



# A teacher's introduction and reference to Mayfly in the Classroom

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<http://www.pennineflyfishingguides.co.uk/torrentis.htm>

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# Introduction to Mayfly in the Classroom

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## What are mayflies?

Mayflies are the fascinating group of short-lived winged insects that comprise the Order Ephemeroptera. There are more than 2000 different species of mayfly in the world and Britain has 51 recorded species. All mayfly nymphs live in freshwater habitats (there are no marine species) and they have colonised both flowing water (rivers and streams) and still water (ponds, lakes and reservoirs). Each species has its own characteristic time(s) of year that they tend to emerge as adult flies. One of the largest species in Britain is *Ephemera danica* (Figure 1) and it is commonly referred to here as "The Mayfly". The reason it is called the Mayfly is because its peak emergence is when the Mayflower (i.e. the Hawthorn) begins to bloom in late May/early June. Interestingly, the use of the term 'Mayfly' for all the Ephemeroptera only became popular in the late 1880s. Before that they had various names including Ephemeron but, more commonly, "Dayflies".



**Figure 1:** *Ephemera danica*  
Photo: Paul Gaskell

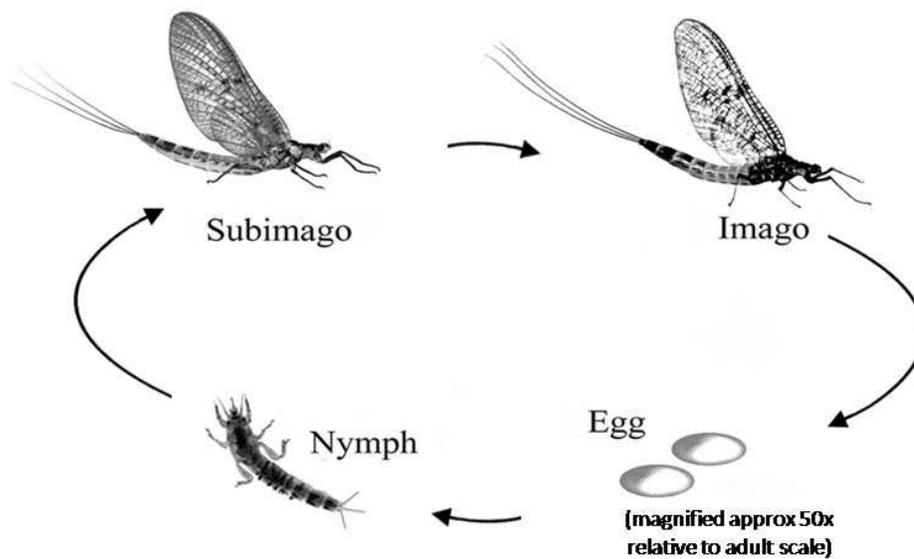
Typically **ADULT** mayflies have:

- Membranous wings held upright over the body
- Two or three fine tails (cerci) comprising many segments
- Non-functional mouthparts (adults do not feed)
- Short antennae
- Relatively large eyes - Males of some species have an enormously enlarged upper eye; females have smaller eyes.

Nymphs:

- Three tails

## Life cycle



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**Figure 2:** Life cycle of *Ephemera danica*.

Mayflies, like dragonflies and damselflies, have an aquatic nymphal stage, but mayflies are unique in the animal kingdom in that they have two adult winged stages: the sexually immature subimago and the fully reproductive adult imago.

After hatching from tiny (<1mm diameter) eggs, the nymphs gradually increase in size through a series of moults. The stages between moults in all insects are called instars. The nymphal period of mayflies varies depending on species; the larger British species take two years to develop whereas the smaller species take one year or less.



When each nymph reaches its maximum size, it undergoes incomplete metamorphosis (hemimetabolism) and moults to become the subimago form. Males usually emerge first. The subimagos fly from the water and take shelter in bankside vegetation where the final moult results in the mature imago. During this final moult, the wings lose their surface layer and become largely transparent; the fly as a whole takes on a brighter appearance. In many species, the forelegs and tails also become hugely elongated compared to the subimago stage.

Mass emergence of adults is one strategy employed by some mayfly species to reduce the risk of predation of an individual and enhance its mating chances. The imagos form mating swarms. Males use their acute vision to focus in on a female, grasp her using their long forelegs and then proceed to fertilise the female's eggs. Females return to the water to lay their fertilised eggs.

Mayfly species differ in their egg-laying behaviour. Some species dive under the water to lay their eggs. Other species fly upstream to release their eggs on the surface of the water either in a single batch or a few at intervals. This is accomplished by dipping the tip of the abdomen into the water or by settling on the surface of the water for short periods. The eggs then drift downstream, sinking eventually underwater to land on the riverbed where they will develop and hatch.

