Section 1: Introduction

Diptera have been saved until last. Why? Simply because these will probably tax you the most.

With 24 families, over 350 genera and around 1600 species in Britain, the Diptera, or true flies, are easily the most diverse group of macroinvertebrates in fresh waters. They are also among the most frustrating to those who wish to identify to species level: some families are straightforward, others are possible following dissection and preparation; for others it is currently impossible to identify larvae even to genus level. The reasons for this are twofold.

First, Diptera are members of the Endopterygota division of insects, in which the larval and adult stages are very different in appearance. Specifically, dipteran larvae are grub-like, maggot-like or worm-like, often with few clear external features. The metamorphosis into the adult stage occurs during the pupal stage, in which the animals look different again.

Second, species diagnoses are made using adults, and among several families, relatively few have been matched to their larval form; indeed, some species are listed as freshwater because it is believed that their larvae are aquatic, but nobody really knows.

This leads to a further problem with Diptera: whilst some families are entirely aquatic, others include both terrestrial and aquatic species and, for those living in damp habitats, it is not always clear when a species ceases to be a terrestrial inhabitant of wet soil and becomes an aquatic inhabitant of muddy pond edges. The only certainty is that all adult dipterans are terrestrial, although they tend to remain close to water, hence the high
density of irritating species – midges, mosquitoes, horseflies – near water bodies.

Add to these problems the fact that there is no single guide or couple of publications that you can turn to. Some families are well served; others have some references scattered in the literature; for yet more you will need to turn to foreign guides that do not cover the British fauna comprehensively; for some, there is simply no way of determining which species you have. In many cases your end point may not even get beyond family level. We have worked out realistic levels of identification to attempt, based on the references that you should have to hand and on our own experience. Many diagnoses will, however, be difficult, so we emphasise the message from Module 1: do not go any further than your confidence allows.

Note. All photographs and line drawings in this module, along with the key to families in the Appendix, are copyright the Freshwater Biological Association, and must not be used without permission.
Note on pictures. In all photographs and drawings of whole animals, the anterior (head) end is to the left and the view is lateral (from the side) unless otherwise stated.

As with all groups of organisms, there are the formal mechanisms for differentiation and the things that work just as well in practice. We will use the latter wherever possible but, certainly once you have reached family level, you are going to have to learn about a whole new range of features. As we are dealing with such a large and diverse group, you will find that you need to be looking at different morphological features for different families, but the first task is to make sure you have got the family right. For this, you need to look at the following features.

1. The head. Is it obvious, hardened and fixed onto the front of the thorax? If there is no apparent head, is it one that is present but retractable into the thorax? If you have a dead specimen, and its head is retractable, then it will almost certainly have retracted it before death, so there will be no visible head or perhaps just part of one that is clearly otherwise drawn into the body cavity. So if a head is obvious, it is not retractable.

In order to see what it means by retractable, find yourself a large tipuloid (see below for what this means), keep it alive and drop it into a container with some water. Then just watch it as it wanders around, and you will see it constantly extending and contracting its hardened (and therefore darkened) head as it explores its environment. If you then kill it (the quickest and most humane way is to drop it into freshly boiled water) and examine it, you will find that, unless you are very lucky, its head has disappeared from view.
Have a look at Figure 2.1. To the novice, this might look like the head end, with two eyes and some jaw-like features. In fact, this is the rear end, the ‘eyes’ being the respiratory spiracles and the ‘jaws’ being spiracular lobes (see below). The true head is safely retracted into the thorax at the other end (and features in Figure 3.1a). Now, you are obviously much more advanced than this, but just in case you are not familiar with the nuances of fleshy dipteran morphology, keep this image in mind.

Figure 2.1 The rear end of a pediciid larva, in this case Pedicia.

2. Segmentation. The body is clearly segmented in all dipteran larvae. The number of segments can be an important diagnostic feature, as can swelling of segments in certain parts of the body. All have the requisite three thoracic segments, but the number of abdominal segments is sometimes seven, sometimes eight. A couple of families have further subdivisions, so the number of segments appears to be considerably greater. The differentiation between the thoracic and the abdominal segments is normally poor, so the total count of body segments is usually referred to. Count segments from the front (so segment 1 is the first segment of the thorax), and do not include the head, even if it is fixed.
3. **Prolegs.** Prolegs are also called pseudopods or parapods, depending on which source you are using. The presence or otherwise of prolegs and their position and number is diagnostic for many families. Prolegs are fleshy protuberances that the animal uses for locomotion, and are therefore on the underside (the ventral side) of the body. They may be simple stumps, or may have spines or other features at their base, and they come in pairs or, occasionally, fused together as a central feature. They should not be confused with respiratory spiracles or other fleshy structures that, if present, normally cluster around the posterior end.

4. **Welts.** Larvae that do not have prolegs may have welts to aid movement. These are roughened features on abdominal segments, often including some protrusion from the segment. Some are only on the ventral side, others dorsal and ventral and yet others form rings all the way round each segment. For some species, such as many of the Tabanidae ([Figure 6.2](#)), these welts are effectively true prolegs, so the difference between welts and prolegs is one of interpretation.

5. **Spiracles** (holes into the respiratory system). These are important in diagnosis among some groups. Normally you will be looking for a pair of spiracles at the rear end (the ‘eyes’ in [Figure 2.1](#)), and seeing how close together they are, whether they are flush with the abdominal segments or on some sort of extension, and whether they have an extension each or share one between them. If there are spiracles at the rear, there will probably also be spiracles at the front and, although less obvious in most groups, in others they are very distinctive (e.g. [Figure 5.3](#)) and can be important for diagnosis in Syrphidae ([Figure 4.21](#)). On the other hand, some families don’t have any spiracles.

6. **Lobes and other features** at the posterior end of the abdomen. Make sure you are looking at the correct end (remember [Figure 2.1](#)). Features to be found at the posterior end vary among families and genera, and include a range of soft or hard appendages, which may be extended siphons or shorter lobes. The spiracular disc, the flattened end in which the spiracles sit, has diagnostic lobes around its edge in some families.
The order Diptera is divided into three suborders, based on the presence of a fully or partially sclerotised (hardened) head, the structure and orientation of mouthparts and the morphology of the antennae. These are as follows:

**Nematocera.** Head entirely or mostly sclerotised, normally not retractable. Mandibles pincer-like (Figure 3.1 a) or brush-like. Antennae usually distinct. Often free-swimming.

**Brachycera (also known as Orthorrhapha).** Head only partially sclerotised, very small and retractable into thorax. Mandibles consist of parallel hooks, not pincer-like, but downward facing (Figure 3.1 b). Antennae not distinct. Never free-swimming.

**Cyclorrhapha.** Head unsclerotised, very small or apparently absent. Mouthparts hook-like or absent. Never free-swimming.

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**Figure 3.1.** Diptera jaws. a) jaws of Pedicia (Pedicoidae), showing the opposable mandibles of Nematocera. This is the front end of the same animal in Figure 2.1. b) jaws of Tabanidae, showing the parallel hooked jaws of Brachycera.

That is fine if you are familiar with the various types of head and know, for example, the difference between a very small retracted head and an absent head. A more user-friendly subdivision for those of us who are not fully confident about dipteran heads is as follows:

1. **The Head group.** All families that have a clear, sclerotised head, with eyes, mouthparts and the like, that is fixed to the front of the head, belong here. It includes all of the Nematocera apart from the tipuloids (below), plus one Brachyceran family, the Stratiomyidae. Most of the dipterans that you will come across commonly in water belong here, and they include the only free-swimming ones.
2. The Tipuloid group. The Tipuloidea is a superfamily within the Nematocera, comprising four families (Cylindrotomidae, Limoniidae, Pediciidae and Tipulidae) that until recently were lumped together as Tipulidae. They have a retractable head, but it is hard and obvious, with large pincer-like mandibles. They are normally quite pale and, if a light is shone through the body, you can usually make out the normally dark head inside.

3. The Soft group. These are the ones without obvious head or pincer-like mandibles. These tend to live in mud and other soft sediments, so are fairly rarely encountered unless you are actively looking in the right places.

Allocation of families to suborders and friendly groups


<table>
<thead>
<tr>
<th>Nematocera</th>
<th>Brachycera</th>
<th>Cyclorrhapha</th>
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<tbody>
<tr>
<td>Dixidae (+)</td>
<td>1</td>
<td>Stratiomyidae (+) 1</td>
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<tr>
<td>Simuliidae*+</td>
<td>1</td>
<td>Tabanidae 3</td>
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<tr>
<td>Chironomidae*+</td>
<td>1</td>
<td>Rhagionidae (+) 3</td>
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<td>Thaumaleidae +</td>
<td>1</td>
<td>Athericidae (+) 3</td>
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<tr>
<td>Ceratopogonidae</td>
<td>1</td>
<td>Empididae 3</td>
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<tr>
<td>Chaoboridae+</td>
<td>1</td>
<td>Dolichopodidae 3</td>
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<tr>
<td>Culicidae+</td>
<td>1</td>
<td>Psychodidae 1</td>
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<td>Psychopteridae</td>
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<td>Tipulidae*+</td>
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<tr>
<td>Limoniidae(*)+</td>
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<tr>
<td>Pediciidae(*)+</td>
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<td>Cylindrotomidae(*)+</td>
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Also included on this table is some information about the use of different families in indices

* Families with BMWP Score

(*) Families formerly merged with Tipulidae and therefore counting as this family for the purpose of calculating BMWP score

+ Families with LIFE score

(+) Families due to have a LIFE score after the next review of the system.
For those of you who are not familiar with these indices, both are widely used in Britain as biomonitoring tools. BMWP assesses a water body in terms of organic pollution, by ranking invertebrate taxa by their sensitivity to reduced oxygen concentrations, and then summing the individual taxa scores; a higher scoring site is therefore assumed to be less negatively impacted. LIFE places taxa into categories according to their flow preferences, with higher scores for those requiring greater flow, and can therefore be used to indicate changing flow patterns. BMWP only operates at the family level of determination; LIFE works at the species level for most macroinvertebrate taxa, but only at family level for most dipterans.

