Welcome to Mayfly in the Classroom: bringing healthy rivers to life in schools

Key components:

Core

- Collecting empty plastic fizzy drinks bottles and assembling them into the mayfly "aquaria" apparatus (as per instructions)
- Caring for the "nearly mature" nymphs of a particular species of mayfly and recording daily observations on holding conditions, husbandry duties (including feeding and temperature control), adult emergence and nymph survival
- Storing the emerged sub-imagos in Tupperware boxes (with air-hole perforations) in the fridge until "release day"
- Releasing the emerged sub-imagos (and imagos that may have arisen) and observing a real mayfly hatch in their local stream (including observations of bird and fish predation versus mass-emergence to minimize chances of individual mayflies becoming prey)

Associated activities (structured worksheets)

- Observational activities relating anatomy to habitat
- Metamorphosis and emergence worksheets (incorporating both metamorphosis as a process amongst mayflies and other animals as well as surface tension experiments with soap to illustrate how emerging insects break through the water meniscus).
- Art activities, exhibitions and awards related to observational activities
- Experimental activities such as survival rates across different species within the test system and also experimental feeding regimes for detritivores (with survival/emergence as measurable endpoints)

Stuart Crofts Photo

Conceptual overview: Mayfly in the Classroom

Aims

Through Mayfly in the classroom, students will learn about and witness the lifecycle of iconic invertebrates as well as experiencing real-life hatches on their very own local "outdoor classrooms" (aka rivers). Crucially, the accompanying educational material would include accounts of how each and every facet of the aquatic AND riparian (terrestrial) habitats are interdependent. Aquatic invertebrates lend themselves to education about aquatic conservation very readily. Their biology perfectly illustrates requirements for good aquatic habitat. They also play a pivotal role in linking aquatic and terrestrial biodiversity. These less well known aspects of their biology would (for most people) include the crucial subsidies that aquatic invertebrates make to terrestrial predators once they metamorphose and take to the air. In this way, calorific energy that has arisen in the aquatic habitat is transferred into the diet of terrestrial predators like birds, bats and spiders. All activities will be linked (differentiated accordingly) to specific National Curriculum Key Stages.

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

Dr. Paul Gaskell and Dr. Cheryl Gibson

Resources produced with generous support from:

Stuart Crofts/Torrentis Products

(http://www.pennineflyfishingguides.co.uk/torrentis.htm)

Dr. Cyril Bennett

Introduction to Mayfly in the Classroom

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 Ephemerons 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

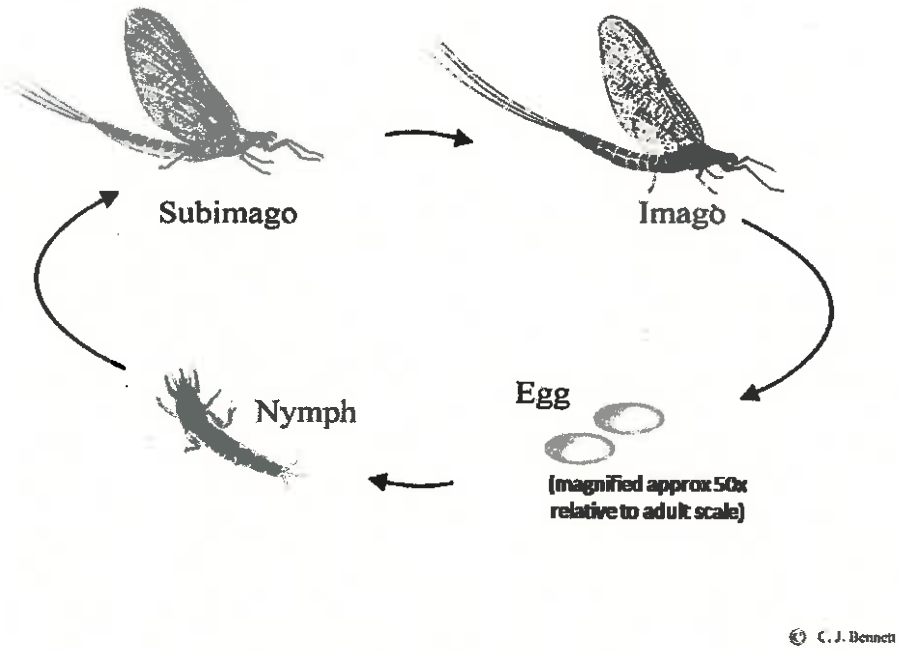


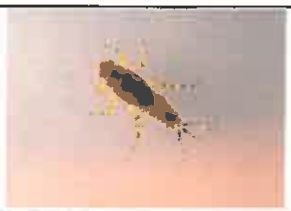
Figure 2: Life cycle of *Ephemera danica*.

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.

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)

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

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.

