

Horseflies, Robberflies and Blowflies

Editor's Introduction | Horseflies, robberflies, blowflies and their allies are all members of the Diptera, an order which accounts for some of the most widespread and successful insects in the world. They are extremely diverse in their biology: many are predators or parasites, some mimic bumblebees in order to invade their nests and eat their young, others infect sheep, and sometimes humans, as a strategy for survival. John Chainey and Nigel Wyatt of The Natural History Museum, London, introduce the colourful world of the Diptera.

The Diptera are an order of the class Insecta. They are known as true flies and their name refers to the fact that they possess only two wings. The Diptera are the most important group of insects considered in medical entomology--many are vectors for parasites and diseases while most maggots are actually dipterous flies during the larval stage.

The Diptera order is perhaps more widespread than any other group of insects; they occur in almost all available ecological niches and have been found on all continents and in all habitats other than at the extreme poles and tops of the highest mountains.

The Diptera order is traditionally classified into three suborders; Nematocera, Brachycera and Cyclorrhapha. Many nematoceran adults are characterized by their slow flight and long antennae with numerous segments, while their larvae usually have a well-developed head capsule. They are the most primitive group of Diptera and fossils have been found in rocks that date back to the upper Triassic period.

The Brachycera are generally swift fliers and their antennae are often no longer than the head. The Cyclorrhapha are characterised by the adult flies' short antennae and reduced segmentation, while the larvae are headless "maggots" that pupate inside a puparium (a case formed from the skin of the final larval instar within which pupation takes place). It is these two latter suborders which are explored in this feature.

Horseflies, hoverflies and blowflies are all members of the Brachycera suborder which contains a huge diversity of species, from some of the largest flies in the world, such as *Gauromydas heros* which grows up to 60 millimetres, to some of the smallest, measuring only two millimetres in length.

The sexes are usually very easy to distinguish, in many cases by the arrangement of the eyes: the females usually have widely separated eyes whilst the males' are closer together or not separated.

There are at least six major families in the Brachycera suborder, each with numbers of species ranging in the thousands and worldwide distribution:

- Robber flies, the Asilidae family, tend to have the vertex of the frons (the area between the eyes) sunken in, with the eyes raised above. Another characteristic feature is a tuft of bristles between the antennae and the oral margin (the edge of the cavity in the lower part of the head that contains the proboscis) which is called the mystax.
- Long-legged flies, the Dolichopodidae, almost always have a metallic green colour.
- Soldier flies, the Stratiomyids, and their sister family the Xylomyids, are characterised by very small discal cells (a space enclosed by veins in the middle of the wing) and very often large spines on the scutellum (at the apex of the thorax) which is not found in any other Brachycerous group.
- Horse flies and deer flies, the Tabanids, have a characteristic wing venation with the veins R4 and R5 (the veins which reach the edge of the wing on either side of its tip) separated to enclose the tip of the wing.
- Bee flies, the Bombyliidae and dance flies, the Empididae, are both very diverse in appearance and are therefore quite difficult to characterise although many empidids can

be identified by the fact that their antennae are almost surrounded by the eyes.



Adult bee fly (Bombyliidae).

Most Brachycera families are very old in evolutionary terms with fossil evidence that goes back to the Jurassic period. The vast majority require a warm sunny climate, at least seasonally. The exceptions are the long-legged flies and dance flies which are more temperate; these two families, which form the vast bulk of the British Brachycera, each contain well over 100 species.

Adult Brachycera are strong fliers. A species of North American Tabanid, *Tabanus atratus*, has been caught on oil rigs about five miles offshore, although it is not thought that any of these groups go in for regular migration as such. Very few species have been spread around by human activity. One that has is *Hermetia illucens* which is associated with decaying organic materials and has been found in most parts of the world. Most Brachycera are active during the daytime although some of the blood feeders are nocturnal or crepuscular.

The main food sources for adults are flowers, vertebrate blood and other invertebrates. Some will use other sources of food such as honeydew and there are a few that do not feed at all. Flower feeding accounts for the vast majority of Brachycera including the males of all the blood sucking groups. Some species have a very long proboscis suggesting that they must specialise in certain types of flowers.

The largest Diptera to take blood are the horse flies and deer flies (the Tabanid family). Apart from them, the blood feeders are members of two rather similar looking small groups, snipeflies, the Rhagionidae and water-snipeflies, the Athericidae. Only the females take blood, with the purpose of providing protein for egg production. Some Tabanid species are involved in disease transmission, for example the *Chrysops silaceus* group which transmit *Loa loa*, the cause of a non fatal but rather nasty human disease in West Africa. In general terms, Tabanids are of more importance when it comes to livestock, both in mechanical transmission of disease and in the sheer numbers of biting flies.



Tabanid flies (Tabanidae) feeding on the leg of a cow.

The main predatory groups are the robber flies (Asilidae), dance flies (Empididae) and long-legged

flies (Dolichopodidae). Many of these predators are opportunists; they wait on a perch for prey items to fly past and then grab them. This means that a large range of prey may be eaten. The Dolichopodids tend to prey on soft-bodied organisms and some will land on water to prey on mosquito larvae.