As you can see, not all dipterans are included in indices. In some cases, as we will find out, this is because they are probably not truly aquatic, and in others because they are rarely encountered, but some of the overlooked families have clearly aquatic and sometimes commonly encountered representatives.

Quick fixes in dipteran identification

There are unfortunately few quick fixes beyond family level, but at least knowing you have the right family is a good start.

Head group

1. If your animal has a long siphon, more than half the length of the rest of its body, sticking out of its posterior end, it is going to be *Ptychopteridae*, or perhaps *Stratiomyidae*. (Make doubly sure it has a head, because there is a long-siphoned member of the Soft group) To distinguish the two, Stratiomyidae will have a circle of feathery hairs around the end of its siphon, whereas Ptychopteridae is bare. Not all Stratiomyidae have the tufts, however, so the final giveaway is the shape of the head: in Stratiomyidae it is elongated and more-or-less parallel-sided, with a ridge that runs longitudinally along the head, whereas the head of Ptychopteridae is short, rounded and smooth. Some stratiomyids will cause more trouble than this, but that is what the formal key is for.

2. If your animal has a clearly swollen posterior half of its abdomen, a slightly swollen thorax (i.e. a dumb-bell shape) and a single pair of prolegs immediately behind the head, it is *Simuliidae*.
3. If your animal has a swollen thorax, no swelling to its abdomen and no prolegs, it will be Culicidae or Chaoboridae. These can be distinguished by colour. Chaoboridae are transparent (hence their name: phantom midges); they also have long antennae that are described as prehensile, which basically means that they have joints and can bend in certain places. Culicidae are the usual off-white colour and have short, simple antennae (although with lots of hairs associated with them). Further identification to genus level is not a problem with these, and is described under the family sections later.

4. If your animal is bent into a U-shape, chances are it is Dixidae. Look for the two flat ‘paddles’ at the posterior end to be sure and, if that is not enough, two pairs of prolegs, one on each of the first two abdominal segments, will clinch it. This is the only family in the head group that has prolegs at the front of the abdomen.

5. If your animal appears to have more than about 14 segments and has a series of elongated transverse (i.e. sideways orientated) sclerites (one per apparent segment) along its dorsal side, it is Psychodidae. Not all psychodids fit this, but if it has these features, it is a psychodid.

6. The quickest fix of all is Blephariceridae, but this is the only European dipteran family not found in Britain. If you are in the Pyrenees or the Apennines or some other such mountainous part of southern Europe and you come across this, please collect a few and send them to MD, as his collection lacks them.

Figure 3.2.
Blephariceridae (ventral view).
Not actually recorded from Britain, so if you do come across one, make sure you keep it!
7. So what is left? Chironomidae, Thaumaleidae and Ceratopogonidae. For Thaumaleidae, look for the flattened front to its head (as if it has hit a wall head first), and the curious bumps on its head, small but distinct; no other family has anything like these. Chironomidae have prolegs at each end: first thoracic segment and last abdominal segment. If it is bright red and has a head (so is not a tubificid worm!), it is a chironomid, but be warned: most chironomids are not red and the red fades very quickly once the animal is dead. And so that leaves the Ceratopogonidae, actually a very diverse family with no single jizz feature for the lot of them but some quite distinct groups. Make sure you are familiar with the ceratopogonid subfamily Dasyheleinae, which might be mistaken for a chironomid (see under Chironomidae later in the module).

A note on Ceratopogonidae. These are very familiar to all of us, even if we have never seen them, because if we have been to the uplands, and particularly the Scottish highlands, we have been bitten by the adults. The larvae give the impression of being much less common than the adults, as they are easily overlooked. In samples from rivers, for example, there is the subfamily Ceratopogoninae which occurs quite commonly but is almost devoid of features and lies dead straight when dead (!), so can look just like a small piece of vegetation (see Figure 3.3). Once you have had this one pointed out to you, you will never miss it again, but until such time you may have been discarding it thinking it is not an animal.

Figure 3.3 – Ceratopogoninae. Despite looking like a piece of vegetation, it has a very distinct (if small) head.
Tipuloid group

8. **Cylindrotomidae** are unmistakable, because they are covered in soft protuberances that are very distinctive in form. Some of the Soft group have fleshy protuberances, but look at the pictures and you will see that cylindrotomids really should not be confused with anything else (except perhaps terrestrial things that have fallen in – always a hazard with dipterans in water).

9. For the rest, look to the posterior end of the abdomen. Tipuloids have what is called a spiracular disc. All but one genus have a pair of spiracles. These spiracles sit in a sort of flattened, circular area. If this circular area has fleshy lobes growing out of it, then count them. Two lobes behind and ventral to the spiracles show you have **Pediciidae**; zero, four or five lobes is **Limoniidae**, while six lobes is **Tipulidae**. Do not confuse these lobes with the anal papillae, which grow out in pairs beneath the spiracular disc and can be large. Look at Figure 2.1 and you will see the two obvious spiracular lobes beneath the dark spiracles, but look more closely and you will see more lobes behind them: the anal papillae.

Soft group

The jizz features of the Soft group are less definitive than those of the other groups. If it has the features described it probably is that family; if not, it isn’t necessarily not this family. Most of what you come across should conform to a quick fix, but you will probably have to use the formal key occasionally. Always check against pictures as well, because sometimes the general shape and structure can be diagnostic.

10. If it is very wrinkled, with a single long siphon (that it can extend well beyond the length of its body), it is **Syrphidae**, the famous rat-tailed maggot. If it is very wrinkled, but without the siphon, look at its spiracular disc (see Tipuloid group for how to find this) for lobes around the edge and for curious hairy bits (Figure 3.4) on the edge of the spiracles themselves; this will be **Sciomyzidae**.

11. If it has small fleshy appendages along its body, plus either two feathery appendages or several pairs of long slender appendages sticking out of its posterior end, it will be **Athericidae**.

12. If it has prolegs, and the posterior pair are considerably larger than the others, see if it has a single siphon at its posterior end which branches into two towards its apex. If so, you have **Ephydridae**. If it does not have a branched siphon, it could be **Empididae**.
13. A chunky looking larva with girdle of welts around most of the abdominal segments, along with a short posterior siphon that is inserted dorsally (i.e. points upwards) will be **Tabanidae**.

14. No prolegs, no long lobes but some short, triangular lobes around it posterior end? You probably have **Ragionidae**, **Muscidae**, **Scathopagidae** or **Dolichopodidae**. See later for how to distinguish these.

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**Figure 3.4.** The posterior end of a sciomyzid, showing the filamentous structures around the spiracular openings.

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**Do not confuse with…**

Before starting your identification, make sure that what you have is definitely a dipteran. Here are some fleshy larvae with very short, easily overlooked legs among the Lepidoptera (**Figure 3.5a**), Coleoptera and Trichoptera.

There is also the Curculionidae, the weevils, a family of beetles with some sort-of-aquatic species that burrow into vegetation and, annoyingly, key out as Diptera because they are legless. Here you have to rely on jizz: if it looks like **Figure 3.5b**, then it is a beetle.

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**Figure 3.5.** Things that might be confused with Diptera. a) Pyralidae, an aquatic moth caterpillar. Note the three pairs of tiny yet distinct legs. b) Curculionidae: a legless beetle larva.
Keys to the families of Diptera

If the quick fixes have not worked, or you want confirmation, then try keying your animal out. Remember that, whichever key you use, there is much variation in form, particularly if you are working on a member of the Soft group. You may have to resort to looking at pictures for your final determination.

We have provided a key as an Appendix, taken from Dobson et al. (2010), which is not yet in print. It is based wherever possible on morphological features that should be straightforward to find and will not require dissection. Towards the end, rather than families as end-points it comes to groups of families, which are then considered separately after the key as it is easier to identify them using descriptions rather than a formal key structure.

Other keys to families are available, if you do not like the one provided. There is a nice one by Sundermann et al. (2007), but it is a paper in a journal and is only really designed for rivers. The one in Smith (1989) covers both terrestrial and aquatic families and is probably the definitive one, although for some of the soft groups you will be asked to look at some fiddly features. Nilsson (1997) also has a key to families, which sticks to aquatic ones and uses some different, but equally difficult, features. Nilsson also has keys to genera of most families – these are often the only ones available, but remember that they are designed for Northern Europe and the genera covered are not necessarily the same as those found in Britain; they can also be frustrating – figures widely separate from text, key features not figured, specialist morphological parts not clearly defined, etc.

