



S.16

MIMICRY IN THE BUTTERFLIES OF FIJI.

By Professor E. B. POULTON.

MY attention was first directed to this subject by the kindness of Professor Gustav Gilson of Brussels, who in 1899 gave me some specimens collected by him a year or two earlier in Fiji. Among them were two species of *Euploea*, one of which appeared to have been obviously modified in mimicry of the other. Both were black butterflies with a marginal white pattern consisting of two series of spots, but whereas in one species, *E. boisduvalii proserpina*, the white spots were equidistant from the margin of both wings, in the other, *E. helcita eschscholtzi*, they turned inwards and crossed the fore wing obliquely, while the central spot of the inner series placed a little beyond the middle of the wing was greatly enlarged and by far the most conspicuous feature in the whole pattern. Now in *proserpina* the spot of the inner marginal series which was nearest in position to the large one of *eschscholtzi*, but of course closer to the margin, was also greatly enlarged and lengthened inwards, producing a strong superficial resemblance to the chief spot of the other species. Upon the wing the two would easily be mistaken the one for the other. It was the obvious production of likeness by the distortion of the inner series in the fore wing of *proserpina* which suggested that this species was the mimic and *eschscholtzi* the model, and made me long for more material in order to test and if possible extend these conclusions.

However, long before this material came to hand, I suggested that the two species should be figured by my friend, Major J. C. Moulton, M.A., D.Sc., Magdalen, in his paper published in 1908 (*Trans. Ent. Soc.*, p. 585). Finally, just 20 years after receiving Prof. Gilson's *Euploeas*, abundant material began to reach me through the great kindness of Mr. H. W. Simmonds of the Agricultural Dept. at Suva, Viti Levu. In 1923 an account of his most interesting collections in many

of the islands was published in *Trans. Ent. Soc.*, with 25 plates.

The first confirmation of the original interpretation was provided by evidence that the chief fore wing spot of *proserpina* was on the average much larger in the female than the male, thus following the law that, when the sexes differ, the female is a closer mimic than the male.

A second result of the highest interest was afforded by Mr. Simmonds' collections from three eastern islands of the group. In two of these, Cicia (Thithia) and Vanua Balavu, the ancestral form of *proserpina* was found with the marginal pattern only slightly developed and sometimes very nearly absent. The fore wing spot was prolonged inwards by a narrow stalk-like extension in one specimen from Cicia, but in the other and in all three from Balavu it remained when visible on the upper surface as a minute undeveloped member of the inner series. All these five specimens are males. Furthermore a single male *proserpina* among the specimens from Taveuni, an island near to the eastern group, also shewed an early stage in the development of the chief spot, while the only specimen, also a male, from the isolated southern island of Kandavu was still more primitive in this element of its pattern. Thus the conclusions reached in 1899 were more fully confirmed than I had ventured to hope. Since the appearance of the 1923 paper further confirmatory evidence on a large scale from Balavu has been kindly sent by Dr. Silvester Evans.

Mr. Simmonds' fine material also shewed that two other species of *Euploea* enter the associations with *helcita* and *boisduvalii*, developing a strong white marginal pattern in the western islands but retaining the primitive undeveloped pattern in the east. In these two species, *E. tulliolus* and *E. macleayi*, no fore wing spot is produced inwards as in the *proserpina* race of *boisduvalii* and it is probable that we here see the effect of the original constitution of species in rendering the first steps of evolution possible. The spot which becomes produced in *proserpina* already occupies a somewhat inward position in the dark forms of the eastern islands, probably because it is placed opposite a very shallow bay in the contour of the fore

wing, whereas in *tulliolus* and *macleayi* there is no such bay and both wing margin and marginal spots form continuous curves.

It has been shown that in the western islands the local form of *helcita* acts as a model for *proserpina* and that two other Euploeas entering into association with them, gain a strong white marginal pattern. In the eastern islands the opposite change has taken place. In the presence of three dark Euploeas the pattern of the local form of *helcita* shows distinct reduction, the chief forewing spot being partially clouded over and the hind wing inner series much reduced in some individuals. That this is the correct interpretation is confirmed by Mr. Simmonds' visits to two islands between Fiji and Samoa. On Fotuna I. he found, on May 25 and 26, 1922, only one species of *Euploea*, a race of *helcita* with a pronounced white pattern and strongly developed chief fore wing spot. The seven examples taken by him are all alike in these respects (*Trans. Ent. Soc.*, 1923, *pl XLII.*, *figs. 13-19*). On Wallis I., 150 miles distant, visited on May 30, 1922, he also found a race of *helcita*, but accompanied by a dark form of *boisduvalii* similar to that from Vanua Balavu in eastern Fiji. Of this form, *boisduvalii simmondsi*, two males and five females were captured, together with five *helcita*, all of which shewed an extremely reduced pattern, contrasting sharply with that of the Fotuna specimens. Two of the females and one male of *simmondsi* showed a slight pattern, probably a reciprocal approach towards the pattern of *helcita*. All these Wallis Euploeas are shewn on the same plate with the Fotuna *helcita*.

