The Study of Butterflies

4. Defences and Defensive Behaviour

Peter Smetacek

Peter Smetacek works on the taxonomy and zoogeography of Indian Lepidoptera. He is also interested in exploring the potential of Lepidoptera as bio-indicators of ecological functions and groundwater.

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In this part we look at some strategies adopted by butterflies that enable them to avoid predators.

Butterflies are a fine example of how creatures that are perfectly non-aggressive can survive in nature. Indeed, they are not only surviving, but are also thriving. These fragile-looking, shortlived creatures have been around for millions of years, much longer than humans, or even the genus *Homo*: 35 million year old butterfly fossils from Europe and North America all bear the distinguishing characters of modern-day butterfly families, so ancestral butterflies must have evolved much earlier than that. Butterflies are found almost everywhere that it is possible for a creature to survive, from the harsh and cold Arctic tundra to hot deserts like the Thar and Sahara and, of course, in very large numbers in equatorial rain forests.

No butterfly can bite, sting, cause an itch, squirt acid or spring similar unpleasant surprises on would-be attackers. This is one of the major reasons why they are among the most attractive insects to us. The other reasons are obviously their large size, wonderful colours, and graceful flight. One would expect that creatures other than humans would also find them attractive for the same reasons, but with a sinister rather than appreciative purpose in mind. If butterflies were entirely defenceless, they would probably be more or less extinct by now. In reality, they are thriving, so they must have a few dissuasive tricks up their sleeves, or rather on their wings. These tricks are mainly passive defences, of which butterflies have an impressive array and some of the better known ones are discussed in this article.

The adult stage of butterflies differs from the early stages in that it is highly mobile. Due to this mobility, it has to face and outwit

not only actively foraging predators such as birds but also predators that lie in wait, such as praying mantises, web-spiders, flower spiders, frogs and toads. As a result, no butterfly restricts itself to a single line of defence.

Flight

Flight is the primary mode of progression of adult butterflies. As with other modes of progression, it is also the primary means of escape from dangerous situations. A large number of butterflies have mastered the intricacies of rapid flight and habitually zip about. Others have a rather moderate or even slow flight, but nearly all are capable of considerable bursts of speed over short distances if they feel the need to escape. Few can keep up the 'escape velocity' for long and generally slow down as soon as they feel themselves to be out of danger.

The ability to fly fast requires the development of powerful flight muscles. These, in turn, require large amounts of energy to operate efficiently, besides turning the possessor into a specially dainty morsel, with more flesh than bones (sorry, chitin). The best examples of the followers of this model of passive defence are perhaps the Skippers (Hesperiidae), which are Lepidoptera intermediate between moths and butterflies. Almost all the 3000 species of Skippers found worldwide have a stout thorax housing powerful flight muscles (*Figure* 1) and habitually fly at such a speed that they are quite difficult to follow with the eye. They are very wary and rarely allow one to approach close. The drawback of this otherwise very safe system is that the minority of species that are active throughout the daytime need to spend a great deal of their waking hours searching for and sucking up nectar to feed their powerful muscles. The majority of Skippers are active only for a few hours each day at dawn and dusk, when they zip about in the gloaming to locate mates. It is suspected that such species are also active at night (*Box* 1) but nothing is known about this for certain.

Figure 1. The broad thorax of this Skipper (Celaenorrhinus sp.) houses powerful muscles that enable the butterfly to fly very fast. *(Credit: Peter Smetacek)*

Other groups that habitually fly fast are the Hairstreaks (Lycaenidae) and some Nymphs (Nymphalidae). Like the Skip-

Box 1

It has been proposed that, originally, there were no day-flying Lepidoptera. However, as bats perfected their sonar-based hunting system, pressure grew on the night-flying Lepidoptera and some species evolved to exploit the hours of daylight, when predator pressure is comparatively less. In support of this proposition is the fact that, compared with moths, there are relatively few butterfly species. Nor does the diversity of physical structures found among butterflies match those found among moths, suggesting moths are a more ancient group. Even today, predator pressure is much greater for night flying Lepidoptera, for though birds fill the role of predators during the day, most birds capture resting butterflies and there are very few species of birds worldwide that habitually capture flying butterflies, unlike bats which routinely predate upon flying insects.

pers, the Hairstreaks are rather small butterflies that fly so fast it is difficult to follow them with the eye. They are active during the daytime and, like the diurnal Skippers, spend a good part of their time locating food and feeding.

Among the Nymphs, the Rajahs (*Charaxes* spp.) and Nawabs (*Polyura* spp.) are notably swift fliers, with a broad thorax. They are capable of very fast flight but, because of their large size, they are comparatively easier to follow with the eye than Skippers and Hairstreaks. Like these two groups, they require large quantities of food but prefer rotting fruit or crabs, animal droppings and other foul substances to flowers.