Each family is considered in turn below. We introduce its general form, so you can confirm your diagnosis, provide a few quick fixes where they occur, and give some help with morphological features needed for further identification, if this is possible.

Self-assessment exercise: Diptera families – Get yourself at least ten Diptera specimens, making sure that they all seem to be different. Identify each to family. Note the features that you had difficulty with and those that were straightforward, and let the authors of this guide know!
a. Simuliidae – blackflies

Diagnostic features
These are unmistakeable: they are short and stocky with clear swelling to the posterior half of the abdomen and, to a lesser extent, the thorax, giving the characteristic ‘dumb-bell’ shape of this family (Figure 4.1). They have a distinct non-retractable head, with mouthparts modified into feathery structures for filter-feeding. They are up to 12 mm long.

There are three genera in Britain. All members of this family are aquatic and confined to running water. They are particularly prevalent where water is flowing rapidly over solid substratum, which acts as an effective attachment.

Identification
Bass (1998) provides keys to all British species. He includes a clear description of larval morphology, highlighting those features of most importance to identification, so these are not repeated in detail here. Note that in order to have any chance of identification, you need a specimen with a heavily pigmented head; if it is washed out (due to years in alcohol or recent moult, for example), you will simply not see the features that you need to.

Perhaps the least familiar feature of importance to identification is the postgenal cleft, a feature at the posterior end of the head capsule on its ventral side (Figure 4.2a); its shape and size are diagnostic characteristics in many cases, including differentiation of genera. Although obvious when you see it, it is often obscured by the fused proleg, and so you may need to pull the head off. If you do so, make sure you keep hold of the body, as you may need it for further identification. At the opposite end of the ventral head capsule plate (i.e. towards the anterior end) and sitting between the moveable mouthparts is the hypostomium, a small, approximately triangular plate (Figure 4.2a). Dorsally, the head capsule has a series of markings creating a pattern that is diagnostic of many species; the standard pattern is shown in Figure 4.2b.
Figure 4.1. Simulidae. Simulium

Figure 4.2. Head of Simulium. a) Underside of head showing (A) postgenal cleft and (B) hypostomium. b) Upper side of head, showing patterning.
This mandatory exercise is worth 10 points.

Find two simulid specimens from different sites, if possible fairly widely separated geographically.

Draw or photograph the postgenal cleft of each specimen. Then flick through the key by Bass until you think you have found each, simply by looking at the pictures of the postgenal clefts.

Now key each specimen out, working methodically through the key. Record your decision at each couplet and draw or describe the features that you use at each couplet to make your decision.

Submit your working and images for each specimen, along with a note about how close you were by just looking at the pictures.
b. Culicidae - mosquitoes

Diagnostic features
Culicidae are cylindrical, with a swollen thorax and no prolegs (Figure 4.3). They are similar to Chaoboridae but, they are not transparent, and they have antennae without joints. They are up to 12 mm long.

All members of the Culicidae are aquatic, living in standing waters. There are four genera in Britain.

Identification
There is an FBA key (Cranston et al., 1987) which covers all British species. Identification to genus level is straightforward and the features used for species-level identification, although often small, are generally distinctive.

There are two subfamilies of Culicidae in Britain. The distinguishing feature is the presence of a siphon, a large dorsal respiratory tube at the end of the abdomen. This is present in the Culicinae, but absent in the Anophelinae, which instead have a distinct pair of spiracles on a slightly raised appendage (Figure 4.3). The siphon is hardened, and both subfamilies also have a hardened ventral appendage, not to be confused with a proleg, which is soft.

The dorsal siphon of Culicinae is short and pointed in the genus Coquillettidia, in which it is adapted to pierce vegetation. In other genera it is used to breathe atmospheric air and is long and slightly tapering. The dorsal siphon sports a range of spines and/or cerci, and their number and arrangement are important in identification.
Almost all species of Culicinae have a row of spines on each side of the siphon, on its underside; this is known as the pecten (Figure 4.4). This is absent in one genus – Orthopodomyia, which only occurs in flooded tree holes - so most specimens you see should have this feature. In some cases you may see not spines but a row of hairs, a distinguishing feature of the subgenus Culiseta (Culiseta) (Figure 4.4).

The dorsal siphon supports tufts of setae, the tufts occurring in pairs on either side of the siphon (Figure 4.4). The number of pairs of tufts and, if only one pair, where it is inserted, allow the genera Culex, Culiseta and Aedes to be distinguished. Make sure you do not confuse these tufts with the rows of hairs in the pecten of Culiseta (Culiseta).
Figure 4.4. a) Close up of siphon of *Aedes* showing the pecten as a row of small spines (A), and a central tuft of setae. b) Close up of siphon of *Culiseta (Culiseta)* showing the pecten as a row of long hairs (C) and a basal tuft (D).

**Self-assessment exercise: Culicidae** – Find some culicid larvae and familiarise yourself with the tufts of hairs and pecten on the siphon. Draw or photograph the siphon of at least two different genera, showing the tufts and pecten. Now have a go at identifying to species using the FBA key.
c. Chaoboridae – phantom midges

Note: in older texts these were considered a subfamily of Culicidae.

Diagnostic features

The transparency of these animals (Figure 4.5) is diagnostic, and also means that they are probably overlooked a lot. Apart from this, the swollen thorax and absence of prolegs, along with the hardened cylindrical structure or structures at the posterior end, mean they can only be confused with Culicidae. There is a distinct non-retractable head and the antennae are the defining feature, being long, downward-facing, with long hairs that are equal to the length of the rest of the antennae, and joints so that the antennae can bend (Figure 4.6). They are up to 12 mm long.

All members of the Chaoboridae are aquatic, living in standing waters. They are the only dipterans found regularly in the open water of lakes or pools, other swimming forms tending to stay close to the edges of vegetation. There are two genera in Britain.

Quick fixes

Differentiation of genera is easy. Chaoborus has only a single hardened cylindrical feature on the rear of its abdomen, and also has a distinctive oval or sausage-shaped feature visible within its first thoracic segment – an air sac to help it float; it also has one towards the back of the abdomen, but this is normally smaller and less obvious. Mochlonyx lacks the obvious air sac at the front but has a second cylindrical structure, its respiratory siphon, on the dorsal side of the last abdominal segment.

Identification

All British species are covered by the key in Nilsson (1997). There is also a key by Brindle (1962a), covering the same species (although his Chaoborus culiciformis is now known as C. velutinus); it uses fewer features than Nilsson and has fewer illustrations, but personally we find it easier to follow.
To determine the species, you will need to find two features, the mandibles with their teeth, and the labral blade or ante-labral appendage. The mandibles are no problem, although they may be curved under the head and need pulling out to see properly. The labral blade is obvious in shape when you see it (Figure 4.6), but it is very small, transparent and often hidden by the labral filaments, the tuft of hairs at the base of the antenna. If you have several specimens, first check to see if any have this feature revealed before pulling your animals apart.

The key in Nilsson refers to antennae being approximated – this simply means attached to the head adjacent to each other, as opposed to having a large gap between them.

Figure 4.5 Chaoboridae. Chaoborus. The air sacs are the little silvery things towards each end. This is a live animal, seen from above; a dead one will normally lie on its side and its air sacs may change colour and become darker than the rest of the body.

Figure 4.6 Head of Chaoborus. a) the entire head, showing the showing the mandible with its darkened teeth.(arrow). b) a different specimen which better illustrates the labral blade (A), the labral filaments (B) and the large jointed antenna (C). Note these are two different animals; the picture on the left is of a specimen in which you would have difficulty in seeing the labral blade.
d. Chironomidae – non-biting midges

![Chironomidae](image)

**Figure 4.7.** Chironomidae (in this case, Orthocladiinae)

**Diagnostic features**

Chironomids are slender animals, with an obvious head, prolegs at each end and, apart from some gills towards the rear of the abdomen in some genera, few other distinctive body features (Figure 4.7). Some have fused front prolegs. They are up to 20 mm long.

This is easily the most diverse aquatic dipteran family in Britain, with 139 genera (at the moment). Almost all chironomid larvae are aquatic, including some that are marine, although there are a few terrestrial genera. In fresh waters, there are species adapted to every habitat type, although they are more common in still than flowing waters.
Really, the chironomids deserve an entire module to themselves, in view of their richness (around one third of all aquatic dipteran species), their ubiquity and their importance. They are probably the most neglected family, relative to their importance, of any freshwater group, because identification is so difficult.

We cannot really do more here than try to encourage you to appreciate their diversity and to stop simply lumping them as ‘Chironomidae’. You should at least be able to recognise most of the various subfamilies.

Unfortunately, identification of larvae is not easy. The bits you are looking for tend to be very small. There are keys available, such as the FBA one for the subfamily Orthocladiinae by Cranston (1982), but such keys invariably require you to look at tiny features of the mouthparts right from the beginning. Even identification to subfamily level is fraught with difficulties. There are, however, some quick fixes which, while not always definitive, will help you to allocate your specimens to a subfamily.