The subimago and imago stages are very short-lived (ranging in the order of seconds/minutes to days) as both males and females die shortly after mating.

The Pond Olive *Cloeon dipterum*, a species which is bivoltine (two generations per year) to multivoltine (multiple generations per year), remains alive for up to 14 days giving the female time to let her eggs fully develop in her abdomen. She lays the eggs on the surface of the water where they immediately hatch into nymphs and swim to safety.

## **Adaptations to different ways of life**

The various families and species of mayflies have adopted a variety of strategies that enable them to exploit particular microhabitats in the freshwater environment.

Each family has moulded their nymphal body plan to best exploit their preferred living environment. These body plans that are specifically adapted to micro habitats (Table 1) mean that finding a diverse range of mayfly families is indicative of a good quality stream, i.e. a stream with a variety of desirable habitats.

Because mayfly nymphs are generally exceptionally sensitive to pollution, the presence of a range of

## Common stream-dwelling British mayfly families

Table 1: Mayfly families and adaptations to microhabitat/lifestyle

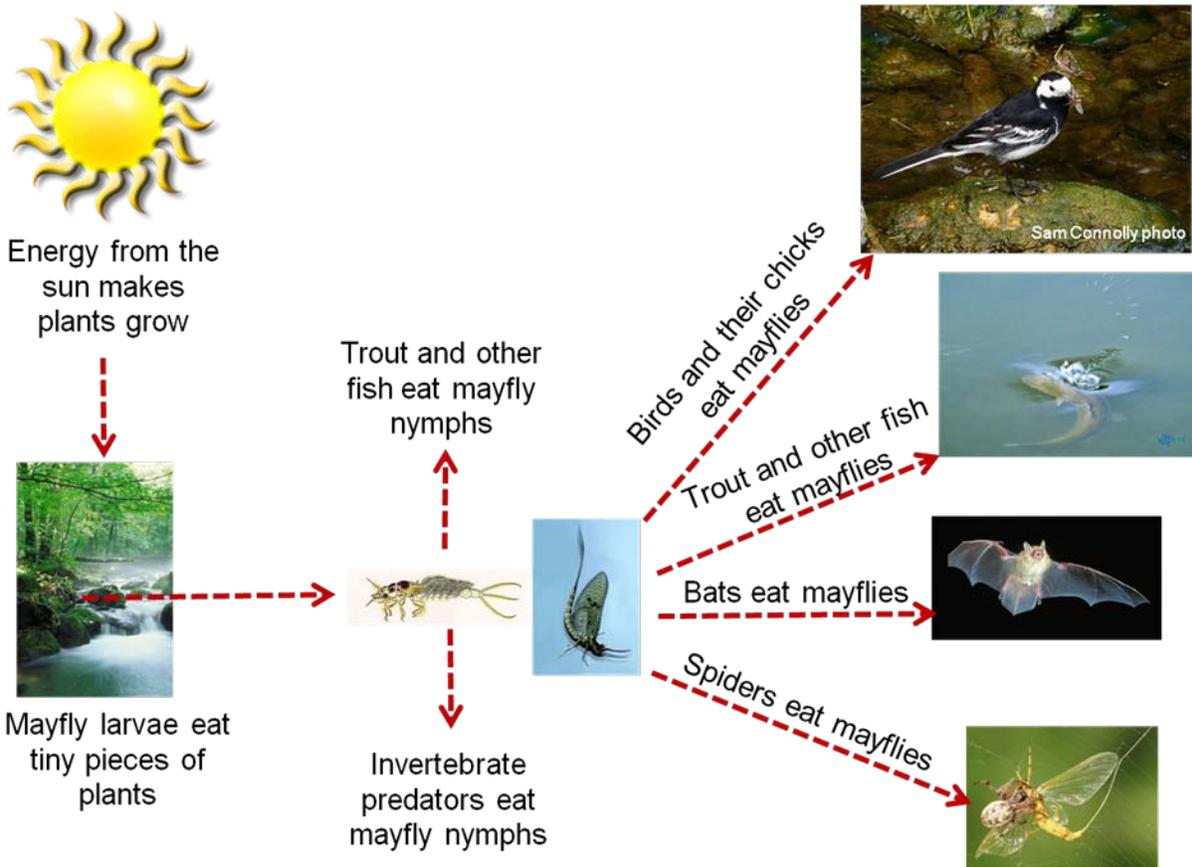
Family	Microhabitat	Body plan	Feeding strategy	Behavioural classification
Heptageniidae	smooth cobbles in fast current in the boundary layer		Grazer	Flat Stoneclinger Current acts on flat profile & presses nymphs onto rocks.
Baetidae	stones and plant fronds within strong flow		Grazer	Agile darter Fuselage shape & rapidly wriggling body with gripping legs to dart between fronds in fast flow.
Ephemerellidae	plant fronds within strong flow		Grazer	Crawler stout Strong legs grip weed fronds in strong flow .
Ephemeridae	sand/silt pockets in well oxygenated water		Detritus collector	Burrower Very short legs and cylindrical shape facilitates burrowing.
Leptophlebiidae	slow flowing water/ accumulated detritus		Detritus collector	Laboured swimmer Huge gills extract oxygen from static water.
Caenidae	slow flowing water/silt		Detritus collector	Silt crawler < 4 mm long beetle-like profile

