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Flies: the forgotten pollinators

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Most of us are aware by now of the key role insects play in pollination – we are bombarded with countless adverts asking us to 'help save the bees' and buy 'bee-friendly' plants and limit the use of insecticides and other chemicals to not harm the bees. But are bees the only insect pollinators and - to be even more heretical - are they the *best* pollinators? So, first off: no, they are most definitely not the only pollinators - the Lepidoptera (moths and butterflies), Coleoptera (beetles), Hemiptera (true bugs) as well as the rest of the Hymenoptera and countless other insects are pollinators too. And so are the Diptera (true flies). Folk seem to not want to hear that; because aren't flies revolting? Aren't flies associated with disease and filth and decomposing bodies – what can these creatures do that the poster girls of the pollinator world, the bees, can't? Well, the answer is: *a lot,* and not only that – the flies provide many secondary services on top of pollination that many of the other insects don't.

Fig. 1: Lavender successfully repelling nasty insects and encouraging the good ones in!
Photo: Fred/Flickr

Let's start from the basics – what is a fly? A dragonfly is neither a dragon or a fly, scorpionflies similarly are neither scorpions nor flies but a house fly is a real fly (but not a house. It's the problem with common names that over time confusion has crept in. A true fly – Diptera from the Greek Di (two) pteron (wing) – like all insects has a head, thorax, and abdomen as well as three pairs of legs, but unlike the dragonflies and scorpionflies, only one pair (if any) of wings. Adult flies also have suctorial mouthparts (if mouthparts are present) and one pair of balancing organs called halteres (again, not all do). This blueprint is seen by flies more as a working guide rather than something to strictly adhere to! But this is just the adult stage, and this is the first main point I wish to make – the adult stage is just one part of the flies' life cycle. Flies go through complete metamorphosis – a life-cycle consisting of eggs, larva, pupa, and adult form. The length of each stage varies depending on the species, environment, and many other factors with a few species even forgoing the egg stage altogether. Eighty percent of all insects go through a complete change in form and habitat, and for many species this enables the adults and their offspring to lead separate lives. And for flies more than bees, beetles, and butterflies this has led to an incredible diversity in food preferences. For flies are predators, parasites, parasitoids, herbivores, sanguivores, fungivores, decomposers and pollinators.

Flies, when not vilified, are often ignored because of misidentifications. Incorrect identifications by the public have caused many folk to misunderstand what is happening in their local environments - you only have to check online for information about getting rid of pests to see this. Countless websites will tell you what you can plant to get rid of the nasty insects and encourage the much more beautiful and beneficial insects, the bees – because bees are the only pollinators, right? Let's plant lavender as it repels those terrible flies! (Fig 1). However, the image in question shows a fly, not a bee, thankfully ignoring all the untruths said about it. A taxonomic failure – one of many – that helps to push the rhetoric that flies are not important in our gardens, for our crops or for the wellbeing of the planet. We need to ensure that we are educated in entomology. And this is important as many different aspects of fly ecology are being ignored. Another site

I stumbled across talks about bees 'making' chocolate, ice-cream, coffee, broccoli, and clothes. Apart from the obvious fact that bees technically only make honey, it is not true that they are the pollinators of the plants from which these products are derived.

Flies are primary pollinators of the cacao (or cocoa) tree *Theobroma cacao* L., the beans of which are used to make chocolate, with one genus of midges, *Forcipomyia* Meigen, 1818 (in which there are at least 1,000 described species), playing a key role in pollinating the tree's flowers. These midges are around one to three millimetres in length, which makes them small enough to enter the hooded, pollen-producing anthers of the cocoa tree's small flowers (Fig 2). And these trees are the pandas of the plant world – very inefficient at breeding! Only one in every 400 or so flowers will produce fruits and of these only 10% to 30% will mature. That's not the only problem facing this plant. Cacao naturally is an understory plant, growing beneath the canopies of other trees in its native tropical rainforests. But in most commercial plantations this is not how they are grown and this is leading to problems. Midges prefer the shade, and their larvae thrive in damp conditions such as in rotten wood or composting leaf litter, two habitats no longer present in these agro-ecosystems. By not understanding the pollinators and their life cycle you can say goodbye to chocolate.