WARNING. Do not get complacent in deciding which of your specimens from upland streams are chironomids. Be aware of the subfamily in the Ceratopogonidae called Dasyheleinae (Figure 5.1), which look very like chironomids, but do not have prolegs on the thorax and have abdominal prolegs that can be retracted into fleshy tubes. Probably quite a few of these have gone down as Chironomidae in the past.
Quick fixes

There are few quick fixes among the Chironomidae. However, most subfamilies and tribes can be separated fairly easily, and the notes below should help you with this. To start with, look at the eyes, whose number and shape, although not definitive, gives a good indication. Is there one on each side, or two? If one, it is probably Tanypodinae, especially if the eye is kidney-shaped (Figure 4.8a). If there are two eyes, placed one above the other, it is Chironominae (Figure 4.8b), but if they are at a 45 degree angle to each other (Figure 4.8c), it is one of the other families.

Figure 4.8 Chironomidae – comparison of head capsules, showing different configuration of eyes. a) Tanypodinae; b) Chironominae; c) Prodiamesinae.
Identification

You should normally be able to get to subfamily level with no more preparation than pulling the animal's head off, but identifying beyond this will require dissection and preparation of slides, a specialist task.”

When dividing Chironomidae into subfamilies, the features you are looking for are normally quite distinct, but incredibly small. There is a key to subfamilies in Cranston (1982), but the first couplet will probably floor you. The one in Nilsson (1997) is a little more user-friendly, but will still need lots of manipulation of your specimen and some high powered magnification. The one in Dobson et al. (2010) will hopefully help a little. The key in Sundermann et al, (2007) is good, but bottles out at the critical bit.

So what to do? Well, the first thing is to know what you are looking for. The following features are used by both Cranston and Nilsson. Sundermann et al and Dobson et al. prefer to avoid looking at the mentum, but otherwise use most of these features as well, so there is no avoiding them really.

a) Antennae – retractile versus fused. If the antennae are not retracted, how do you know they are retractile? Look at Figure 4.9, showing the heads of two chironomids. Note how the one on the right has its antennae sticking out at an angle, and therefore with nowhere to go were they to be retracted. The one on the left, meanwhile, has its antennae sticking straight out towards the front, and if you follow the line of the antenna there is plenty of room in the head behind to withdraw it; therefore it is retractile. Retractile antennae are definitive for Tanypodinae.
b) A strong versus a weak mentum. The mentum is where the plate covering the back of the head meets the mouthparts. It is either straight, without features (Tanypodinae), or bulging forward, with teeth (others). Tanypodinae have teeth, but these are on the thing behind the mentum, and which is obscured by the mentum in other subfamilies.

Figure 4.10. Chironomidae – comparison of the procercus (the long appendage on the dorsal side of the last abdominal segment) in a) Tanypodinae, where it is long; b) Orthocladiinae, where it is almost non-existent.

c) Long versus short procercus (see Figure 4.10). The procercus is the appendage on the dorsal side at the end of the abdomen, normally with a tuft of hairs on its end. If it is long and slender, then you have Tanypodinae or Podonominae.

d) Premandible present or absent. This is a tiny feature of the mouth, sitting just inside the mandible of each side. Often it is obscured by other features, but you should be able to differentiate your subfamilies without need for this one. Figure 4.11 shows where it is.

e) Antennae annulate or non-annulate. ‘Annulate’ simply means made up of a series of rings. Unfortunately, the antenna is so small that you may have difficulty seeing this. This is the distinguishing feature of Diamesinae, and the only way really of separating it from Orthocladiinae.
f) Ventromental plates. These are easy (see Figure 4.12). If present, see if they look like fans, or are at least clearly semi-circular in shape; if so, you have Chironominae, tribe Chironomini. If they are present but do not look like fans, and the animal has 'whiskers' (Figure 4.12) you have Prodiamesinae. The other tribe in Chironominae, the Tantarsini, has elongated ventral plates but, more importantly, has enormous antennae, at least half as long as the head and attached on pedestals.

Once you have got the subfamily, the FBA key by Cranston (1982) covers the Orthocladiinae, but for the other families there is only the guide edited by Wiederholm (1983).
This mandatory exercise is worth 10 points.

Prepare a slide to allow you to examine the mouthparts of a chironomid. Draw or photograph the underside of the head and then label the parts that you consider to be important in identification for your specimen. Identify at least to subfamily (or tribe for Chironominae) and give reasons for your diagnosis.

Repeat with one more specimen, representing a different subfamily or tribe.

Submit your identification, reasons and images for each specimen.
e. Dixidae – meniscus midges

Diagnostic features

Dixids have a cylindrical body with a distinct non-retractable head. They are very distinctive because of their habit of remaining bent into a U-shape; be warned, however: dead specimens are equally likely to be straight (Figure 4.13). The prolegs on the two anterior abdominal segments are truly diagnostic. The paddles, flat plates present on the posterior abdominal segments, are also unique to this family, although similar structures appear on the pupae of some families: Chaoboridae, Culicidae and Chironomidae (see Section 8). They are up to 10 mm long.

All members of this family are fully aquatic, living close to the surface in standing or slow-flowing waters. There are two genera.

Identification

There is an FBA key (Disney 1999) which covers all British species. Identification to genus level is straightforward, but differentiation into species may cause problems as features are often small and differences relative.

The two primary features to find are both on abdominal segments. On the ventral side, there is a comb on segments 5 and 6 or 5 to 7; this consists of a central plate (the ‘median bar’ of Disney [1999]), with an array of small hooks on either side, forming a slightly curved structure. On the dorsal side, look for the crown, a ring of setae on abdominal segments 2-7 or 3-7. This is absent in the genus Dixella but present in Dixa.

Also important for identification are the shape and structure of the paddles. Some couplets of Disney’s key require examination of structure and arrangement of finer setae on the paddles or the head, for which high magnification and preparation of slides will be required.
Figure 4.13. Dixidae. **a)** *Dixa*, showing U-shape and the crown of setae on the abdominal segments; **b)** *Dixella*, showing the straightened form of a dead specimen. The arrow points to one of the combs (the dark thing).
f. Tipulidae – craneflies

Diagnostic features

These are fleshy, often large, with cylindrical bodies and six lobes around the spiracular disc (Figure 4.14); this disc has two obvious spiracles, although these may be hidden if the lobes are curved inwards. They have a dark, shiny head that is retractable into the thorax (and is normally hidden in this way in dead specimens) and supports a pair of large mandibles. No species have prolegs or any other fleshy protuberances other than the lobes and anal papillae at the posterior end. They are up to 60 mm long.

This family includes both aquatic and terrestrial species. Most aquatic species are associated with detritus on the bed or at the water’s edge. There are eight genera in Britain, of which five have aquatic representatives.

Figure 4.14. Tipulidae. a) *Tipula*. b) rear end of *Tipula*. The six spiracular lobes are clearly visible. The paler things running diagonally and sticking out on the bottom left hand side are anal papillae, not spiracular lobes; they do not grow out of the edge of the spiracular disc.
Quick fixes

The genus *Prionocera* is easily distinguished from the others by its long, narrow lobes supporting long hairs (Figure 4.15). *Dolichopeza* holds its central lobes together. *Nephrotoma* has dorsal lobes considerably smaller than lateral lobes (although so do a few *Tipula*). If it is more than 40 mm long, chances are it is *Tipula*.

Identification

There is an old key to species in Brindle (1960), which works entirely using external features, but it lacks some of the currently recognised species. The light and dark patterning in the spiracular disc (Figure 4.14) is diagnostic of many genera and species. Nilsson (1997) is no good, as only two of the British genera are covered.

Figure 4.15. Posterior end of *Prionocera*

Self-assessment exercise: *Tipulidae* – Using a tipulid specimen, draw or photograph the rear end of the abdomen, end on. Identify and label the spiracles, the spiracular lobes and the anal papillae. How many of each are there? Identify any patterning on the spiracular disc.
g. Limoniidae- short-palped craneflies

Diagnostic features
These are similar to Tipulidae, but never with six spiracular lobes: there are either four, five, or none (Figure 4.16). If there appear to be none, check closely because some Pediciidae have two short ones. There may be a tuft of posterior hairs. They are up to 20 mm long.

Limoniids occur in wet soils and decaying vegetation in or close to all types of water habitat. There are 48 genera in Britain, all of which are aquatic or believed to be so.

Quick fixes
Several genera can be picked out without too much difficulty.

In one genus (Antocha), spiracles are absent.

*Eloeophila* has four cylindrical lobes of equal length that join together at the base and are smaller in diameter than the last segment.

*Neolimnomyia* (*Neolimnomyia*) (formerly known as *Pilaria* [filata group]) has no lobes but a triangular final segment with a tuft of hairs at its end.

*Hexatoma* has four anal lobes with long hairs on them. The dorsal lobes are slightly shorter than the ventral lobes and the hairs are about as long as the lobes.

*Pilaria* has four lobes with extremely long hairs on them.
Further Identification

Nilsson (1997) has a key to genera, but this does not include all British genera so is not definitive. To use this key, you need to be familiar with the hypostomal bridge on the ventral side of the anterior part of the head. This is very small and will require some cutting away of the thoracic segments, if not complete dissection, to be seen. The main features to look for are the number and shape of teeth on the anterior edge of the structure. As limoniids are relatively small, you may have difficulty seeing these features.

Brindle (1967) is a nicely illustrated key, including some genera to species, but does not include all genera. It does, however, avoid reference to the hypostomal bridge, so all identification features are external.