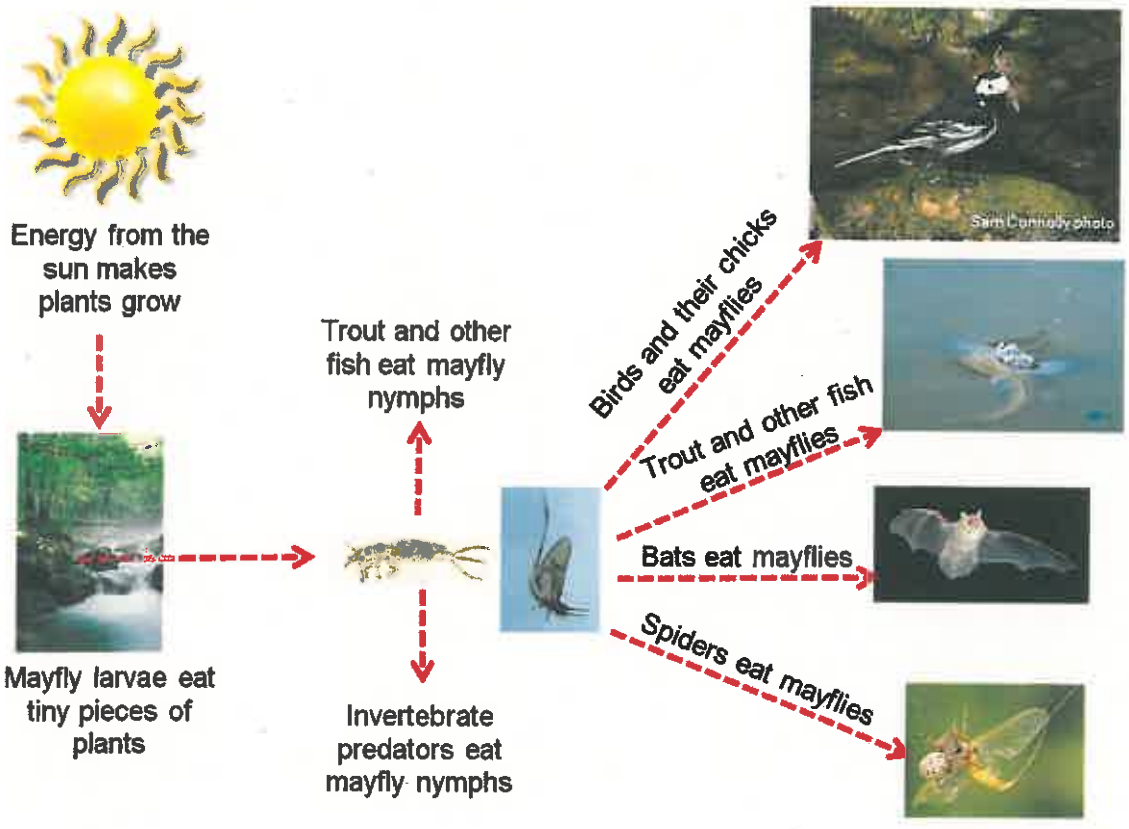


Figure 3: The central role played by mayflies to the flow of energy in aquatic and terrestrial food chains.

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
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.flyanglersonline.com/begin/101/part17.php
11. http://www.critterzone.com/magazineresource/magazine-article-mayfly-shadfly-Ephemerida-may-flies.htm
12. 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

Genera:

1. http://delta-intkey.com/britin/eph/www/heptagen.htm (requires key download)
2. http://www.fishermonk.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
5. http://www.nhm.ac.uk/nature-online/life/insects-spiders/common-bugs/dragonflies-mayflies-stoneflies/index.html
6. http://flood.nhm.ac.uk/jobj/runjava.jobj?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
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.mdfrc.org.au/bugguide/diagrams/ephemeroptera.htm (photos of mayfly nymph, abdominal gill and ventrial view of head)
4. 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

Pictoral Keys and Diagrams of nymphs:

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_0C&pg=PA47&lpg=PA47&dq=plastron+mayflies&source=web&ots=1RLlKG3F-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/aqresp.html (Chapter 10 Aquatic respiration)

Mayfly Poem:

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

Glossary of selected terms

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

Basic Schedule (can be modified)