It is reasonable to ask why the three other Euploeas have followed *helcita eschscholtzi* in West Fiji, while *helcita* has in the main followed them in East Fiji and one of them in Wallis I. The answer is probably to be found in the important screen of islands which lies to the west of Fiji and is connected by stepping-stones with the Solomon Islands and New Guinea. It is probable that the West Fijian race has been kept constant by fresh invasions from the nearest islands of this western screen, especially the New Hebrides and New Caledonia, with races of *helcita* very similar to *eschscholtzi*.

Another deeply interesting example of mimicry is seen in

the approach of a Danaine butterfly to the four Euploeas in West Fiji. Both *Danaini* and *Euploeini* belong to the distasteful, conspicuous, slow-flying and much-mimicked sub-family the *Danainae*, and there is no reason for considering one section any better protected than the other. The Euploeas however, belonging to four species, are of course much commoner and therefore a far more effective advertisement of distasteful qualities than the single Danaine. The latter belongs to an Oriental group, placed by Moore in his genus *Tirumala*, characterised by a pale green, nearly white pattern of radiate streaks on the inner part of the black wings and rows of spots on the outer section, especially strongly developed in the fore wing. In many parts of the Oriental Region this pattern is common to several groups of allied Danaines, and is mimicked by other butterflies, in one case at least by the female of a Euploeine. But in West Fiji, as stated above, there is only one species bearing this pattern, and it is in the presence of four dark Euploeas with white marginal markings. The result has been a reduction and, in extreme instances, a loss of the internal markings of the Danaine, leaving the external to resemble the marginal Euploeine pattern. The stages of this mimetic approach are clearly shewn on plate XLIII. of the paper referred to above. Mr. Simmonds has observed that these Danaine butterflies resemble the Euploeas on the wing, as will be inferred from the comparison of plate XLIII., figs. 7-9, with plate XXX. The most gradual transition is to be found between a Danaine with the ancestral strongly developed pattern, the form *protoneptunia*, and the mimetic *neptunia*. There is some evidence for the conclusion that this superficial approach towards the Euploeine pattern has not advanced so far in East Fiji where the three dark and almost patternless Euploeas are less favourable models for so strongly patterned a butterfly as *protoneptunia*. More material and from as many eastern islands as possible, is much wanted in order to test this conclusion.

Another mimetic butterfly on which Mr. Simmonds' collections, and especially his breeding experiments, have thrown much light is the Nymphaline *Hypolimnas bolina*, allied to our well-known Vanessas. It is one of the most widely ranging

butterflies in the world and its female forms commonly mimic the Euploeine or Danaine butterflies of their district. Thus, in India, they are black, white-bordered butterflies resembling the commonest Euploeas, and the race with this form of female has spread beyond the area of its models into Socotra and, of recent years, into Madagascar where it has become abundant. The female of another race in the Malay Archipelago is apparently a mimic of a Danaine, and this race also has left its model far behind while it has extended its range into Australia and the great screen of islands to the west and northwest of Fiji. Up to this point the females retain the *nerina* pattern, as it is called, mimetic of the Malayan Danaine; but further east in Polynesia they vary in the most extraordinary manner, although vestiges of *nerina* appear in some specimens in probably every Pacific island where *bolina* is known to occur. In Fiji there is the most extraordinary mixture of female varieties, but as we pass further east these are less numerous, and finally in the most easterly part of its range the females for the most part take on a male-like pattern.

One dark form of female in Fiji, recently described as *euploeoides*, is a beautiful mimic of the dark *Euploea* pattern, and its existence in the western islands is probably due to persistence from the period when the western Euploeas were dark-bordered as the eastern are still. Another female form, very like the Indian, is probably developing into a mimic of the Euploeas with a pronounced marginal pattern. The other female forms are non-mimetic and their abundance and conspicuousness together with the habits of the species suggest that the butterfly is distasteful and its mimicry Müllerian.

Mr. Simmonds has bred families from several of these forms, the parents producing offspring of various types as well as their own. In the main island, Viti Levu, captured females, in his experience, always produced all-female families, although males are known to occur in small proportions, and there is no reason to suppose that parthenogenesis occurs in this species. In some of the other islands the proportion of males was higher and bisexual families were reared. It seemed probable that there were two castes of female, one producing females only, the other males and females, but both requiring fer-

tilization ; also that the first of these castes was especially predominant in Viti Levu.

An objection has been raised to the theory of mimicry that butterflies are not greatly attacked by almost the only enemies which seem capable of exerting an efficient selection based on sight, viz., birds. Some naturalists have even been disposed to believe that butterflies are never attacked by birds. It was therefore of much interest to find on some of Mr. Simmonds' specimens undoubted beak-marks, proving conclusively that the specimens had been seized by these enemies. In other areas, especially Africa, a large body of evidence on this subject, based on direct observation of attacks, had been brought forward and published by many naturalists, especially G. A. K. Marshall, C. F. M. Swynnerton, S. A. Neave, G. D. H. Carpenter, and W. A. Lamborn.