Figure 4.16. Limoniidae. a) *Eloeophila* type. The swelling is not a diagnostic feature – many limoniids can inflate their rear segment like this. b) *Neolimnomyia* (*Neolimnomyia*), formerly included in *Pilaria*. 
h. Pediciidae – short-palped craneflies

Diagnostic features

Again, these are similar to Tipulidae, but the spiracular disc has only two lobes (see Figure 2.1), both ventral to the spiracles. Some of the more commonly encountered ones also have prolegs. They are up to 50 mm long.

*Dicranota* and *Pedicia* occasionally turn up in samples from streams, but they are more closely associated with very shallow still waters and trickles. There are four British genera, of which three are aquatic.

Quick fixes

Genera are straightforward, but this is as far as you can realistically go. *Dicranota* and *Pedicia* are the most commonly encountered. *Dicranota* has five pairs of prolegs, each of which has a prominent array of hooks at its end. *Pedicia* (Figure 4.17) has four pairs of prolegs, without any hooks or other features; it can be large (up to 50 mm long) and is normally very pale; Figures 2.1 and 3.1 are of *Pedicia*. *Tricyphona* has very short anal lobes, and a large spiracular disc (nearly as wide as the abdominal segment on which it sits).

![Figure 4.17 Pediciidae: A live Pedicia. Note the extended jaws.](image-url)
This mandatory exercise is worth 5 points.

Find a specimen of Pediciidae or Limoniidae. Draw or photograph this specimen so that the diagnostic features of the family and of the genus or genus group can be seen. Identify this specimen, noting which key or guide you used and the features used at every stage in the identification.

Submit your identification, reasons and images.
i. Athericidae – water-snipelflies

Note that earlier texts and guides include Athericidae within the Rhagionidae.

Diagnostic features

Athericids all have seven pairs of prolegs and, in addition, two genera have an eighth proleg, sitting centrally in the middle of the ventral side of the last abdominal segment. Their soft, pointed appendages running along the back and/or sides of the abdomen, and particularly the extended appendages sticking out behind the rear of the abdomen, are very distinctive. Their mouthparts contain small but strong hooks, which may be visible at the extreme front end. The head is retractable and rarely visible. They are up to 25 mm long.

All athericids are fully aquatic, occurring in running waters. Atherix (Figure 4.18a) and Ibisia may be found in rapidly flowing channels, while Atrichops (Figure 4.18b) is more commonly found in sediments in areas of slow currents, including ponds and reservoirs.

Quick fixes

There are three genera of athericids in Britain, each containing a single species. All are distinctive. If it has just seven pairs of prolegs and five pairs of long, simple projections from the rear abdominal segments, more than a third as long as the body, then it is Atrichops crassipes. If it has the extra single proleg on its last abdominal segment, and only two rear projections, much shorter than the body length and quite feathery in appearance, it is one of the other two. Atherix ibis has lateral projections only from its abdominal segments, whereas Ibisia marginata also has dorsal projections.
j. Syrphidae – hoverflies

Diagnostic features

Syrphidae include the unmistakeable rat-tailed maggot, with its extremely long and flexible siphon (Figure 4.19), but unfortunately this is not a defining feature of the family, even for aquatic species, and others have extremely short siphons. The defining feature is in fact that the two posterior spiracles are very close together, on the end of a single siphon. Look at the tip of the siphon of a rat-tailed maggot. You probably thought it was going to be rounded, but it isn’t, and if you look closely you will see two spiracles sitting side by side. Having said that, syrphids are typically heavily wrinkled and hairy, and a long siphon, if present, in association with lack of a hard head, is diagnostic. They are up to 20 mm long, excluding the siphon, which can extend in some species several times the body length.

Most species are terrestrial. Even some terrestrial larvae are normally found in damp or muddy environments, but several genera are fully aquatic, typically occurring in still water enriched with detritus and, by extension, organically polluted waters. Seventeen genera in Britain are fully or partially aquatic. Curiously, for a group so closely associated with polluted environments and recently created pools, there is one species – *Eristalis cryptarum* – that is UKBAP listed, one of the few aquatic dipterans with this dubious honour.

Quick fixes

If it is truly aquatic (as opposed to fallen in) and short-tailed, then see if that tail is in the form of a needle (Figure 4.20); if so, it is probably *Melanogaster*. Otherwise, there are no quick fixes. Even the long rat-tailed form, often just referred to as *Eristalis*, covers several genera. Having said that, differentiation to tribe and sometimes even genus level is not as difficult as you may think having looked at the key in Nilsson, and there are some decent keys available.
Identification

Nilsson (1997) provides a key that covers most British genera. It requires you to find the anterior spiracle, which may be difficult, so use Figure 4.21 as a guide, and do not confuse it with the “antennal-maxillary organs”, which are basically its external mouthparts. It also uses features such as the tracheal trunk, which is internal. There is a simpler and excellent key by Rotheray (1993), although some of its names are out of date (most importantly, it classes Melanogaster, along with several other less distinctive genera, in the genus Chrysogaster). Other keys worth looking at, by Hartley (1961) and Rotheray & Gilbert (1999), are fairly straightforward to follow but again do not recognise Melanogaster. The soon to be published key by Dobson et al (2010) gives some quick fixes to tribe level and even a couple of genera.

Don’t be confused by the mass of soft extensions you may see in some specimens (as in Figure 4.19); these anal papillae are normally internal but can be exposed, and are not a diagnostic feature. The key by Rotheray (1993) does not even mention them.

Self-assessment exercise: Syrphidae – If you can find a syrphid, have a go at identifying it further. Note which features you need to use at each stage and how straightforward or difficult they are to find and interpret.

Figure 14.19. Syrphidae. a) Eristalis. b) Myathropa florea, showing exposed anal papillae (arrow).
Figure 4.20. *Melanogaster hirtella*, showing the needle-like tail (arrow).

Figure 4.21. **a)** *Eristalis* anterior end, showing the location and form of the anterior spiracle (arrow). **b)** *Myathropa florea*, showing the antenno-maxillary organs (arrow).
a. Ceratopogonidae – biting midges

Diagnostic features

These are generally long, slender animals with a distinct head. There are three subfamilies in this family and three different morphologies, which is why it drops out at several places in the key to families.

First the Forcipomyinae, which has prolegs both at the front (first thoracic segment) and rear (last abdominal segment) and has distinct lumps or spines along its body; these are very small animals, up to 5 mm long (Figure 5.1a). If it has posterior prolegs but no anterior ones, it will be Dasyheleinae (Figure 5.1b), which are up to 10 mm long. If it has no prolegs, it is Ceratopogoninae (Figure 3.2), which are up to 15 mm long.

There are 20 genera in Britain. This family includes inhabitants of both terrestrial and aquatic habitats but, as some genera and even species may occur across a range of habitats, most of them at least damp, it is not possible to distinguish terrestrial from aquatic taxa; all may turn up at some time in aquatic samples. Most of species are confined to pools, ditches, wetlands and aquatic marginal habitats, but larvae of the Ceratopogoninae turn up fairly frequently in stream samples, although always at low densities.
Quick fixes

Obviously the first quick fix is getting the subfamily.

Dasyheleinae has only one genus – *Dasyhelea*. Its prolegs are distinctive because they end in a group of hooks and because they are retractable into the abdomen, so look for some darkened hooks in a hole at the end of a tube towards the rear of the animal.

Forcipomyinae has two genera. If there are lateral projections as well as dorsal ones (e.g. Figure 5.1a) it is *Atrichopogon*; if there are only dorsal projections it is *Forcipomyia*.

Identification

Nilsson (1997) has a key to genera that covers most of the British ones. The Ceratopogoninae may give a few problems, simply because the animals are so small.

![Figure 5.1. Ceratopogonidae. a) Forcipomyinae: Atrichopogon. b) Dasyheleinae](image)
b. Thaumaleidae – trickle midges

Diagnostic features
These are long slender animals, superficially like chironomids, with cylindrical bodies, a distinct non-retractable head and reaching up to 10 mm in length (Figure 5.2). The diagnostic features are the spiracles: a dark spot on either side of the first thoracic segment (Figure 5.3) and then another one, partially concealed by rounded flaps on the posterior side of the last abdominal segments. The head has little bumps (Figure 5.3), which are characteristic.

All members of this family are aquatic, specialising in shallow water flowing over rock faces. There is a single genus in Britain – Thaumalea.

Identification
Disney (1999) provides keys for the identification of species of Thaumalea. There are, however, difficulties encountered when trying to separate larvae, so an allocation to the genus is probably the best option unless you are absolutely sure of your diagnosis.

Figure 5.2. Thaumaleidae: Thaumalea

Figure 5.3. Head and prothorax of Thaumalea, showing the distinctive head bumps and the spiracle (arrow).
c. Psychodidae – moth-flies or owl midges

Diagnostic features
These are often flattened and generally with complex arrays of hairs, spines or fleshy protuberances along the thorax and abdomen, with a distinct non-retractable head. Diagnostic features are the subdivision of segments so they seem to have many more than other Diptera, along with the transverse hardened plates on at least some, and usually most, of the segments (Figure 5.4). Unfortunately a few aberrant ones don’t have these features, but they are inhabitants of damp terrestrial environments rather than truly aquatic, so you are unlikely to come across them. The only one that might confuse you initially is Sycorax; which does not have the subdivision of segments; we have never seen this one but according to the drawings in Smith (1989) and Nilsson (1997) it looks pretty distinctive. They are up to 30 mm long.