The second division consists of those butterflies that fly rapidly but not as fast as the Skippers and the Rajahs and Nawabs. Nevertheless, such butterflies are capable of short bursts of speed that can match those of the Skippers. Most of the Swallowtails (Papilionidae), Nymphs, Whites (Pieridae), Blues and Coppers (Lycaenidae) fit in this category. Their flight is moderately swift and even a hint of danger is enough to cause a burst of speed that will leave most pursuers behind.

This is the middle path in the trade-off between powerful muscles and the ability to live off relatively scarce food resources. While members of the 'second division' are avid feeders, they do not have as stout thoraxes as Skippers and Hairstreaks. They spend a good part of their waking hours flying and most are capable of sustained flight, unlike the very fast fliers that tend to settle frequently.

The third approach to safe flight is practised by the Tigers, Crows, Costers, Windmills, Roses, some Browns and some Whites that habitually fly slowly and are capable of only moderate bursts of speed even when threatened. While the Tigers, Crows, Roses, Windmills and Costers deliberately fly slowly to advertise their distastefulness, the Browns and Whites depend on erratic flight to escape attacks (*Figure* 2). The hopping flight of some Browns, which proceeds in a series of bounds or hops, with

the wings closed over the thorax in the upper half of the hop, enables them to move through dense vegetation where pursuit is impossible. Many Browns feed on grasses or bamboos and they are consequently commonest in areas where these plants grow. They are the only butterflies capable of getting through bamboo clumps undamaged and, when disturbed, will often fling themselves into the middle of a handy bush or bamboo clump where, if followed, they will display equal dexterity in making their way to the other side of the bush or clump, leaving the cause of disturbance struggling to get through!

Figure 2. Cabbage Whites (Pieris spp.) have developed erratic flight to a fine art. (Credit: Rajani Smetacek)

The Whites, especially Cabbage Whites, species of which are found throughout Europe, N Africa, N Asia, the Himalaya and the Nilgiri and Palni hills, have mastered the art of erratic flight. Seen from a distance, they appear to be progressing in a single direction, but the lurches, dips, hops and spurts that make up the flight of these creatures make it difficult to believe that the creature is not thoroughly intoxicated. Such flight, though ludicrous at one level, is a masterful feat at another, since it enables the butterfly to dispense with powerful muscles and the fuel required to power them, while permitting relatively safe passage through hostile territories.

Certain species of birds, such as crows and seagulls, are known to enjoy utilising upcurrents of air, rising effortlessly with wings outspread and diving down again from a height, to repeat the process over and over again. At least two species of butterflies, the common mime (*Papilio clytia*) and the Blue Apollo (*Parnassius hardwickei*) do more or less the same thing. The former butterfly occurs at low elevation, occasionally ascending to 2250 m in the hills but commonest below 1000 m while the Apollo is most often found above 3000 m in the Himalaya. Numbers of each species congregate in some steep ravine or on a spur where there is a strong upward breeze and practise their aerobatics for hours at a time, sometimes jousting with others of the same species, at other times chasing other species of butterflies, but always returning to rise upward with outspread wings and dive down to the bottom again, to repeat the process. These butterflies are

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usually males and the Mime is known to await mates on hilltops and ridges, as several other butterfly species do.

Settling

After high speed travelling which is comparatively safe, there comes a time when the insect has to settle, whether to eat, sleep, bask or merely rest. This is the time all the slower predators wait for, when they can creep up to, leap upon or otherwise lay jaws or claws upon the elusive morsels. However, the very existence of a species is proof of its members' ability to survive and nothing that has survived is going to allow itself to be an easy prey every time it settles.

Most of the Swallowtails rarely settle for long during the day: instead, they perch briefly upon a flower or hover over wet sand, their wings trembling nervously, ready to carry them to safety at a moment's notice. If the weather turns chilly they settle down, usually under a twig or leaf and hang there until a warmer period. They also pass the night in this manner.

In very few cases, as in the Snow Apollos (*Parnassius* spp.) and the Swordtails (*Pathysa* spp.), Swallowtails settle on a flower as other butterflies do without hovering nervously about and, with wings outspread, drink their fill of nectar. During the daytime, many Skippers habitually settle under leaves with their wings outspread and pressed flat against the leaf, making them invisible from all sides except below. Since they usually settle on low growing bushes and herbs, the view from below hardly matters.

Figure 3. Most Blues settle so that they cast almost no shadow, like this white-spotted Hairstreak (Euaspa ziha). (Credit: Peter Smetacek)

While the majority of butterflies settle facing forward, some of the Hairstreaks settle facing the direction they came from, turning sometimes in mid-air just before they settle, at other times turning around soon after settling. The strategy behind this will be discussed in a future instalment of this series.

A rather curious habit has been observed among the Blues and Hairstreaks (Lycaenidae). Soon after settling, they move about to align themselves with the Sun in such a manner that they cast

a shadow consisting of no more than a line (*Figure* 3). If the Sun is at an angle to their perch, they will even lean over to get the angle right. The reason is probably that, in Nature, predators such as birds tend to recognise the silhouettes of their prey. A shadow is often as good as a silhouette, hence the need to reduce it to a minimum. Secondly, butterflies absorb heat from the substratum. It is possible that one side in shadow and the other in the Sun is not the ideal position for basking. However, butterflies of almost all other families do not seem to mind casting a shadow.

