a laboratory. Hybrid larvae grew well on *Citrus* and none died before the 5th instar stage, but some died at the 5th instar and many died by failing to molt at the prepupal stage. Only 4 good pupae were obtained and two male butterflies emerged (Fig. 1a). Many larvae died before the 5th instar in rearings on Kihada and Karasuzansho, especially failing to molt at the end of the 4th instar. Many also died by failing to molt at the prepupal stage. Only one good pupa was obtained from the larvae reared on Kihada and it emerged as a male. All larvae reared on Karasuzansho died without reaching their prepupal stages. Three and 10 larvae of Brood N-40-10 were reared on Kihada and *Citrus* respectively, but all of the larvae died at their young stages. Four larvae of Brood M-15-6 were reared on *Citrus*. One died at its prepupal stage and three pupae were obtained, but only one of them was fully formed and emerged as a male (Fig. 2a). Four larvae of Brood R-54-35 were also reared on *Citrus* (in 1961), and one good pupa was obtained. A male adult body was fully formed in this pupal shell, but it failed to emerge.

Noticeable differences were not observed in development rates of the above hybrid rearings. However, their pupae were very small in comparison with any of the laboratory reared parental species. Therefore, the hybrid butterflies obtained were very small.

LARVAL APPEARANCE

Larvae of the three parental species, which the writer used in this experiment, resemble closely each other in all stages of their development, and their mature larvae are all "orange-dog" type (Figs. 3b, 4b, 5b). However, it is possible to distinguish them in any stage of development. Appearances of the hybrid larvae of the above two kinds are generally intermediate between the parental species (Figs. 1b, 2b). The writer describes here a few striking characters. The ground color of young larvae of *memnon* is more greenish than in *helenus* or *protenor*. The ground color of both hybrids are greenish but they are not so prominently greenish as in *memnon*. The color of the two abdominal stripes of the 5th instar larvae of *memnon* is white and of other two species is brown. These stripes in both hybrids had whitish-brown color. The first stripe of *memnon* (the 4th and 5th abdominal segments) is wider than other two species. The second stripe of *memnon* (the 6th segment) is prominent only at lateral sides of the larvae, but it also appears clearly at the dorsal side in *protenor* and *helenus*. The shape of these stripes in the hybrid larvae are *protenor* or *helenus*-like according to the direction of hybridization.

Table 1. *Papilio memnon* hybridization

Parents		Eggs laid	Eggs fertile	Eggs blackened	Eggs hatched
Brood and female No.	Male No.				
N-40-1	M-14-1	67	63	62	61
N-40-10	M-14-3	23	21	-	13
N-40-13	M-14-2	29	9	3	0
M-15-6	R-68	11	11	11	4
R-54-35	M-8	5	5	5	4
N-40-4	N-40-9	14	12	9	1
N-40-12	N-40-8	75	71	68	66
M-19	M-18	44	43	43	42
M-17	M-16	58	58	58	57