Fig 2: The chocolate midge

Not only are flies important for chocolate but also for more than one hundred other cultivated plants as Jeff Ollerton writes in his 2021 Book *Pollination and Pollinators: Nature and Society,* including mango, cashew, tea, onions, strawberries, cauliflower, mustard, carrots, apples, leeks, and cassava. Further, Ollerton writes that those of us wanting to enjoy a chaste kiss under the mistletoe need not only bees (as most sources state) but also flies to ensure this Christmas pleasure.

We dipterists are very much aware of how much flies are ignored by most people, but finally these creatures are beginning to receive some very overdue credit. Although social bees have been (and still are) credited with being the most important pollinators we are now seeing that this is not the case and that many groups/species of flies are also incredibly important. At least half of the described families of flies include flower feeding adults but this figure will more than likely change as we learn more about Diptera ecology. A review by Radar and co-authors in 2016 looked at the impact of non-bee insects on crop pollination, and found that previous studies had shown that non-bees performed between 25 and 50 percent of the flower visits; and that although they were said to be less effective pollinators (something we know now is not always the case) they make up for it by making more visits. Flies do not have to return to a hive and so can keep active for longer. Flies, unlike social bees, don't have pollen baskets, in fact they are mucky pups, often flying around with bits of pollen stuck all over them. This can be commonly seen with the Empididae – the dagger flies, so called because of their long proboscis making them look like mosquitoes in armour. Research published in 2019 by Lefebvre, V et al, found that this family of flies were incredibly important pollinators of the *Geranium sylvaticum* L. – the wood crane's-bill – just over 80 of the visits were from flies, of which 74% were by the Empids (and of them 62% was by one species *Empis pandellei* Daugeron, 1999). Interestingly a quick search of the common pollinators of this plant species doesn't mention Empids at all! And not only were they frequent visitors, they were effective visitors. The same study looked at pollinator effectiveness and determined that these flies were indeed very good at pollen transfer (nectar feeding does not always mean pollination is occurring).

Fly pollination can be split into two categories – myophily, the pollination of plants by flies, and sapromyophily, which too is the pollination of plants by flies but through the method of deception! Sapromyophily encourages flies to come to plants not by the promise of pollen but instead by the plants falsely advertising themselves as either decomposing or dead organic material. Either way, the flies (and the plants) have undergone some amazing adaptations throughout their history. As we have seen, flies, like other insects, have bodies divided into three parts. The head contains most of the sensory equipment, the thorax the locomotory apparatus and the abdomen the essential components of reproduction – all the essential elements for a long and successful life. And from their heads to their abdomens flies have undertaken some amazing morphological changes.

The head is often dominated by the eyes, and flies have an amazing sense of vision including the ability to see colours and patterns hidden to us. And they have also been shown to have preferences for different colours. For example, a very common and welcome garden visitor – *Eristalis tenax* (Linnaeus, 1758), the drone hoverfly - has a soft spot for yellow flowers, even when these flies have been 'trained' to land on other colours. It is important therefore to ensure that our gardens offer a variety of colour, shape, and form to attract all our local pollinators. And we see more examples of adaptation when we look at their mouthparts. An adorable and very welcome sign of spring is *Bombylius major* Linnaeus, 1758– a hirsute bee fly that has a very long proboscis able to penetrate many a long-tubed flower. And what is more

incredible about this species is that they can extend their proboscis for even greater penetration. Anyone who has ever seen *Rhingia* Scopoli, 1763, a genus of hoverflies, feeding will see that there is a very long proboscis that when not probing the long tubulous flowers is safely tucked up in its 'beak'. Hovers are truly formidable pollinators but that is not the only reason that we like them. Hovers, as their name implies, do just that. They are great aviators and some even migrate over continents. *Episyrphus balteatus* (De Geer, 1776), the marmalade hoverfly, is another common and welcome visitor to our garden. But some of these flies may have journeyed far to get to the UK as recent research has found. Will Hawkes and colleagues (Hawkes et al. 2022) have been these (and other species) that may have started off several generations before in North Africa or Asia. These foremothers and fathers have then moved *en masse* across Europe to reach our shores. Along the way they have been feeding, and thus pollinating, helping gene flow between plant populations, as well as dying and decomposing, and thus supplying nitrogen back into the environment. That's great but there is more. For unlike baby bees who stay at home and are cared for, the immature stages of flies are often very active. And with this species of hoverfly the larva are aphidophagous (they eat aphids), and they have a voracious appetite. The larvae will consume on average 600 aphids (but with one study reporting double this amount) (Lavoipierre, F. 2021) before they pupate. These tiny little warriors are a gardener's first line of defence against the marauding masses.