In the case of the Evening Browns (*Melanitis* spp), who resemble a dry leaf on the underside (see *Resonance*, Vol. 6, No. 5, p.11, 2001), a common response when they are disturbed or feel threatened is to dash off among the undergrowth and, settling among dry leaves on the ground, to lean over until they are nearly horizontal. By doing this, they look even more like dry leaves than if they were to remain erect. When they are not disturbed, though, they settle with the wings erect. The Banded Satyrs (*Aulocera* spp) of the Himalaya also lean over sometimes so that their wings almost touch the ground. They are cryptically patterned on the underside. Being mainly residents of grassy hillsides, they do not resemble dry leaves but their cryptic pattern makes them quite difficult to spot when they settle among tussocks of grass and gravelly paths. The Oakleaf butterflies (*Kallima* spp.), which are perhaps the best example of camouflage are found in forested hilly areas over most of India. They perfectly resemble the shape and colour of dry leaves and are almost impossible to spot when they sit amid genuine dry leaves. They, however, do not lean over as do the Evening Browns. When disturbed, they dash off and plunge into thickets, settling with head downwards among dense foliage. the tip of the lower or hindwing touching the twig on which the butterfly is perched so that one gets the impression that the 'leaf' is attached to the twig. Some other leaf mimicking butterflies also do this when disturbed. Since few other butterflies do this, i.e. touching the twig they are settled upon with the tip of their

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hindwing, one is left with the suspicion that there is more to the whole business than meets the casual, or even discerning eye. Why, for one, do they touch the wingtip to the twig only when they have been disturbed and are in hiding and not at other times? How do the Oakleaf butterflies always head for a tree whose leaves they resemble when they need to hide? What immortal hand or eye prompted the development of a translucent window in the centre of the upper or forewings, that enables light to pass through thereby breaking up the outline of the butterfly? The genetic code, no doubt, is ultimately responsible for all this and much more, but, is there a 'ghost in the machine'?

Distastefulness

Of the 20,000 species of butterflies known to science, a relatively small percentage are distasteful to varying degrees. This means that they store chemical compounds in their tissue and/or haemolymph (butterfly blood) that may be distasteful or even downright poisonous for potential predators. Such butterflies are known as 'protected' species.

The Crows and Tigers (Danainae) are well-known poisonous butterflies that contain pyrrolizidine alkaloids. Birdwings and Red-bodied Swallowtails (*Ornithoptera, Troides, Atrophaneura, Pachliopta*) store aristolochic acids.

Earlier, it was believed that such butterflies obtained their poisons by sequestering them from their larval foodplants, i.e. the plants the caterpillars feed upon. Therefore, since the Red-bodied Swallowtails feed on the pipe-vine of *Aristolochia* family of plants (Aristolochiaceae), it follows that they contain aristolochic acids. Similarly, the poisonous Tigers and Crows feed on Asclepiads (Asclepiaceae) which are known to be poisonous. African Costers (Acraeinae), of which two species are found in India, feed mostly on passion vines (Passifloraceae), a group of plants known to be poisonous. However, this rather simple theory was turned on its head as a result of experiments

with some Costers. It turned out that some members of this subfamily, of which all members were considered distasteful, were in fact not so, despite the fact that they fed on passion vines. Meanwhile, some among the most poisonous species in the group did not even feed on passion vines but on a plant not known to contain poisons. It was therefore concluded that some butterflies actually manufacture the poison they contain in their body tissue, rather than merely sequestering them from the larval hostplant.

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In India, the Yellow Coster (*Acraea vesta*) of the Himalaya, which is distasteful, feeds on *Debregeasia bicolor* and *Boehemiria platyphylla*, both members of the nettle family that are relished by cattle and do not contain poisons. The Common Jester (*Symbrenthia lilaea*), which is relished by birds, also feeds on the same plants. It seems likely from the above that the Yellow Coster actually manufactures the poisons that protect it.

To complicate matters, experiments with a North American butterfly, the Pipe-vine Swallowtail (*Battus philenor*) produced some unusual results: members of the species that were fed on leaves of the pipe-vine (*Aristolochia*) were distasteful while members of the same species that were fed on knotweed (*Polygonum*) were not distasteful. In this case, it seems evident that the butterfly cannot actually manufacture poisons but depends on its larval foodplant for them.

While the ability to store chemicals that are distasteful or even poisonous confers some advantage to the butterfly, the effects of the chemicals vary from group to group of predators: birds and bats may find a butterfly nauseating, but a toad, praying mantis or spider will hardly notice the difference between a protected or unprotected species. In other words, the chemical defences are effective only against certain potential predators and the butterfly has to use other means to circumvent the remainder.

Address for Correspondence
Peter Smetacek
Jones Estate
P.O. Bhimtal, Nainital
Uttaranchal 263 136, India.