N - *helenus*;M - *memnon*;R - *protenor*

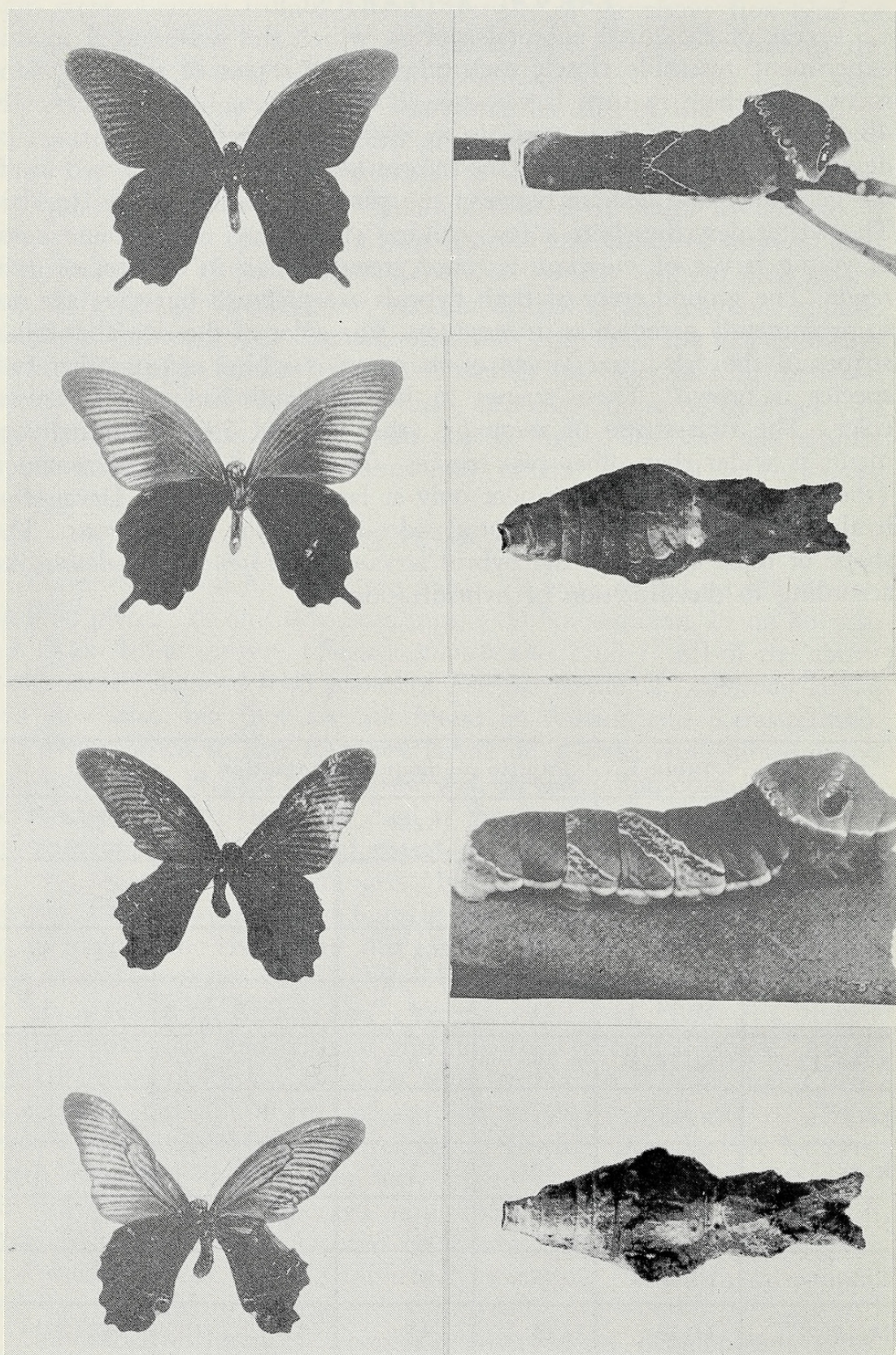


Fig. 1. *Papilio memnon* X *P. helenus*:
 (a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

Fig. 2. *Papilio memnon* X *P. protenor*:
 (a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

PUPAE

Pupae of the three parental species also resemble closely each other as do their larvae, but they are easily distinguished in the shapes of the head processes (Figs. 3c, 4c, 5c). The angle of the mid-ventral bend is the sharpest in *helenus*, and *memnon* pupae have the strongest look in their appearances. The hybrid pupae were intermediate in these characters between the parental species (Figs. 1c, 2c).

IMAGINES

The *P. memnon* male is tailless and has red patches at the base of the under side of the both wings (Fig. 3a). *P. helenus* and *P. protenor demetrius* both are tailed (Figs. 4a, 5a). *P. helenus* has white patches, which usually cover a part of cells Sc-R₁, R₂, and M₁ of the hind wing, and *protenor* (male only) has a white band in cell Sc-R₁ of the hind wing. Hybrids between *memnon* and *helenus* are tailed (Fig. 1a) and the hybrid between *memnon* and *protenor* are tailless (Fig. 2a). Neither the red patches of the base nor the white patches or band appeared on the wings of both kinds of hybrid.

Scattering of blue scales, which appear on the upper side of the hind wing of *memnon* and sometimes of *protenor* but does not appear on *helenus*, appeared on both kinds of hybrid. The band of the under side of the hind wing of *memnon* only, which is formed by the scattering of blue scales, appeared in both kinds of hybrid.

Seven crescent red patches appear on the under side of the margin of the hind wing of *helenus* and *protenor*; *memnon* has only a few patches of the same kind. The appearance of these patches in both kinds of hybrid were *memnon*-like.

DISCUSSION

The high egg fertility and hatchability of one mating between *helenus* and *memnon* suggests a close relationship between these two species. The fact that all of the eggs (16) from two matings between *memnon* and *protenor* started to develop may suggest also a close relationship between these two species. However, the fact that the large number of prepupae failed to molt in *memnon-helenus* hybrids may indicate that the relationship between these two species is not so close as the relationship between *protenor* and *helenus*, or between *helenus* and *polytes*, which were not lost in large numbers in one particular molting (Ae, 1962a, b and 1963).

