

LVII.—*On Butterflies' Enemies*. By SYDNEY B. J. SKERTCHLY, F.G.S., M.A.I.

I. *Introduction*.

THE following notes are the result of observations in the forests of British North Borneo. They were written in the jungle with the butterflies about me, and, I think, throw a little new light on the questions of protective resemblance and mimicry, especially in relation to hereditary memory.

Mr. W. B. Pryer, in his notes on the *Rhopalocera* of British North Borneo, casts a doubt on certain points connected with the theory of mimicry, stating that during twenty years' collecting in the far east he never saw a butterfly taken by a bird *. Discussing this question with him in England and Borneo I was led to study the matter more particularly, and as my work takes me for months at a time into the virgin forest, my opportunities have been unusually great.

My references must be few, as my library is necessarily very small; but this is hardly a drawback, since the observations are original, and there has already been quite enough theorizing from published data. The literature of the subject is, however, quite familiar to me.

II. *The Evidence as it exists*.

That mimicry does exist probably no one has ever doubted since Bates first called attention to the phenomena. The explanation, too, proffered at the time, that edible species copied nauseous morsels, was so simple, so full, so entirely explanatory that, like Darwin's theory of coral-reefs, it seemed unassailable. Indeed, so strong was this feeling, that few naturalists ever seem to have looked for facts to support it.

Yet how meagre the evidence is! Surely if birds are in the habit of eating butterflies as a staple article of food, the fact would be patent to every ornithologist and entomologist, to everyone who delights in the beauties of nature. Such is not the case, and even Distant, in his '*Rhopalocera Malayana*' †, can only cite a few isolated cases. That some birds frequently, and others occasionally, devour butterflies is certain. But these are rare exceptions, and not the rule.

Mr. Pryer's remark has been paralleled by Mr. Scudder,

* *Ann. & Mag. Nat. Hist.* Jan. 1887, p. 44.

† P. 169.

and after thirty years' observation of insects and birds in Europe, Asia, Africa, and America I can confidently assert that I have never yet seen a bird take a butterfly. Once I saw a black-headed bunting in Wicken Fen snap up a *Callimorpha dominula* (a moth) and immediately drop it, and on mentioning the case to Wallace he was struck with its rarity and asked me to record it. The other day I saw a small Trogon dart at a *Terias* unsuccessfully; but these are the only approaches to the capture of butterflies that have ever come under my notice.

I venture to think there is an explanation of this curious apparent anomaly.

III. *Protective Resemblance and Mimicry.*

Wallace first saw that there were two distinct though allied classes of phenomena often even now confounded together. These he termed protective resemblance and mimicry. Under the former head he classes such cases as leaf-insects, leaf-butterflies, sand-coloured desert-insects and birds, the tiger's stripes, the leopard's spots, and the thousand other cases in which concealment is effected by assimilating the colouring to the environment. Under the latter he groups all the cases in which one insect mimics another.

This distinction, though often lost sight of, has perhaps a deeper meaning than was foreseen, as will presently be shown.

I wish for my argument to emphasize this great distinction and to remind the reader that protective resemblance copies *stationary* objects, mimicry simulates *moving* ones.

IV. *New Reasons in favour of the Theory of Protection.*

Apart from the indisputable fact that butterflies do mimic other insects, leaves, the bark of trees, the ground, and what not, there are one or two facts that I may add to the great stock of speculative evolution.

One is the great shyness of butterflies. The least movement startles them: some fly right away, others (especially forest species) rapidly conceal themselves. Is it not reasonable to suppose they show fear *because they are afraid of something?* The shyness of other animals is due to fear, and why not that of butterflies? It is a fear, too, of something that moves, for they will come all round and even settle on you if you are quite still, as I have experienced with several species of "Blues," with *Papilio sarpedon* and its allies, and even with the swift-flying *Curetis*. It is not a fear of being

trodden upon or knocked, for high-flying species are just as shy.

Again, many butterflies can "dodge" a moving danger. I do not mean simply get out of the way—anything can do that—but really dodge, with a sudden upward, downward, or sideway motion. I do not know any English species clever in this direction; but here in Borneo many species of *Papilio*, *Catopsilia*, *Appias*, *Udaiana*, &c. will dodge a net-stroke with exasperating facility.

Similar dodging-powers pertain to many Erycinidæ while at rest. It is almost impossible to catch an *Abisara*, for instance, while at rest: strike downwards, and they drop; strike upwards, and they bolt; sideways, and away they go.