Generally larvae of this family are inhabitants of wet detritus at the edge of water, rather than being truly aquatic, but some species may be fully aquatic. They are particularly associated with ditches, drains and sewage beds. There are 16 British genera.

Quick fixes
Sycorax is flattened, without subdivision of segments.

Of the rest, there is the Pericoma-type and the Psychoda-type, the former with hardened plates on almost every subdivision of the dorsal side, the latter with them only on the rear subdivisions. Tonnoiriella, a Pericoma-type, is rhomboid in cross-section, with leaf-like appendages (Figure 5.4).

Identification
The key in Nilsson (1997) covers most British genera, but (presumably due to a typesetting error) is missing couplet 13. It requires you to look for lateroanal and preanal plates, which are small but distinctive, except where the animal is covered in fine particles which, unfortunately they often are; Figure 5.5 will help you to locate these plates. If you get as far as looking for the hypostomium, which is part of the mouthparts, then you will need a high powered microscope, a good light source and a nice clean specimen, as you are looking for tiny dark features (the teeth) on a tiny dark feature (the hypostomium) on a tiny dark head. If you have a Pericoma-type, certainly have a go at determining the tribe (Pericomini or Telmatoscopini).
Figure 5.4. Psychodidae. a) Pericoma type (dorsal view). b) Tonnoiriella.

Figure 5.5. Psychodidae. The rear abdominal region, from below. a) Tonnoiriella, showing the preanal plate (A) and the lateronal plate (B). The flabellar appendages are marked as (C). b) Telmatoscopini, showing the absence of lateroanal plates.
d. Ptychopteridae – phantom craneflies

Diagnostic features
Ptychopteridae are long, slender and cylindrical, with a small but obvious head and a single long siphon at the end of the abdomen (Figure 5.6). They are up to 35 mm long.

All members of this family are aquatic, although normally associated with fine sediments rather than open water. A few species occur in mud adjacent to flowing water, but most are found in standing waters.

There are seven British species, all the genus Ptychoptera. Therefore, if you have got this far, you already have the genus sorted out.

Identification
With larger specimens, you can determine the species. The key in Nilsson (1997) covers all British species or, if you prefer, there are keys by Brindle (1962b, 1966), on which the key in Nilsson is based (you’ll need both of Brindle’s papers).

The most straightforward diagnostic feature is the submentum, on the underside of the head (Figure 5.7), whose shape can be used to differentiate several species groups.
Figure 5.7. Underside of the head of Ptychoptera, showing the shape of the submentum (arrow). a) P. albimana; b) P. paludosa.

e. Stratiomyidae – soldierflies

Diagnostic features

Stratiomyidae are flattened, with a leathery, normally pigmented skin. They are the only non-Nematocera with a fixed external head, and it is a distinctive shape, being long and parallel-sided with a clear ridge running along its centre and forming the front of the head (Figure 5.8). They are up to 30 mm long.

Most species are terrestrial. Fortunately the six aquatic genera are easy to distinguish from the terrestrial ones because most have, at the tip of their abdomens, a coronet of hairs, sometimes simple but often feathery (Figure 5.9). The one genus that lacks these hairs, Nemotelus, has a distinctive shape to its rear end.

There is a genus –Beris – that has a couple of species whose larvae live in damp mossy edges to water, so may turn up from time to time.
Quick fixes

*Nemotelus* has a large notch in its last segment. *Stratiomys* has a very long and slender last segment (more than three times as long and wide). A few of the genus *Odontomyia* also have a slender last segment, but if they have this they also have little hooks on the previous segment (Figure 5.10a), which *Stratiomys* never has.

*Beris* has a rounded end that is distinctly hairy (Figure 5.10b).

Of the short-tailed species with feathery tufts at their ends, two groups can be distinguished by the shape of the head. If it has a long ‘nose’, the central part extending well beyond the two side parts of the head where the antennae are, it is *Oxycera/Vanoya*; if it has a short ‘nose’ so the antennae are about level with the front of the head, it is *Odontomyia/Oplodontha* (Figure 5.8).

**Identification**

There are provisional keys to identification of larval Stratiomyidae to species in Stubbs & Drake (2001), although some species are unknown and it includes some larvae that have not yet been associated with adult forms. It uses exclusively external characteristics, particularly patterns of bristles.

The keys by Brindle (1964a and b) are very good, but were written before *Vanoya* and *Oplodontha* were split from *Oxycera* and *Odontomyia*, respectively, and do not include some of the species now covered by Stubbs & Drake. Using these keys together may be your best bet. Brindle (1959) covers just the genera.

![Figure 5.8 Stratiomyidae: Noses of short-tailed species. a) Odontomyia tigrina, an example of a short-nosed species. b) Oxycera trilineata, an example of a long-nosed species. The arrows point to the antennae, which are small but distinct.](image-url)
Figure 5.9. Stratiomyidae. a) *Odontomyia ornata*. b) Rear end of *Oxycera pardalina*.

Figure 5.10. Stratiomyidae. a) The ventral rear end of *Odontomyia argentata*, showing the hooks at the rear edge of the penultimate segment (arrow). b) The dorsal rear end of Beris.
f. Cylindrotomidae – moss craneflies

Diagnostic features
These are very distinctive, due to the growths all over their bodies, a form of camouflage for the habitat in which they live. Of the four British genera, two are fully aquatic, found in submerged aquatic plants, particularly mosses. They are up to 30 mm long.

Quick fixes
The two aquatic genera are easily distinguishable, and each contains a single species. If the growths on its back are toothed, then it is *Triogma trisulcata*. If the growths are elongated, maybe branching into two but otherwise smooth, then it is *Phalacocera replicata* (Figure 5.11).

Be warned that the other genera may turn up in samples from time to time, as they live in damp places. If your *Triogma* has three or more teeth on its appendages, then that is fine; if it has two or fewer, then it is *Diogma*, a terrestrial inhabitant of mosses. If its appendages are short and simple, it is *Cylindrotoma*, another terrestrial one (see Figure 7.1). Brindle (1967) has nice illustrations of all four.

![Figure 5.11 Cylindrotomidae: Phalacrocer a replicata](image-url)
g. Empididae – danceflies

Note: the family Hybotidae was formerly included under the Empididae; it contains one genus, *Stilpon*, that is considered by some to be aquatic. However, Smith (1989) tells us it lives in soil, so it is not considered here.

**Diagnostic features**

Empididae are cylindrical animals with seven or eight pairs of prolegs. The last segment may end in a tuft of hairs, or in a number of short lobes. There is no obvious head. They are up to 7 mm long, so their small size is also an indication of the family.

Most British species are terrestrial, but there are 13 aquatic genera.

**Quick fixes**

Clinocerinae have eight pairs of prolegs; Hemerodrominae have seven pairs of prolegs, of which the rear pair may be relatively large (*Figure 5.12*). The genus *Chelifera*, in the Hemerodrominae, has a rounded back end with a little tuft of hairs (*Figure 5.12a*).

**Identification**

Differentiation of larval empids, even to genus level, is not currently possible apart from *Chelifera*; all that can be realistic achieved is division into the three groups above.

*Figure 5.12. Empididae. a) Chelifera. b) other Hemerodrominae, from above, showing the obvious rear prolegs.*
h. Sciomyzidae – snail-flies

**Diagnostic features**
Sciomyzidae are flattened and heavily wrinkled (Figure 5.13), with distinctive filamentous structures around the spiracles at the posterior end (Figure 3.4). There is no obvious head, although the body may narrow markedly towards the front. They are normally pigmented, and are up to 20 mm long.

Warning. The filamentous structure in Figure 3.4 should not be mistaken for the simple hairs that a few other families have around the end of the siphon (see Figure 5.15, for example)

Most species are aquatic and many others live in transitional wetland habitats. All are associated with snails; normally they are parasitoid, living within the body of their host, but aquatic species are truly predatory and therefore free-living. There are 15 aquatic genera.

**Identification**
Identification beyond family level is not easy, but Nilsson (1997) has a key that covers all British genera.
i. Ephydridae – shoreflies

Diagnostic features

Ephydridae are normally cylindrical animals, showing some variation in body form but all with a distinct pair of posterior siphons. These siphons may be on the end of a single long appendage (Figure 5.14). Others lack the single appendage, having just the two siphons. Some of them look superficially like Syrphidae, but their siphons will be separate towards the end (Figure 5.15). The majority of the specimens that you are likely to come across have prolegs, in which case the rear pair is often considerably bigger than the others (Figure 5.14); some species, however, have no prolegs. They are up to 18mm long.

Most species are terrestrial, and the 10 aquatic genera normally occur in mud in still water bodies.

Quick fixes

Setacera is the only one with prolegs, apart from Ephydra which lives in saline water.

Identification

Nilsson (1997) has a key that includes all British genera. The features it uses are often small and indistinct.
j. Muscidae – houseflies

Diagnostic features

These are cylindrical larvae, variable in form, whose definitive distinguishing feature involves dissection of the mouthparts. However, the ones you are most likely to come across have four anal lobes that are distinctive in that they bend forwards at the tips (Figure 5.16); this is *Limnophora*. There is no obvious head. They are up to 16 mm long.