The tail of the hind wing of many species of *Papilio* may be controlled by a similar gene(s). All local forms or subspecies of *helenus* have a tail and all forms of *memnon* male have no tail. However, most forms of *protenor* are tailless, even though the Japanese form does have a tail. Therefore, the genetic background of the tailed condition of *P. protenor demetrius* is not as stable as of *P. helenus*. This may be the reason that the hybrid between *helenus* and *memnon* has a tail,

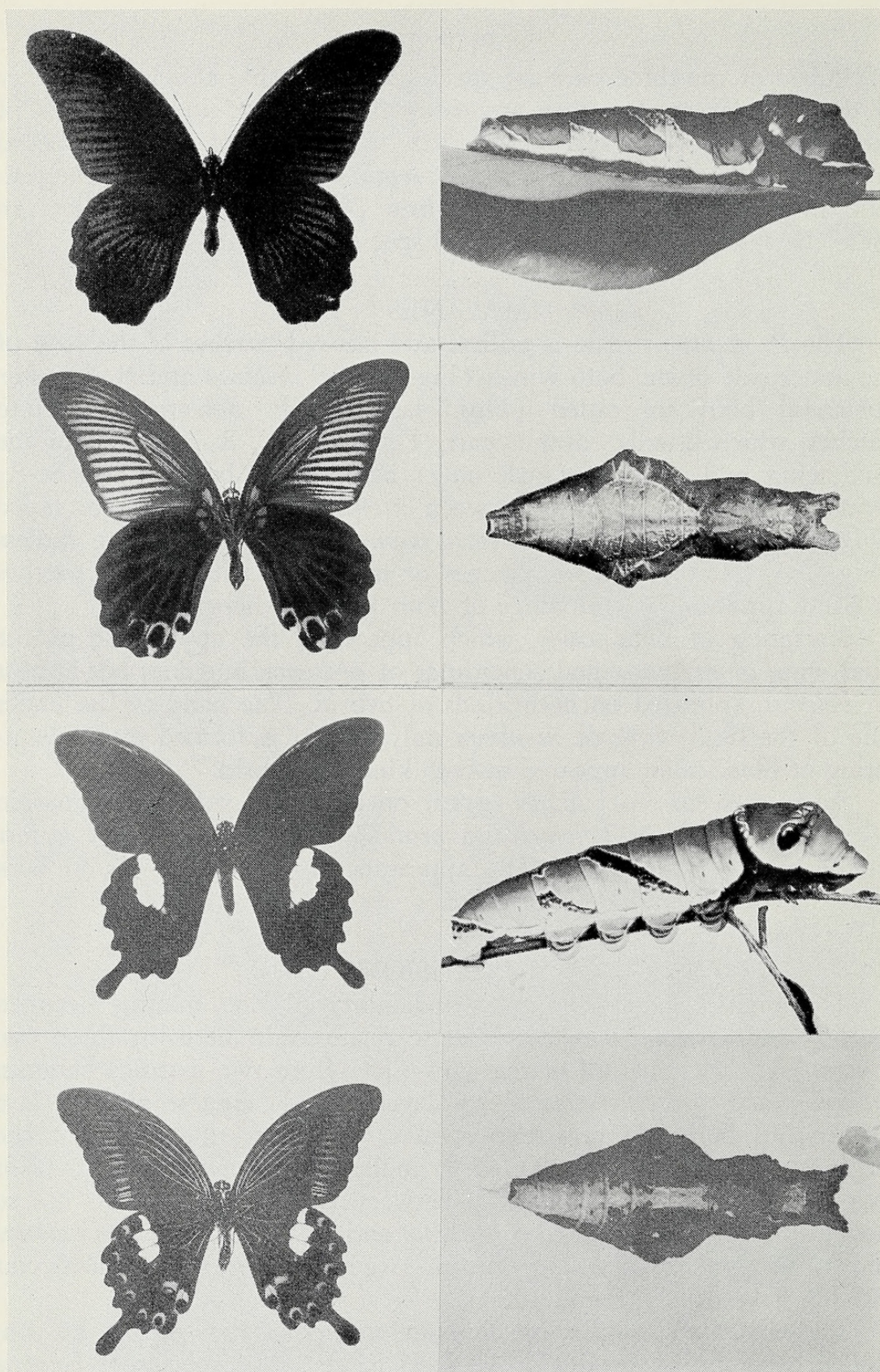


Fig. 3. *Papilio memnon*:

(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

Fig. 4. *Papilio belenus*:

(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

and the hybrid between *memnon* and *protenor* has no tail; the dominant-recessive relationship of the tailed phenotype reverses.