It has been urged that butterflies are very near-sighted, for they have been seen bumping up a wall, as if they could not see the top and did not know how high to fly to get over. But no one can watch great *Hestias* and *Ornithopteras* sailing among the trees unscathed, or fragile many-tailed *Biduandas* flitting unharmed through the undergrowth, without being sure they can at least avoid obstacles.

Another argument can be based upon protective resemblance. It is far more common than mimicry, and it would be hardly too much to say that it is nearly universal among butterflies, and would be more readily noticed if we were more in the habit of watching insects than catching them. Even the most vividly coloured insects are often perfectly protected when at rest. I have watched, for instance, the silver-splashed *Argynnis lathonia* near Florence pitch with folded wings among the stones, and not a trace of glittering betrayed it.

This protection is nearly always confined to the under surface, and generally to the hind wing and tip of the fore wing—a fact the significance of which will shortly appear. A butterfly at rest with folded wings only exposes the tip of the fore wing, and if the under surface is too glaringly coloured, as in our English Orange-tip (*A. cardamines*), its brilliancy is subdued by a dark tip. It is singular how obscure metallic colours appear when a butterfly is at rest. Thus the Bornean *Abisaras* have vivid metallic blue streaks on the under surface of the hind wing; yet they are very difficult to see when pitched.

Another well-known means of protection exists in those insects whose bodies are replete with a strong-smelling, nauseous, generally oily, yellow secretion. This is generally, if not always, accompanied by great vitality. The wings are generally long and pointed and the bodies of a peculiar shape.

Every English entomologist has noticed similar traits among moths, as in the Burnets (*Zygæna*), the Cinnabar (*Euchelia jacobæa*), the Currant (*Abraxa grossulariata*). They are all nauseous and all very hard to kill. Among butterflies this is well marked in the genus *Danaïs*, and their strong vitality I have tested in Southern Europe, Northern Africa, the Straits Settlements, Borneo, the Celebes, and the Moluccas. I believe that a nauseous secretion and strong vitality always go together.

Strong vitality, again, is often correlated with long wings, but not with all long-winged butterflies. It occurs in *Ornithoptera*, *Hestia*, *Idea*, *Ideopsis*, *Euploea*, and *Danaïs*, but not in *Neptis* and *Athyma*. *Danaïs* possesses both round and long-winged species.

These may be "explained" as correlation, but to me that is only an evolutionary shibboleth for "it is, but we don't know why."

None of these specially protected forms avoid publicity. They flap along, quickly or slowly, but always with a jaunty "look at me" sort of air, quite different from such round-winged creatures as *Papilio*, *Charaxes*, *Thaumantes*, or *Melanitis*. Surely we see here what might be termed ostentatious protection!

Contrast these cases with low-flying butterflies like our English Browns, the Bornean *Ypthima* and *Mycalesis*. They flit along, suddenly pitch, close their wings, and are invisible. Often they creep down among grass-roots, and I have seen *Ypthima* hide under stones. So with the "Blues" and "Purples" out here. They flash in the sunshine or forest shade like rapidly revolving blue lamps. They *must* be seen, or the lovers would never meet; but it would take an active bird, as it does a dexterous naturalist, to catch one. When they pitch, down goes the upper wing, and only the knife-edged lower wing and tip of upper wing are exposed, and a sharp eye alone can see them. All these forms are easily killed, and they are undoubtedly protected.

Collating these data, the following inferences seem legitimate:—

1. The almost universal shyness of butterflies indicates fear.
2. The way that shyness is expressed shows fear of moving objects.
3. The theory of mimicry presupposes (a) that danger is universal, (b) that some butterflies escape danger by

secreting a nauseous fluid, (*c*) that other butterflies noticed this immunity, (*d*) that they copied it.

4. It would be of comparatively little use to an insect to be unpalatable if the insect were killed in being tasted. Hence these forms have very strong vitality.
5. Protective resemblance being almost universal shows a strong sense of danger.
6. Being generally confined to the under surface it ensures protection during the period of rest. In this it differs radically from mimicry.

V. *Mimicry's* Raison d'être.

Mimicry we have suggested is a protection against foes which attack butterflies upon the wing. I take it that the amount of danger may be measured by the pains taken to avoid it. On this principle butterflies are in much greater peril when resting than when on the wing; otherwise mimicry would be as common as protective resemblance.

The only foes worthy of such efforts as are displayed in mimicry are birds. Lizards, snakes, and monkeys may occasionally snatch a butterfly, but birds must always have been the chief foes. Yet we have seen that butterfly-eating birds form a very small minority both in species and individuals in the avifauna of the world.

