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THE BREEDING IN CAPTIVITY OF THE HYBRID *PAPILIO GLAUCUS* ♀ × *PAPILIO EURYMEDON* ♂

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In a previous paper (Clarke & Sheppard, 1955) we described the breeding in captivity of the hybrid swallowtail *Papilio rutulus* Lucas ♀ × *Papilio glaucus* Linné ♂. Since an understanding of the relationship between *P. glaucus* and its near relatives must be based in part on genetic information it seemed worth while investigating the closely related *P. eurymedon* Lucas. The account that follows gives details of the hybrid between *P. glaucus* ♀ and *P. eurymedon* ♂ which we obtained in 1956 on three occasions.

The *P. eurymedon* pupæ were kindly supplied by Mr. NOEL MCFARLAND in 1955, from Beverly Hills, California. They were the offspring of butterflies which had emerged in the early spring. The pupæ overwintered; the three ♂ ♂ used for crossing emerged in May 1956.

The *P. glaucus* pupæ were descendants of those originally sent us by Mr. EUGENE DLUHY, from Chicago, Illinois. They had been principally used for work on the genetics of the two forms of *glaucus* female, the results of which are published elsewhere (Clarke & Sheppard, in press). The table gives the matings which we made, some details of their fertility, the dates of the emergences of the hybrid butterflies, and the number of pupæ that remain. From the brood numbers, the pedigree of the *glaucus* females can be found by reference to the other paper (Clarke & Sheppard, in press).

BREEDING METHODS AND LIFE HISTORY

The butterflies were mated by the hand-pairing technique, (Clarke, 1952; Clarke & Sheppard, 1955). Breeding was carried out at room temperature or a little above, throughout the summer months. The caterpillars were fed on *Liriodendron* which they ate readily. This was in striking contrast to all the *eurymedon* larvæ, also received from Mr. MCFARLAND, which invariably refused to eat this food plant. BROWER (1957) also states that he has never known *eurymedon* larvæ to feed on *Liriodendron*.

DESCRIPTION OF HYBRID LARVÆ

The full grown hybrid larva resembled that of *glaucus* except in the eye-spot on the thorax which is pear-shaped with the narrow portion towards the middle line, whereas in *glaucus* it is approximately circular in outline. A second yellow area, medial to the main eye-spot, was also present in most of the hybrid caterpillars. This varied in appearance between merely a black line and a yellow triangular area bordered by black. The photograph illustrates the two degrees of expression in the same hybrid larva. The element seems to represent a reduced version of the large black-bordered yellow patch present in this position in *eurymedon* larvæ. Figure 1 shows the form of the eye-spot in *P. glaucus*, the hybrid, and *P. eurymedon*.

MATINGS OF *PAPILIO GLAUCUS* ♀ × *PAPILIO EURYMEDON* ♂

Mating no. and date of mating	Brood no. and form of mother	Father's symbol*	Remarks	Emergences	Remaining pupæ
954 31/5/56	640 (black)	α	No. of eggs laid not known. "At one time about 15 larvæ."	♂ 28/8/56 ♂ 31/8/56 ♂ 1/9/56 ♂ 13/1/57 ♂ 30/3/57	1 (♀ ?) (19/9/57)
957 31/5/56	640 (black)	β	19 eggs laid. Began to darken but collapsed.	———	———
960 1/6/56	639 (yellow)	γ	No eggs laid.	———	———
968 3/6/56	640 (black)	γ	Laid 18 eggs, 12 fertile, 6 infertile (4 green, 2 collapsed)	♂ 13/8/56 ♂ 18/8/56 ♂ 23/8/56 ♂ 28/8/56 ♂ 16/9/56	4(all ♀ ♀ ?) 19/9/57
974 6/6/56	669 (yellow)	γ	Laid several infertile eggs.	———	———
975 6/6/56	669 (yellow)	β	Laid fertile eggs. Last two males dead; taken from pupal cases.	♂ 25/8/56 ♂ 27/8/56 ♂ 27/8/56 ♂ 27/8/56 ♂ 1/9/56 ♂ 30/9/56 ♂ 16/11/56	———
978 6/6/56	669 (yellow)	α	Laid about 50 eggs, all fertile, all hatched. Brood virused; 2 reached pupal stage but both died.	———	———
999 10/6/56	650 (yellow)	α	No eggs laid.	———	———
1002 11/6/56	650 (yellow)	α	Laid 17 infertile eggs.	———	———
1009 13/6/56	670 (black)	α	No eggs laid.	———	———

* The Greek letters in the third column indicate the multiple matings of the ♂ ♂, and the order of mating can be seen from the date in the first column.

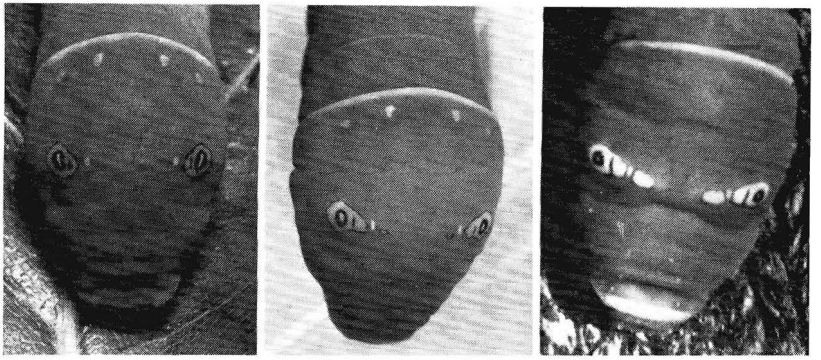

Fig. 1. Thoracic eye-spots of full-grown larvæ: left, *Papilio glaucus*; center, F_1 hybrid *P. glaucus* ♀ × *P. eurymedon* ♂; right, *P. eurymedon*. (Photo of *P. eurymedon* by L. P. BROWER.)