White patches (or band) appeared in hybrids between *protenor* and *helenus*, between *polytes* and *protenor*, and between *polytes* and *helenus* (Ae, 1962a, b and 1963), but these did not appear in the hybrids between *helenus* and *memnon* and between *memnon* and *protenor* (this paper). These facts may indicate that the genes, which control the white patches or the band of *helenus*, *protenor* and *polytes* may have the same origin and/or cooperative relations.

SUMMARY

1. Fertile eggs were obtained from three matings between *P. helenus* female and *P. memnon* male, and in matings between *P. memnon* female and *P. protenor* male and of its reciprocal by the method of hand-pairing.

2. The egg fertility and hatchability of one mating between *helenus* and *memnon* was very high. However, many individuals of this brood were lost at their molting at the perpetual stage.

3. The larvae of the above two kinds of hybrid were reared mainly on *Citrus*. Four pupae of *helenus-memnon* hybrids and one pupa of *memnon-protenor* hybrid were obtained. These pupae were very small

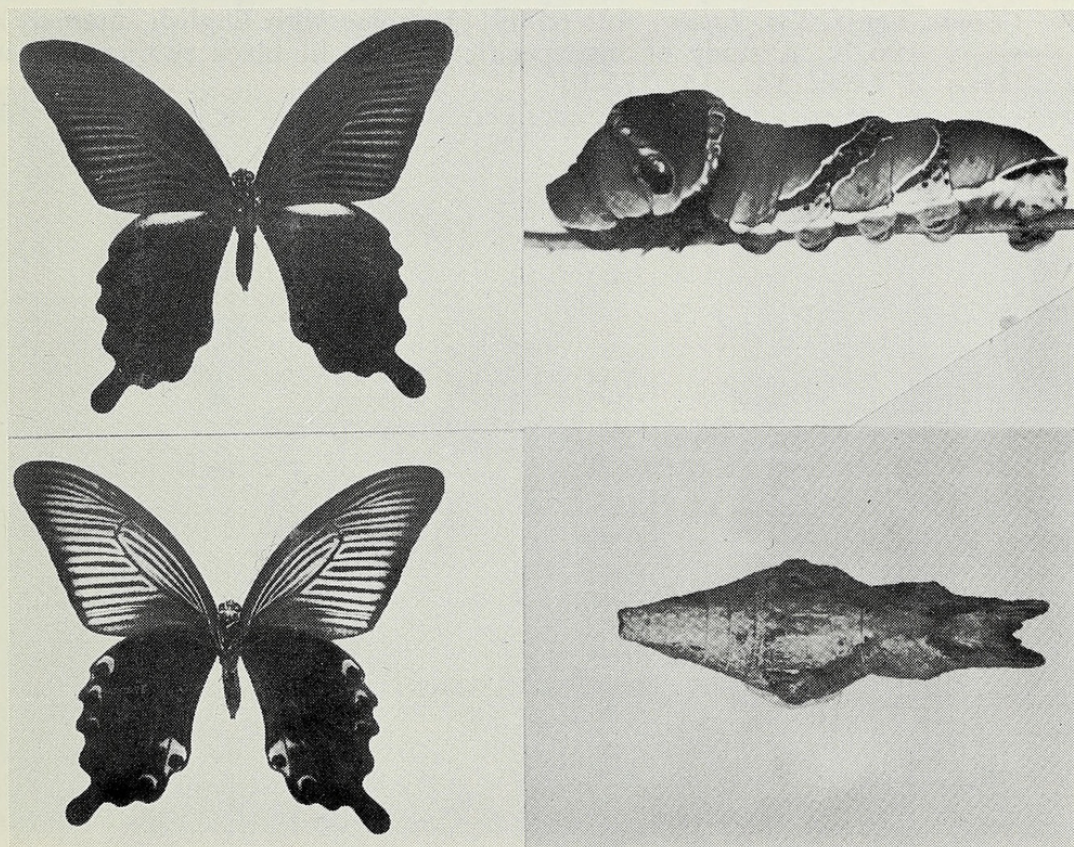


Fig. 5. *Papilio protenor*:
(a) adult male, upper side and under side (b) larva (5th instar) and (c) pupa.

in comparison with the parental species, although their developmental rates were the same.

4. Three male adults of *helenus-memnon* hybrids and one male adult of *memnon-protenor* hybrid were obtained.

5. Larval and pupal appearances of the above two kinds of hybrid were intermediate between the parental species in general.

6. The *helenus-memnon* hybrids were tailed and the *memnon-protenor* hybrid was tailless.

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