Insectivorous birds vary much in their habits. At one end of the scale the woodpeckers and creepers fish insects out of holes, at the other end swallows and swifts catch all their food upon the wing. Between these tits hunt over branches, warblers flit among the leaves, flycatchers make short darts at passing flies. Moreover, birds are capable of profound modification of structure and habit, as in the case of swifts transformed into humming-birds.

Now I suggest that, as shyness and mimicry are proofs of a sense of danger from moving foes, and as the effort so displayed is disproportionate to the danger *as existing at present*, it may be that formerly butterfly-catching birds were more plentiful than now; in other words, that shyness and mimicry are habits acquired long since which have survived the necessity that gave them birth.

This supposes a change in the habits of many insectivorous birds. Such a change may have been assisted by the obvious fact that a butterfly, looked upon as food, is so much more chaff than grain—his edible body so small, his unnutritious wings so large. He must be troublesome to catch, very un-

satisfactory to a hungry healthy bird when caught. Dragonflies enjoy similar safety for like reasons.

VI. *The Raison d'être of Protective Resemblance.*

Applying the law that the amount of apprehended danger is measurable by the efforts taken to avoid it to protective resemblance, and remembering the almost universality of protective resemblance, the conclusion is forced upon us that butterflies when at rest are or were in far greater danger than when on the wing. At first sight this seems axiomatic, since it is clear that more foes are capable of capturing a sleeping than a flying prey. But when we see how comparatively rare mimicry is, and how almost universal protective resemblance is, it is hard to escape the conclusion that if, as suggested, the one refers to dangers almost past, the other has reference to dangers coeval with butterfly life and imminent up to the present time. We must remember that a collection of *proved* mimetic forms (many are spurious) can be got into a cabinet—a collection of protected forms requires a museum. I wish instead of reading this argument, for it reads feeble, entomologists could be with me here day after day, month after month, with all the wealth of tropic forms about me, to realize the great *fact* that one looks upon a new case of mimicry as a prize, but that a non-protected-resemblance species is a greater prize still.

Butterflies rest by day partly, by night always. All butterflies rest a little by day, while they suck flowers or leaves, for in Borneo more butterflies rest on leaves than flowers and many leaves are aromatic. For instance, most species of *Nacaduba*, *Tajura*, *Poritia* (Blues), and even *Apias* (Whites) live upon leaves and are rarely seen at flowers. Other butterflies are crepuscular, like *Melanitis* and *Thaumantis*, and these rest nearly all day. Hence most of a butterfly's life is spent resting. Even if foes were as expert (as swallows are with flies) in capturing flying as resting insects, most would be killed while at rest. But while only birds can catch flying butterflies, birds, lizards, ants, and beetles can capture them when at rest.

The necessity for good protection while at rest is therefore great, and hence we see protective resemblance so common; hence we see it almost exclusively applied to the under surface—the exposed surface in a state of repose.

The struggle for existence in Borneo is glaringly apparent. The country is warm, moist, with perpetual summer. Insect- and plant-life thrive to a degree not realizable at home and

competition is very severe. All sorts of insects—beetles, bees, flies, and what not—are being perpetually thinned out by insectivorous mammals, birds, lizards, frogs, wasps, and ants. One often wonders how any escape, and few would unless all sorts of protective schemes had been adopted to cope with the destroying hosts. Hence the leaf- and stick-insects, hence the universal protection of tropical larvæ. The struggle for existence is no theoretical explanation in Borneo, but a patent cruel fact. Turn the ants loose over England and the British insect-fauna would be destroyed in a year.

Yet I never saw ants touch a living butterfly. Dead ones, as every collector knows but too well, fall a prey to the pests in an incredibly short time, and there is no doubt living ones are equally palatable *if they could be obtained*. Protective resemblance I believe alone saves butterflies from extermination by ants—they do not recognize their food when it is at rest. Butterflies when reposing hide very carefully; but one cannot believe they can select places inaccessible to ants. Yet it is certain but few fall a prey to ants, or the wings of the victims would be much more plentifully found. Some of the small Blues occasionally hide under stones, and I have now and then found the wings, which seemed to be the remains of ants' depredations. I confess that though this seems to be the fact, its explanation is difficult. The resemblance of a butterfly to a leaf or stone may well be a protection in the daytime, but in the long dark equatorial nights it would not seem to matter much whether the butterfly were so protected or not, especially as we know that ants have a keen sense of smell. One would have thought the night-marauders would have hunted by scent and not by sight; but they do not—at least they do not succeed with butterflies to any great extent. I have watched ants both day and night, and our Borneo species seem always to prefer dead or dying prey—centipedes, millipedes, scorpions, defunct or moribund, may be seen carried off in triumph, but a butterfly or moth, or any really alive and kicking creature, never.