(photographed by Stuart Crofts and Dr. Cyril Bennett)

families also indicates excellent water quality. Only the Baetidae are relatively tolerant to organic pollution (nutrient enrichment). Baetidae are, however, sensitive to metal and pesticide pollution. These requirements for good habitat and water quality mean that mayflies are essential indicators of stream health.

## Mayflies as essential links in food chains

Plants trap energy from the sun and convert it into sugars. Mayflies are central to the flow of energy within and between aquatic and terrestrial ecosystems (Fig. 3), because they generally feed on plant material that is living (grazers) or dead (detritivores), incorporating this energy into their own bodies. As mayflies live and move in the aquatic environment and then hatch and fly in the terrestrial environment, they provide vital food for a broad range of predatory species. Without this link, many species (e.g. birds and their young) would be unable to benefit from the energy that plants trap from sunlight.



**Figure 3:** The central role played by mayflies to the flow of energy in aquatic and terrestrial food chains.



## Threats to mayflies

As illustrated in the preceding sections, mayflies are fascinating, beautiful creatures native to the UK that are important indicators of freshwater ecosystem health and are a vital link in aquatic and terrestrial food chains. It is important to note that because of their specialised adaptations to microhabitats and their sensitivity to pollution, they are vulnerable to habitat degradation. The main pressures that threaten our mayflies are:

- Pollution from intensive agriculture and urbanisation (as well as sewage effluent)
- Dredging or straightening of river channels for drainage (destroying microhabitat structure)
- Excessive inputs of fine sediments into streams (smothering microhabitats)
- Removal of bankside vegetation (needed for subimagos to moult and become imagos)
- Abstraction and drought
- Over-predation by invasive species such as the American Signal Crayfish

## Protecting mayflies and protecting trout

In so many ways our native mayflies and our native wild trout go hand in hand. This is true in terms of their requirements for pristine, varied habitats and excellent water quality. Further, it is true that mayflies are a crucial food source of our iconic wild trout. Both also require varied and balanced terrestrial flora in order to thrive. In this way, understanding the requirements of our mayflies and native trout and providing for these needs is an effective way of protecting our wildlife in general. All of the Wild Trout Trust's advice and river restoration work adheres to these principles. We aim to educate youngsters and adults alike in the value of our iconic native species and the importance of caring for their habitats.

## List of available Internet Resources:

### *General biology*

#### **Basic details on mayflies:**

1. <http://www.buglife.org.uk/discoverbugs/bugofthemonth/mayfly.htm>
2. <http://www.naturegrid.org.uk/biodiversity/invert/mayfly.html>
3. <http://www.discoverlife.org/mp/20o?search=Ephemeroptera>
4. <http://www.ucmp.berkeley.edu/arthropoda/uniramia/ephemeroptera.html>
5. <http://ip30.eti.uva.nl/bis/ephemeroptera.php?menuentry=groepen>
6. <http://www.earthlife.net/insects/ephemer.html>
7. [http://www.eoearth.org/article/Insecta\\_\(Aquatic\)#Ephemeroptera](http://www.eoearth.org/article/Insecta_(Aquatic)#Ephemeroptera)
8. <http://science.jrank.org/pages/4187/Mayflies-Biology-mayflies.html>
9. <http://www.life.uiuc.edu/ib/109/Insect%20rearing/Mayfly.html>



10. <http://www.flyangersonline.com/begin/101/part17.php>
11. <http://www.critterzone.com/magazineresource/magazine-article-mayfly-shadfly-Ephemera-may-flies.htm>
12. [http://www.riverflies.org/index/riverflies/ephemeroptera/contentParagraph/05/document/In\\_The\\_Month\\_of\\_Mayfly.pdf](http://www.riverflies.org/index/riverflies/ephemeroptera/contentParagraph/05/document/In_The_Month_of_Mayfly.pdf)

**Basic ID (Mayflies). N.B. keys and guides should only be applied in their country of origin. Misidentification is almost guaranteed otherwise!**

[http://www.midcurrent.com/articles/flies/hafele\\_mayflies.aspx](http://www.midcurrent.com/articles/flies/hafele_mayflies.aspx)