DESCRIPTION OF HYBRID PUPÆ

The male pupæ resembled those of *glaucus* and there were no individuals of the partially green form as is sometimes found in *P. eurymedon* (Brower, 1957). The presumed female pupæ, none of which has yet emerged (September 1957), are very large and though looking healthy appear to be going through a second winter. This phenomenon did not occur in any of the *glaucus* × *rutulus* hybrids (Clarke & Sheppard, 1955), nor among several hundred *glaucus* pupæ kept under similar conditions over the past few years. If the female butterflies do eventually emerge it seems more than probable that they will be black, since we have shown that in *glaucus* almost invariably the colour of the female offspring is the same as that of the mother. This shows that black is not controlled by an autosomal gene (Clarke & Sheppard, in press).

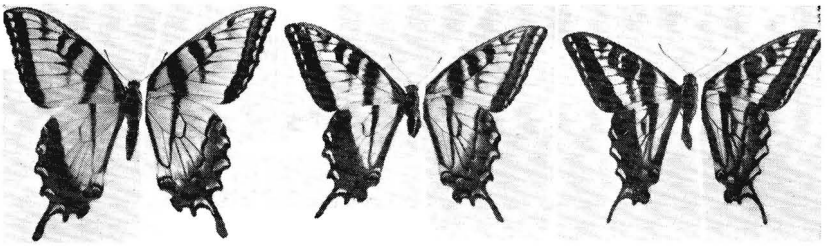

Fig. 2. *Papilio* males, upperside left, underside right of each specimen: left, *P. glaucus*; center, F_1 hybrid *P. glaucus* ♀ × *P. eurymedon* ♂; right, *P. eurymedon*.

DESCRIPTION OF MALE HYBRID BUTTERFLIES

In general the hybrids resemble *glaucus* much more than *eurymedon*. Thus, the yellow ground colour on the wings is no paler than the palest *glaucus* we have observed, and the amount of black on both the forewings and the hindwings also resembles that in *glaucus*, although in general there

is slightly more black than in typical *glaucus* specimens. On the underside the black markings in the hybrid are wider and darker than those of the darkest *glaucus* we have seen. The orange in the outer spots of the underside of the hindwing tends to be intermediate between *glaucus* and *eurymedon* and more orange than in *rutulus* × *glaucus* hybrids (Clarke & Sheppard, 1955). The only feature in which the hybrids resemble *eurymedon* rather than *glaucus* is in the nature of the yellow submarginal lunules, which form a continuous band (as in the *rutulus* × *glaucus* hybrids) and not a series of discrete spots as in all the *glaucus* we have bred.

Figure 2 shows a ♂ *glaucus,* a ♂ hybrid, and a ♂ *eurymedon* for comparison.

DISCUSSION

1. *Larval food plant.* The ability of the larva to feed on *Liriodendron* seems to be dominant as was the case with the *rutulus* × *glaucus* hybrid. Appropriate backcrosses (or F_2) of the hybrid to *eurymedon* would show whether this character is controlled unifactorially or multifactorially.

2. *Wing-pattern of butterflies.* The pattern in *glaucus* seems generally to be dominant to that of *eurymedon,* but again further generations must be obtained before the number of genes controlling this character can be estimated.

3. *Larval spot markings.* These were intermediate between the parent forms and again no further information is available as to the mode of their inheritance.

4. *Fertility.*

a) *The backcrosses to P. glaucus.* Fertile eggs, as judged by change in colour, were obtained on eight occasions when hybrid males were backcrossed to *glaucus* females. In five of these broods no caterpillars hatched, while in the remaining three, although larvæ were produced, all eventually died of disease. It is of note that in two of these families many of the eggs, although they blackened, did not hatch. The findings generally are in contrast with the single fertile backcross mating made with the *rutulus* × *glaucus* hybrid in which the fertile eggs all hatched.

b) *Sex ratio.* It has already been stated that in the *eurymedon* × *glaucus* hybrids no female butterflies have yet emerged, and this agrees with Haldane's rule (Haldane, 1922) that when there is any abnormality in one of the sexes or when one is deficient, it is always the heterogametic sex. Our result with these hybrids is in contrast with those of the *rutulus* × *glaucus* hybrids, where the sex ratio was normal, as was the time of the emergences of the butterflies.

CONCLUSION

The evidence on the difference between the two hybrids, with respect to (1) the development in eggs of the back crosses, (2) the sex ratio, and (3) the time of development of the female pupæ, suggests that there is a greater

genetic difference between *eurymedon* and *glaucus* than there is between *rutulus* and *glaucus*. This is in agreement with morphological considerations including an examination of the male genitalia (Brower, 1957). Further evidence on the inter-relationships of the butterflies should be obtainable by investigating the hybrid between *P. rutulus* and *P. eurymedon*.

ACKNOWLEDGMENTS

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A RECORD OF THE BLACK WITCH, *EREBUS ODORA* (NOCTUIDÆ), IN ALASKA

On October 4, 1957, a female of *Erebus odora* Linné was found by NEDRIA MIELKE at Auke Bay, 12 miles north of Juneau, Alaska. The specimen was in excellent condition when found but the margins of the wings became slightly tattered from confinement in a box before its demise. The specimen was given to E. L. KEITHAHN, curator of the Territorial Museum in Juneau, Alaska. It has been photographed and is now deposited in the museum where I had the opportunity to examine and identify it.

It has been known for a long time that isolated specimens of this moth flew or were carried by wind currents far to the north of their normal habitat in the West Indies and Mexico.

Specimens have been reported from as far north as Canada and west to California. However, as far as I can ascertain, this form has not been previously reported from Alaska.

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