Courtship and mating behaviour is generally rather poorly known in the Brachycera. It is thought that the males of some species attract females by assembling in swarms over hilltops and tree canopies, and the structures of males of some groups suggest that visual signals might be used. Male long-legged flies perform wing waving displays to females and some species have pale tips on the ends of their wings which draw attention to them. However, it may be that these signals are used more in territorial disputes between males. In some species, particularly in the dance flies, the presentation of a prey item is a crucial part of courtship. The males of the genus *Hilara* go a step further and wrap their offering in silk. In some cases they have actually done away with the prey altogether and just present the silk instead.

Some Brachycera are mimics of other insects, especially of the Hymenoptera (bees and wasps), although in most cases the nature of the mimicry is not that well understood. The larvae of a *Hyperichia* species (a robber fly, Asilidae) prey on the larvae of the carpenter bee and it is thought the resemblance of the adult fly to the bee may enable the female robber fly to get near enough to the bee nest to lay her eggs.

Many robber flies have specialised ovipositors--the tubes through which the flies lay their eggs. Some of these are designed for digging into soil or inserting between parts of plants whereas other groups, such as bee flies (Bombyliidae) which are parasitic, either lay their eggs directly on a host or more frequently scatter them loose in the vicinity of their hosts. Many Bombyliids have an internal structure called the sand chamber which is used to gather small particles of sand or other substrates that are glued to the eggs before they are dropped. It is presumed that this gives the fly more control over where they put the eggs. The species that do this can produce a great number of eggs, up to 1000 a day. In contrast, many of the horse flies and deer flies (Tabanids) tend to lay their eggs in large masses. One species, *Goniops chrysosoma*, protects its eggs with its body, staying on top of them until they are about to hatch or until the fly dies. A related group, the water-snipeflies or Athericids, aggregate in swarms of hundreds or even thousands for egg laying, after which they die *in situ*, forming huge mounds.

Most Brachycera immatures (larva), are unknown but, where they are known, the majority are predators or parasitoids (parasites which kill their hosts). There are some species, however, which go in for different strategies, including some of the soldier flies (Stratiomyidae) whose larvae are found in decaying organic matter and a long-legged fly genus (Dolichopodidae) whose larvae are leaf miners and feed between the surfaces of leaves, while the Pantophthalmids have larvae that bore into living trees and live on the sap.

Most of the predatory larvae are found in soil, mud, rotten wood, dung or a variety of aquatic situations and they prey on other invertebrates. Some of them, especially horse and deer fly larvae (Tabanidae), will also attack vertebrates if they get the chance. Workers in paddy fields sometimes get bitten by Tabanid larvae which inject an unpleasant poison.

Some larvae are more specialised in their habits. The larva of the Vermileonid fly behave in a similar fashion to ant lions: they construct a little funnel in the sand and sit at the bottom waiting for insects to fall in. There is also a Tabanid whose larva actually exploits real ant lion funnels to grab the prey first.

There are three families in which the larvae are almost all parasitoids. Nemestrinidae larvae are internal parasitoids of immature and adult Orthoptera (the order which includes crickets and grasshoppers) and also immature Scarabeid beetles. The Acroceridae, or hunchback flies, which

have a characteristic humpbacked appearance and a long proboscis which is held under the body and protrudes beyond the tip of the abdomen, are parasites of spiders, including tarantulas.

The bee flies (Bombyliidae) form a very large family which attacks a lot of different groups. The majority are ectoparasitic (external parasitoids) but those that go for Lepidoptera--moths and butterflies--tend to be endoparasitoids. Some are also recorded as hyperparasites since they attack Hymenopterans (wasps and bees) that are themselves parasitoids. It has been suggested that in these cases the Bombyliid attacks the Hymenopteran after it has left its host, even though there is only a narrow window of opportunity between the larva leaving its host and pupation. Some are not strictly parasitoids as they feed on eggs in the pods of locusts. However, as they remain within a single pod, they effectively behave as a parasitoid.

Many parasitoids scatter their eggs loose on the ground, so the first instar larva is free living and very active and has to find a host. Once it has found a host it has to change into a different form for its parasitic lifestyle--this is known as hypometamorphism.

Most Brachycera larvae pupate in or close to where they have lived as larvae. Under certain conditions a few horse and deer fly (Tabanid) species are known to create, and take refuge in, mud cylinders. The cylinder helps the pupa to avoid becoming exposed when the mud dries out and cracks.

The Cyclorrhapha suborder is split into three parts: the Aschiza, the Calyptrates and the Acalyptrates. This feature deals with the Aschiza and the Calyptrates.

The Aschiza form a small group with only eight families. Their distinguishing feature is that the adults, unlike other Cyclorrhapha, lack an organ called the ptilinum, an inflatable sac situated on the front of the head which helps the newly hatched fly emerge from the pupa. The Aschiza families are all extremely different in terms of both their appearances and their life histories:



Adult rat-tailed maggot, *Eristalis* sp. (Syrphidae).

Calyptrates are a larger group than the Aschiza, and can be roughly divided into four smaller groups, each containing families that are quite similar to one another.

Although only part of the Diptera have been covered here, several thousand species are involved, with a few families, each containing thousands of species. These include some highly successful insects both in terms of their diversity and in the adaptability of some individual species, such as the Common House-fly, enabling them to colonise most parts of the world. Though a few species can be harmful to people, others are beneficial by controlling pests and in other ways such as pollinating flowers, while many more play an important and often under-appreciated role in breaking down dead, decaying or waste matter.

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