### **Genera:**

1. <http://delta-intkey.com/britin/eph/www/heptagen.htm> (requires key download)
2. <http://www.fishermunk.com/programs/keys/shortkey.html>
3. <http://www.kendall-bioresearch.co.uk/ephem.htm>
4. [http://www.first-nature.com/insects/ephemeroptera/ephemera\\_danica.htm](http://www.first-nature.com/insects/ephemeroptera/ephemera_danica.htm)
5. <http://www.nhm.ac.uk/nature-online/life/insects-spiders/common-bugs/dragonflies-mayflies-stoneflies/index.html>
6. <http://flood.nhm.ac.uk/job/runjava.job?java=ctol.CTOLServer&method=printNamePage&accountref=987&NAMEID=20618>
7. [http://www.nature.british-towns.net/nature/06\\_genus\\_menu.asp?GetLFID=925&page=1](http://www.nature.british-towns.net/nature/06_genus_menu.asp?GetLFID=925&page=1)
8. <http://www.entm.purdue.edu/entomology/research/mayfly/mayfly.html>
9. <http://www.independent.co.uk/environment/one-mans-mission-to-put-millions-of-mayflies-back-into-british-rivers-589992.html>
10. <http://www.brc.ac.uk/schemes/RRS/homepage.htm>

**N.B. videos posted on net - teachers should vet first to make sure they do not contain material unsuitable for children**

### **Photographs:**

1. <http://www.bioimages.org.uk/HTML/T369.HTM>
2. <http://www.arkive.org/mayfly/heptagenia-longicauda/info.html>
3. <http://www.mdrc.org.au/bugguide/diagrams/ephemeroptera.htm> (photos of mayfly nymph, abdominal gill and ventral view of head)
4. [http://www.cirrusimage.com/ephemeroptera\\_mayflies.htm](http://www.cirrusimage.com/ephemeroptera_mayflies.htm) (N American species, excellent photos)
5. <http://www.troutnut.com/hatch/31/Mayfly-Ephemera/index.php> (N American species, excellent photos)
6. <http://www.troutnut.com/specimen/591>
7. <http://www.pbase.com/tmurray74/mayflies>



## **Pictorial Keys and Diagrams of nymphs:**

[http://sunsite.ualberta.ca/Projects/Aquatic\\_Invertebrates/?Page=36](http://sunsite.ualberta.ca/Projects/Aquatic_Invertebrates/?Page=36)

## **Recording:**

1. <http://www.ephemeroptera.pwp.blueyonder.co.uk/>
2. <http://www.riverflies.org/index/riverflies/ephemeroptera.html>

## ***Invertebrate physiology:***

### **Aquatic Entomology by W Patrick McCafferty (book preview);**

[http://books.google.co.uk/books?id=wiTq7x-fl\\_OC&pg=PA47&lpg=PA47&dq=plastron+mayflies&source=web&ots=1RLIKG3F-o&sig=phfa2L6jkJAAFrVxRGmqMdCJYX4&hl=en&ei=87eZSZimD4mJ\\_gbt8smaCg&sa=X&oi=book\\_result&resnum=1&ct=result#PPP1,M1](http://books.google.co.uk/books?id=wiTq7x-fl_OC&pg=PA47&lpg=PA47&dq=plastron+mayflies&source=web&ots=1RLIKG3F-o&sig=phfa2L6jkJAAFrVxRGmqMdCJYX4&hl=en&ei=87eZSZimD4mJ_gbt8smaCg&sa=X&oi=book_result&resnum=1&ct=result#PPP1,M1)

## **Course:**

<http://bugs.bio.usyd.edu.au/Entomology/course.html>

## **Respiration:**

1. <http://www.cals.ncsu.edu/course/ent425/tutorial/respire.html>
2. <http://bugs.bio.usyd.edu.au/Entomology/internalAnatomy/respiration.html>
3. <http://entomology.unl.edu/ent801/agresp.html> (Chapter 10 Aquatic respiration)

## ***Mayfly Poem:***

<http://www.poetryarchive.org/poetryarchive/singlePoem.do?poemId=1673>

## ***Glossary of selected terms***

<b>Aquatic:</b>	Consisting of, or being in, water
<b>Bivoltine/multivoltine:</b>	Creatures that produce two or many generations per year (respectively)
<b>Flora:</b>	The community of plants
<b>Imago/sub-imago:</b>	Winged adult stages - sexually mature and immature (respectively)
<b>Instar:</b>	An insect or other arthropod between moults
<b>Membranous:</b>	Relating to, made of or similar to a membrane
<b>Microhabitat:</b>	A very small, specialised habitat unit (e.g. the space between gravel particles)
<b>Nymph:</b>	The larval form of certain insects, usually resembling the adult but lacking wings
<b>Nymphal :</b>	“of the nymph”
<b>Riparian:</b>	Of or relating to or located on the banks of a river or stream
<b>Terrestrial:</b>	Of or relating to the earth, land or its inhabitants (as opposed to air and sea/water)