We have no foraging *Ecitons* here, nor anything like them; but Belt, though he enumerates all kinds of other creatures turned out and slain by the ant armies in America, does not mention butterflies, but he *does* record the case of a leaf-locust that stood stock still amidst the foragers, who utterly failed to recognize him as meat. This is a good case in point, for *Ecitons* have poorly developed eyes and might be expected to hunt by scent, whereas we have a clear case of them failing to recognize a protected insect.

My attention was directed by my son, E. F. Skeritchly, to

some peculiar mutilations of the wings of butterflies, which have led us to think that perhaps lizards and small insectivorous mammals are to be added to the list of foes, and that they are more successful than ants. It is not unusual to capture butterflies which have both hind wings mutilated in the same manner, as if a piece had been bitten out. We first noticed it in the crepuscular species *Melanitis leda*; and I find that Distant figures a specimen of *Panchala apidanus* said by its captor to have been bitten by a bird, but no details are given*. Since then we have found this not uncommon, and a list is appended of the species in which it has been noticed. Of course these specimens represent only a few of those which escape, but they are sufficiently numerous to show that the phenomenon is not accidental.

Melanitis leda and *Amathusia phidippus* are crepuscular and lie hid nearly all day and all night; hence they may be bitten by birds in the daytime, but I do not think it likely. The Satyrinæ, like *Mycalesis* and *Ypthima*, fly low, never rising more than 4 feet above ground, and they hide by night in the grass as well as by day in dull and rainy weather. *Papilio sarpedon* is a very swift flier, with a habit of settling in compact flocks on damp sand, and it is highly unlikely that they are ever molested by day. *Hestia* seldom settles by day, is one of the earliest on the wing and the latest to retire. It certainly does not fear birds, for it never flies quickly nor attempts concealment. Here, then, we find examples of butterflies of the most diverse habits all subject to similar mutilation.

The conclusion seems inevitable: butterflies are bitten chiefly by night, when they are most defenceless. Both hind wings are bitten symmetrically, so that when the wings are folded as in repose the mutilations correspond. Protective resemblance seems to be the only mode of ensuring safety during sleep.

The only creatures that appear likely to hunt sleeping butterflies are lizards and perhaps some of the small insectivorous mammals. Lizards are enthusiastic moth-hunters, and my son has seen a little house-lizard capture one.

It will be noticed that no examples of the Erycinidæ or Lycænidæ are recorded. I have not yet seen one of the latter mutilated that I could be sure of. So many are delicately tailed and get so damaged by the net that it is difficult to make certain on this point. I think they are mutilated. I know as yet no case of a mutilated species of the Hesperiidæ.

It will be noticed that species protected by nauseous secretions do not escape. *Hestia* and *Euploea* are cases in point. A mutilated *Danaïs* I have not seen.

* Rhop. Malaya, p. 273.

In point of numbers the Satyrs suffer most, as might have been expected. It is quite common to find *Melanitis* mutilated.

We hope to gather more information on this point and are about to experiment with freshly killed protected species to see if ants can find them when they are placed in a suitable position for protection to act.

List of Species observed with Mutilations.

NYMPHALIDÆ.

Hestia lynceus.	Amathusia phidippus.
—— leuconœ.	Discophora celinde.
Ideopsis daos.	Thaumantis lucipor.
Euplœa midamus.	Junonia atlites.
Melanitis leda.	Euthalia derma et spp.
—— ismene.	Tanaœcia, spp.
Mycæsis anapita.	Parthenos gambrisius.
—— mincus.	Cirrochroa calypso.
Ypthima pandocus.	——, sp.
—— fasciata.	

PAPILIONIDÆ.

Papilio memnon.	Papilio agamemnon.
—— sarpedon.	—— demolition.

VII. *Conclusions.*

The conclusions to be drawn from these observations are:—

1. Mimicry is a protection from foes which attack butterflies on the wing.
2. Protective resemblance is a protection from foes which hunt sleeping prey.
3. Mimicry was a protection from birds.
4. Birds seldom attack butterflies now, but butterfly-catching birds were formerly more plentiful.
5. The comparative rarity of mimicry shows the danger to have been of relatively short duration.
6. The shyness of butterflies is further proof of danger. It is now probably an inherited instinct.
7. Protective resemblance is almost universal.
8. It is a protection during the sleeping-hours.
9. Ants seldom capture living butterflies.
10. The symmetrical mutilations of butterflies points to lizards and perhaps small insectivorous mammals as the foes which hunt for sleeping butterflies.
11. The amount of danger feared is measurable by the efforts made to avoid it.