Most members of this family are terrestrial, but four genera are aquatic. *Phaonia* is among the aquatic ones but is a tree hole specialist, so you are unlikely to find it unless you are looking in that specific habitat.

Identification

*Limnophora* is described above. If you have something else that you think might be Muscidae, then look at its siphons. *Graphomya* has two short siphons, attached dorsally to the end segment, *Lispe* has no siphons but a pair of distinct spiracles. These are all illustrated in the soon to be published key in Dobson et al. (2010).
This mandatory exercise is worth 5 points.

Find representatives of two of the families in this section. Attempt to identify each using the keys you have to hand. Once you have reached a point beyond which you can no longer be confident of your identification, then for each species:

a) Draw or photograph your specimen.

b) Write a short explanation about why it is what you say it is.

c) Write a short explanation about why you cannot proceed to species level (unless you have succeeded in determining the species!).
EXERCISE 4: CONTINUED

Mark = / 5
a. Tabanidae – horseflies

Diagnostic features
Tabanidae are cylindrical in body form, with distinctive rings of welts around each body segment. The head is retractable and rarely visible. There is usually a short dorsal siphon at the posterior end of the abdomen (Figure 6.1), and there is a ridge around the anal area (Figure 6.2). They can get up to 40 mm long, but most species are up to 25 mm long.

There are five British genera in this family. Most tabanids are not truly aquatic, but occur in the damp margins of fresh waters. A few species are, however, generally encountered in water.

Quick fixes
Look at the number of lateral and ventral welts on each segment (ignore the dorsal pair, which often merge together as an elongated feature). If you have four, widely spaced welts, it is Chrysops. If you have six welts, of which four are in closely adjacent pairs (Figure 6.2), you have one of the others, and if the final segment is higher than it is long, it is Haematopota (Figure 6.3).

Identification
There is a provisional key to identification of larval Tabanidae to species in Stubbs & Drake (2001), based on patterning of the last segment.

Figure 6.1. Tabanidae – Hybomitra sp., showing the dorsal siphon (arrow).
Figure 6.2. *Hybomitra*, rear from below, showing single welt (A), closely paired welts (B) and the ridge around the anal area (C).

Figure 6.3. *Haematopota*
b. Rhagionidae – snipeflies

Note that earlier texts and guides include Athericidae within the Rhagionidae.

Diagnostic features

Cylindrical in body form, with welts, the Rhagionidae is one of those families where you are looking at the lobes at the posterior end of the abdomen. There are four such lobes, all approximately the same length. There are circles of welts around the abdominal segments, making them superficially similar to Tabanidae, but they lack the single dorsal siphon of the tabanids. The head is retractable and rarely visible. They are up to 12 mm long.

Most British species are terrestrial, and only two species of the genus Chrysophilus (Figure 6.4) are considered to be aquatic (other species in this same genus are terrestrial). Even these are probably not truly aquatic, but occasionally turn up in samples, hence their inclusion here.

Identification

There is a key to identification of larval Rhagionidae to species in Stubbs & Drake (2001). The shape of the ventral lobe on the last segment is important in diagnosis: look to see if it has a sinuous upper margin, in which case it is Chrysophilus; if it has a smooth margin, or is notched, it is a terrestrial genus. The shape of the head is more diagnostic, although this requires dissection. Separating the species of Chrysophilus is not definitive, so you are best trying to confirm it is the aquatic genus and leaving it at that.

Figure 6.4. Rhagionidae: Chrysophilus
c. Scathophagidae – dung-flies

NB. Nilsson (1997) refers to this family as Scatophagidae. This is a spelling error.

Diagnostic features
Scathophagidae are cylindrical in body form, with a flattened rear end, normally surrounded by various short lobes (Figure 6.5). There is no obvious head. They are up to 10mm long.

A few species are peripherally aquatic, occurring in detritus at the edge of water bodies and therefore turning up occasionally in samples. Hydromyza livens mines within the leaves of water lilies (Nuphar spp.).

Identification
It is not possible to differentiate larvae beyond family level.

Figure 6.5. Scathophagidae
d. Dolichopodidae – danceflies

Diagnostic features
Dolichopodidae are cylindrical, elongated animals with ventral welts and with four lobes on the last segment (Figure 6.6). These lobes are different sizes, the two ventral (lower) lobes being longer than the dorsal (upper) lobes. There is no obvious head. They are up to 10 mm long.

Most species in Britain are terrestrial. There are 21 genera that may be considered partially aquatic. None are, however, likely to be truly aquatic, as larvae generally occur in wet soil, mud and damp moss. One genus – Aphrosylus – is exclusively marine and occurs on rocky shores.

Identification
Identification of larvae beyond family level is not currently possible.

Figure 6.6. Dolichopodidae. a) The entire animal. b) Detail of the rear end, showing the different-sized lobes.
A further problem with Diptera is that there are many terrestrial species, and some of these occasionally end up in water and therefore in samples. As accidentals they obviously don’t count towards any faunal assessment, but you need to know whether they are truly terrestrial before rejecting them.

Terrestrial Diptera fall into three groups. First are those of fully terrestrial families. Those most commonly encountered include Bibionidae (Figure 7.1a) and Cecidomyidae.

The second group is terrestrial representatives of families with aquatic species, but whose terrestrial forms are clearly distinct from the aquatic ones. There are relatively few of these: Stratiomyidae and Syrphidae (Figure 7.1b) are worth highlighting.

The third group is those families which have both terrestrial and aquatic species that look similar, and the distinction between the two is unclear (for example Figure 7.1c). These will cause you the most trouble. In the case of Tipulidae, any individual found in water probably intended to be there, or at least close to the edge, even if it is nominally a terrestrial species.

The best key to all the Diptera families is that in Smith (1989), which is copiously illustrated so you can usually have a stab at identification just by looking at the pictures. It’s a bit difficult to get hold of, however, if you don’t already have it.

Figure 7.1. Some examples of terrestrial Diptera. a) Bibionidae; b) Syrphidae (Volucella); c) Cylindrotomidae (Cylindrotoma).
During your travails you will probably come across the occasional dipteran pupa. As adult Diptera are terrestrial they often pupate somewhere handy to allow emergence into the air, and several families pupate on land, while others head for the water's edge before pupating. There are, however, some that pupate in the water and therefore may turn up in samples. The table gives an idea of which pupate where.

<table>
<thead>
<tr>
<th>Family</th>
<th>Pupation site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tipulidae</td>
<td>Land</td>
</tr>
<tr>
<td>Limoniidae</td>
<td>Land</td>
</tr>
<tr>
<td>Pediciidae</td>
<td>Land</td>
</tr>
<tr>
<td>Cylindrotomidae</td>
<td>Water</td>
</tr>
<tr>
<td>Dixidae</td>
<td>Land</td>
</tr>
<tr>
<td>Simuliidae</td>
<td>Water</td>
</tr>
<tr>
<td>Chironomidae</td>
<td>Water</td>
</tr>
<tr>
<td>Thaumaleidae</td>
<td>Water</td>
</tr>
<tr>
<td>Ceratopogonidae</td>
<td>Normally on land</td>
</tr>
<tr>
<td>Chaoboridae</td>
<td>Water</td>
</tr>
<tr>
<td>Culicidae</td>
<td>Water</td>
</tr>
<tr>
<td>Psychodidae</td>
<td>Land or water</td>
</tr>
<tr>
<td>Ptychopteridae</td>
<td>Water (mud)</td>
</tr>
<tr>
<td>Tabanidae</td>
<td>Land</td>
</tr>
<tr>
<td>Rhagionidae</td>
<td>Land</td>
</tr>
<tr>
<td>Athericidae</td>
<td>Water</td>
</tr>
<tr>
<td>Stratiomyidae</td>
<td>Land</td>
</tr>
<tr>
<td>Empididae</td>
<td>Water</td>
</tr>
<tr>
<td>Dolichopodidae</td>
<td>Land</td>
</tr>
<tr>
<td>Syrphidae</td>
<td>Land</td>
</tr>
<tr>
<td>Sciomyzidae</td>
<td>Land</td>
</tr>
<tr>
<td>Ephydridae</td>
<td>Water</td>
</tr>
<tr>
<td>Scaphophagidae</td>
<td>Land</td>
</tr>
<tr>
<td>Muscidae</td>
<td>Water</td>
</tr>
</tbody>
</table>

The pupa is the stage during which the terrestrial adult form develops whilst protected within a hardened outer shell. Features of the adult stage, such as wings, large eyes and legs, are often distinguishable. The pupal stage is non-feeding and, in most cases, immobile. Exceptions are the Chaoboridae and Culicidae, whose active swimming pupae can often be found hanging vertically in open water.
As the pupal stage is a ‘resting’ stage, the larva will find a sheltered place in which to pupate and will often attach itself to the substratum and, in some families, build an outer cocoon in which to pupate. Therefore, pupae are caught relatively uncommonly using sampling techniques such as kick sampling or Surber sampling.

There are two fundamental types of Diptera pupae. First are those that look like the larva, except with a hardened and darkened outer skin (Figure 8.1). These are the families that use the last larval skin as a pupal case, and include all of the Cyclorrhapha (see table on page 7), plus the Stratiomyidae. A key to larvae will enable you to determine which family you have got.