Fig 3: Although superficially resembling fried eggs, these sticky flower mimics were used to sample the insects visiting Mountain Avens (Dryas) Photo: Malin Ek

And what about all the other flies? Houseflies (Muscidae) are some of the more surprising pollinators, but they too can be very important. The arctic tundra may not be somewhere we think about when we think about pollinators but it contains a unique flora looked after by a unique fauna (Fig 3). Of the 4000 species of insect described from this region, half of them are flies. A study with one of my favourite research titles ('One fly to rule them all—muscid flies are the key pollinators in the Arctic') by Tiusanen and co-authors (Tiusanen et al. 2016) found that the houseflies that may annoy you in your gardens and homes are key drivers in pollination in the Arctic, and sadly, they are seeing a decline in their abundance.

It's not just on the arctic tundra that flies flourish but up in the mountains too. Flies become dominant pollinators as the bees and the beetles cry off their pollinating duties. And once more it is not the hovers that have been found to be the important players but the Empids, Muscids and Anthomyiids (another family that has migratory species). These high-altitude assemblages may have developed over a long period of time with the plants and their pollinators co-evolving resulting in some amazing adaptations that are seen across the world from the Himalayas to the Chilean Andes. In the Himalayas there is an extraordinary species of horse fly that has one of the longest mouthparts in relation to body size.

Philoliche longirostris (Hardwicke, 1823) emerges as an adult during the flowering season of Roscoae (a member of the ginger family) that these flies are thought to pollinate (fig 4).

Fig 4: *Philoliche longirostris* from the NHM collection collected in Nepal at 2500m

We don't think of horseflies as being pollinators – aren't they are just blood suckers that cause some of the most painful insect attacks on our soft skinned skeletons? Well, no. With the majority of the sangivorous or blood feeding species of Diptera, it is only the female that takes this specialised meal and then only for egg development. For the rest of the time, she will feed on nectar, like the males, to provide her with the necessary energy to carry out her daily tasks. So yes, horseflies are pollinators, as are the aforementioned midges and as are mosquitoes. We have known that mosquitoes are pollinators since the turn of the last century but only in the last fifty years have we properly started paying any real attention. In the 1970s researchers found that *Aedes communis* (De Geer, 1776) was an important pollinator of the Blunt-leaf orchid – *Platanthera obtusata* (Banks ex Pursh) Lindl. Not only is the adult stage useful but the offspring are too, because the larval stage, unlike that of bees, is active.

Mosquito larvae (and pupae) occur in a large number and many species exploit temporary habitats which us humans love to create whether it be in abandoned water-filled buckets, pots or pans. Under the right conditions these may become

occupied with loads of wriggling instars – whose movement Henri Fabre, the eloquent French entomologist and author, compares with that of the graceful dolphins. These wrigglers are food for so many birds (and many more species).