Figure 8.1. Examples of pupae that look like their larvae. a) Muscidae (*Limnophora*). b) Sciomyzidae

Second are those in which the adult structures can be seen, most notably wings wrapped around the front of the body but also legs held close to the body and, on the head, eyes and often antennae.

This second group needs a key to help in identification. Nilsson (1997) does not have a key to families of pupae, although it has illustrations of many scattered throughout the book. The wonderful guide by Tachet et al. (2000) has a pictorial key to these pupae, but it has two disadvantages for the general user: (1) it is in French; (2) it is not particularly easy to get hold of in the UK (or even in France at the moment). The key in the appendix is based heavily on Tachet’s guide, but has some modifications of its own.
Figures 8.2 to 8.4 give examples of some of the features that the key in the Appendix will ask you to look for. In practice, while some pupae will require you to look for legs and the like, a few are obvious because they are so different to anything else. The most unusual are probably the Hemerodromiinae illustrated in Figure 8.4, because of its filaments, and the Ptychopteridae (Figure 8.3).

The Chironomid pupal exuviae technique (CPET)

Wilson & Ruse (2005) have written a very useful guide to identification of pupal exuviae of Chironomidae. This method, which uses the pupal case discarded by the adult on its emergence, is an excellent method for identifying chironomids and is straightforward, requiring no specialist preparation of specimens. Furthermore, Les Ruse is always keen to teach his method, so look out for one of his training courses. The book provides all you need, including sampling methods and identification keys.

Figure 8.2. Examples of pupae with antennae (highlighted by arrows). a) Chaoboridae. b) Psychodidae. Antennae are long and, in the pupae, held against the body, so do not confuse with breathing siphons, the ear-like things that the animal on the right has on top of its head.
Figure 8.3. Pupa of Ptychopteridae. A close look at the front of the head shows that it has an extremely long breathing siphon and a very short appendage, one on each side. It is a rare example of a clearly asymmetrical animal. The arrow points to the legs, clearly extending beyond the end of the wings.

Figure 8.4. Pupae of Empididae, in which the two subfamilies are completely different. a) Clinocerinae. b) Hemerodrominae.
Acknowledgement

Dmitri Logunov, curator of invertebrates at Manchester Museum, allowed MD to examine Alan Brindle's collection of Diptera larvae, and to photograph a couple for this guide. He would be happy to welcome others who wish to use this collection to enhance their identification abilities.
References

Some of these references are papers in scientific journals. Those marked * can be supplied, for a small charge, by the document supply service of the FBA.


*Brindle A. (1964b) Taxonomic notes on the larvae of British Diptera. No. 17.- The Clitellariinae (Stratiomyidae). The Entomologist 97, 134-139.


Appendix. Key to Diptera families
from Dobson et al. (2010)

a) Larvae

(1) Distinct, hard head present, not retractable into the soft body (this may be very small) (2)
  - No obvious head, or head retractable into soft body (14)
(2) Body has fewer than eight segments, with suckers on the underside
  Blephariceridae
    - Body with more than eight segments, and lacking suckers (3)
(3) Ventral prolegs present (at the front and/or rear of the body or at the front of the abdomen
    - Prolegs absent (9)
(4) Spiny protuberances present on thorax and abdomen
    Forcipomyinae (Ceratopogonidae)
      - No spiny protuberances (5)
(5) Distinct swelling of the rear half of the abdomen; basal pad of abdomen with many small hooks in a circular formation; a single fused proleg at the front only
    Simuliidae
      - Base of abdomen no wider than thorax and lacking a circle of hooks (6)
(6) Prolegs on the front two abdominal segments; often bent into a U-shape
    Dixidae)
      - Prolegs on thorax and/or posterior end of abdomen, but not at the front of the abdomen (7)
(7) Prolegs present only at the rear of the abdomen
    Dasyheleinae (Ceratopogonidae)
      - Prolegs both on the thorax and at the rear of the abdomen (8)
(8) Spiracles on first thoracic segment and on dorsal side of last abdominal segment; a single fused proleg at the front
    Thaumaleidae
      - No spiracles on thorax. Anterior prolegs separate, although they may appear fused towards the base
    Chironomidae
      (9) Thorax clearly swollen relative to abdomen (10)
      - Thorax not swollen relative to abdomen (11)
(10) Antennae jointed and ending in stout hairs at least as long as the final antennal segment; very pale or transparent (although preserved specimens may become opaque)
    Chaoboridae
      - Antennae without joints and with hairs considerably shorter than final antennal segment
    Culicidae
(11) Posterior end with a long tapering siphon, at least half as long as the rest of the body, with two small papillae at its base

**Ptychopteridae**

- No long siphon

(12) Body very slender and cylindrical in cross section

**Ceratopogoninae (Ceratopogonidae)**

- Body flattened in cross section

(13) Dorsal surface with numerous transverse sclerotised plates and/or lateral fringes of hair; mouthparts opposable mandibles

**Psychodidae**

- Dorsal surface roughened and patterned; mouthparts parallel hooks

**Stratiomyidae**

(14) Mandibles horizontal and act as pincers

- Mandibles vertical and parallel, often hook-like, or no obvious mouthparts

(15) Prominent soft extensions, arranged in longitudinal lines, all along the body

**Cylindrotomidae**

- Extensions confined to lobes at the posterior end of the abdomen

(16) Posterior end of abdomen with six lobes around the spiracular disc (do not confuse lobes around the spiracles with anal papillae, which extend from underneath the spiracular disc)

**Tipulidae**

- Posterior end of abdomen with five or fewer lobes around the spiracular disc

(17) A single pair of lobes present on the ventral side of the spiracular disc

**Pedicidiidae**

- Four or five spiracular lobes present, or lobes absent

**Limoniiidae**

(18) Body heavily wrinkled, obscuring segmentation

- Body not wrinkled, so segmentation distinct

(19) A single posterior extension present, either long (at least ¼ body length and often many times this) and flexible or short and needle-like; prolegs may be present

**Syrphidae**

- Not as above

(20) Spiracles not on lobes, but covered by a pair of circular features with branched filaments

**Sciomyzidae**

- Spiracles on the end of two lobes (which may be very short), the lobes either diverging from the end of a single extension or meeting at their base

**Ephydridae (part)**

(21) Prolegs present on ventral side

- Prolegs absent, although hardened welts may be present on ventral side or encircling segments
(22) Either two flattened, distinctly hairy appendages on last abdominal segments or five pairs of very long, slender appendages extending beyond the rear of the abdomen

**Athericidae**

- Not as above; appendages either absent or without fringes of hairs  

(23) A pair of long siphons present at the rear of the abdomen, often diverging from the end of a single extension

**Ephyridae** (part)

- No siphons at rear end, although short lobes may be present

**Empididae** (part) and **Muscidae** (part)

(24) Welts form features encircling each abdominal segment; a single squat appendage on the dorsal side of the last abdominal segment, plus a V-shaped ridge around the anal area

**Tabanidae**

- Welts on ventral side only; end of last abdominal segment normally with a series of short lobes

**Dolichopodidae, Empididae** (part), **Ephyridae** (part), **Muscidae** (part), **Rhagionidae** and **Scathophagidae**. See notes below.

**Notes on Dolichopodidae, Empididae, Ephyridae, Muscidae, Rhagionidae and Scathophagidae.**

These families are distinguished by the shape of the extensions on the last segment. Dolichopodidae has ventral lobes longer than the dorsal lobes, whereas Rhagionidae has four lobes of approximately equal size. Among Muscidae, *Limnophora* has four extensions that are approximately equal in length, of which the dorsal pair are respiratory siphons, with a darker tip, that characteristically bend towards the front, *Graphomya* has two short siphons, attached dorsally, while *Lispe* has no siphons but a pair of distinct spiracles. Scathophagidae have a series of very short lobes around a flat posterior end. If there are two spiracles on the end of a pair of long siphons, it is Ephyridae.

Some terrestrial Empididae may also key out here, if they lack prolegs, but they will have a rear abdominal segment lacking all the features described above, and often have a distinctively rounded rear end.
b) Pupae (excluding those that pupate within the larval case)

(1) Antennae present on pupal head
   - No antennae on pupal head

(2) Pupa fixed to substrate, with large multi-filamentous appendages on head
   - Pupa free living

Simuliidae

(3) Flattened lobes or paddles present on the end of the abdomen
   - No flattened features on the end of the abdomen

(4) Large swimming paddles present, wider than abdominal segments
   - Small lobes present, narrower than abdominal segments

Chaoboridae and Culicidae

(5) Lobes considerably longer than wide
   - Lobes not longer than wide

Dixidae

(6) Legs extend considerably beyond the end of the wings
   - Legs shorter or only slightly longer than the wings

Chironomidae

(7) Two appendages on head of clearly different lengths and structure

Ptychopteridae

(8) Legs of different lengths, so there is a gradation of pairs between the wings

Psychodidae

(9) Long filaments present on the body
   - No long filaments

Ceratopogonidae and Thaumaleidae

(10) Filaments on thorax only
    - Filaments on thorax and abdomen

Dolichopodidae

Empididae (Hemerodromiinae)

(11) A pair of curved hooks present at the end of the abdomen

Empididae (Clinocerinae)

(12) Abdominal segments with a distinct ring of small bristles
    - Abdominal segments with large, widely dispersed spines

Tabanidae

Rhabionidae and Athericidae