Tachinidae are another family of flies whose adults love a bit of nectar and whose larvae consume many a gardener's foe – the hungry caterpillars. Our beautiful oak trees are host to the invasive oak processionary moth - *Thaumetopoea processionea* (Linnaeus, 1758) but luckily, we don't have to rely on just spraying as *Carcelia iliaca* (Ratzeburg, 1840) - a tachinid or as they are more affectionately called 'punk flies' - hitched a ride with an oak from mainland Europe back in 2006 and is now helping us fight the fight in controlling population numbers. And we can't leave the beneficial larvae without once more turning to the helpful hovers. And here there are not one, but two stories to tell. We have already heard about the first - the aphid munchers - but there are other types of feeders within this family: a type of maggot commonly known as a rat-tailed maggot, that I affectionately call a bog snorkeller. The name maybe off-putting to some, as is their habitat, as these larvae are found in decomposing habitats which include our compost heaps. But thanks to the evolution of an elongating abdominal breathing siphon they are able to feed in very anoxic environments whilst still breathing from the surface, and as such are brilliant nutrient recyclers. As is so often the case with flies, the variation of habitat and diet between the larval and adult stages provides a multifunctional species. One of the more regular bog snorkelling visitors to the garden is the rather striking batman hoverfly *Myathropa florea* (Linneaus, 1758) with the diagnostic bat on its back, who lays her larvae around the edges of ponds (Fig 5).

Fig 5: Batman Hoverfly *Myathropa florea*

Dank and decomposing habitats may not seem attractive to us, but thankfully they are to these flies. It is the habit of some flies to lay their eggs in decomposing meat or flesh, and certain plants have capitalised on this. Sapromyophily lures unsuspecting pollinators by mimicking fungi (attracting the Drosophilidae or vinegar flies), faeces (appealing to Muscids) or carrion (for the Sarcophagidae or flesh flies and Calliphoridae or bluebottles/blow flies). I have had the (mis)fortune of sampling a slightly past-its-sell-by-date *Amorphophallus titanium* (Becc.) Becc. ex Arcang, commonly known as the titan arum, for flies and I can testify that the smell was stomach churning (Fig 6).

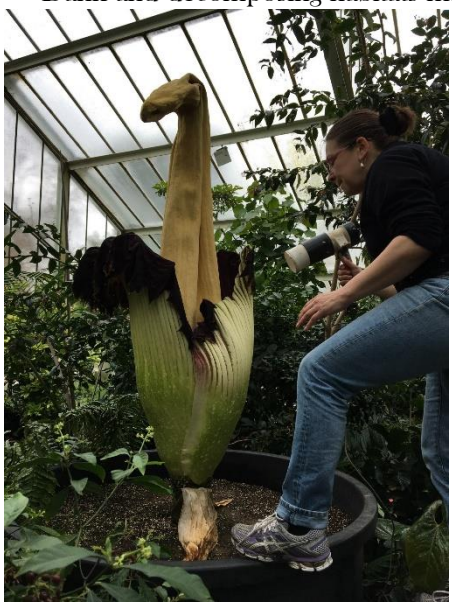

Fig 6: The cuckoo pint – Arum maculatum

The cuckoo pint – *Arum maculatum* L., is pollinated by females of the owl midge *Psychoda phalaenoides* (Linnaeus, 1758), which otherwise feeds on cow dung. The plant produces both indole and *p*-cresol – two volatile chemicals that have been detected in faeces - and these two volatiles appear to be important attractants for flies. Once these flies, mainly the females, have been lured to the plant, the latter effectively kidnaps them for a day, thus ensuring that enough time has passed for the little flies to wander around the spathe chamber (the chamber that encloses the flower cluster), transferring previously collected pollen and then picking up new pollen for the next kidnapper.

Floral deception is common in orchids too. In fact, it is estimated that deception has evolved in at least 7500 species of angiosperms of which two thirds are orchids! *Eupeodes luniger* (Meigen, 1822), (Front cover) one of our migratory species, is a hoverfly that gets tricked by *Epipactus veratrifolia* (Boissier & Hohenacker) Bornmüller, the eastern or scarce helleborine. This species mimics the alarm pheromones of aphids, as well as superficially resembling the bugs, to attract the hoverfly to lay its aphidophagous larvae on the plant. In doing so pollen is transferred by the adult as it moves from plant to plant.

Flies are therefore an important but much maligned component of ecosystems, helping to provide essential and economically important services for us and many other species. Both the adults and the larvae make active contributions and we should give them much more attention, and thanks, than we currently do. Instead of just talking about bee pollinators, it may be time to look past the image of flies as pests and consider the many positive roles that these attractive animals perform.

For further information about flies check out the dipterists Forum https://dipterists.org.uk/home

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