Days	Activities
Pre-project	• Collect plastic drinks bottles (usually 6 x 2-litre bottles) • Download and read "Teacher and Pupil Mayfly basic assembly instructions pdf" • Obtain equipment detailed in basic assembly instructions • Cut down bottles, drill bottle caps and trim plastic pipette tips as per basic assembly instructions • Place cold packs in the freezer
Day 1	• Visit to local stream to kick sample, identify and collect mayfly nymphs (a good starting point is to find nymphs with 6 jointed legs and three tails that are not damselfly nymphs – a great simple ID guide is available here: FSC guide **Group Work (guided by basic assembly instructions):** • Assemble one complete bottle with corresponding individual "branch" of aeration system per group of pupils • Add water and appropriate substrate • Each group to bring their bottle and aeration "branch" and join it to the circular "loop" of aeration tubing that is connected to the air pump • Fill water bath (plastic tray) with tap water and add up to half of the cold packs from the freezer • Nominated pupils from each group add nymphs to their bottle: between one (largest species) and three (smaller species) nymphs per vessel • Different pupils fill out the first entries in the daily record sheets for each individual vessel
Days 1 to 14	• Daily checks for continuous aeration and temperature (must be <20 degrees C) as well as emergence and mortalities • Completion of daily record sheet according to observations • Replacement of thawed cold packs with frozen ones from freezer

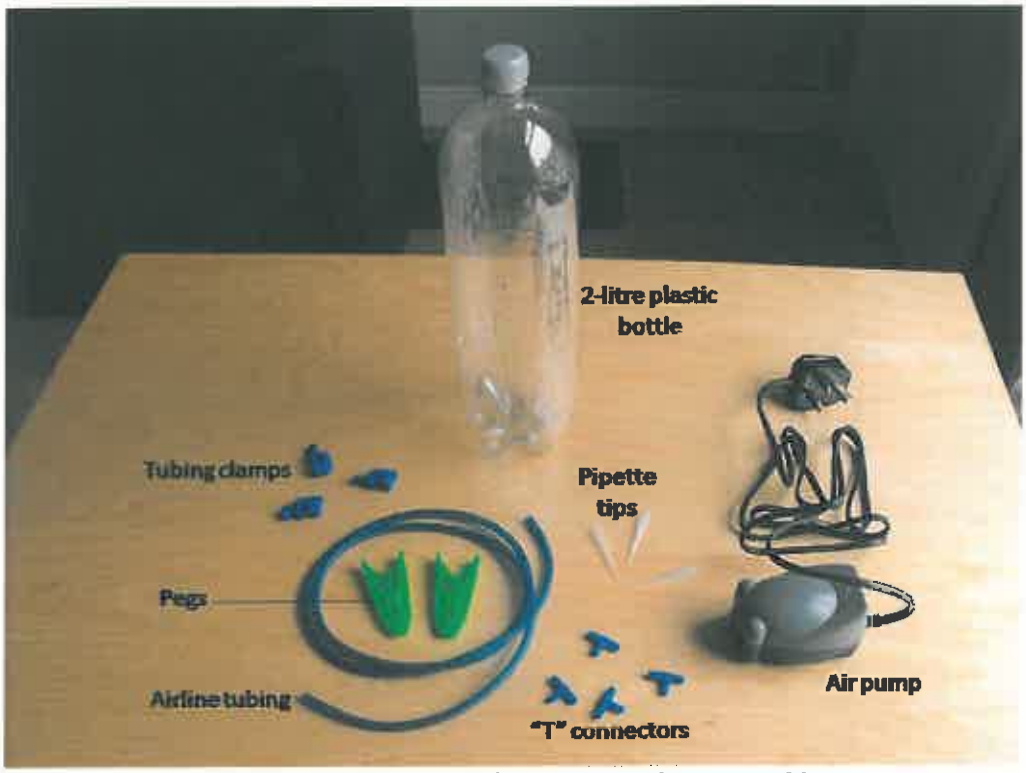
	• Transfer of any adult flies immediately to fridge in storage box with air holes • Learning activities relevant to local issues and efficient domestic water usage e.g. **water efficiency** link • Art and literature activities based on nymphal and adult mayflies • Learning about the foodwebs that mayflies belong to and what healthy streams need to thrive • Learning about other indicator species that require high water and habitat quality like trout • Learning about solubility of gas in liquids at different temperatures (as per aeration system)
Day 14 or other end date	• Transport adult flies back to stream and release into bank-side vegetation • Observe natural hatches of mayflies and other river flies • Try to count the different species feeding on mayflies both in and around the river (e.g. fish, birds, bats and spiders)

Mayfly in the Classroom: Basic apparatus assembly

Equipment list for 6 mayfly vessels:

(adapted from methodology detailed in: Finlay, K.J. (2001), "Construction and Evaluation of a New Laboratory System for Rearing Mayflies" ***Trends in Research in Ephemeroptera and Plecoptera*** **edited by Eduardo Dominguez**
Published by Kluwer Academic/Plenum Publishers
ISBN 0306465442, 9780306465444

- 6 x 2-litre clear plastic bottles (two mayfly nymphs per bottle)
- 7 x Tubing clamps
- 6 x 200-µl plastic pipette tips
- 8 x "T" connectors
- 3 metres of soft plastic airline tubing
- 12 x clothes pegs or small bulldog clips
- 1 x electric air pump



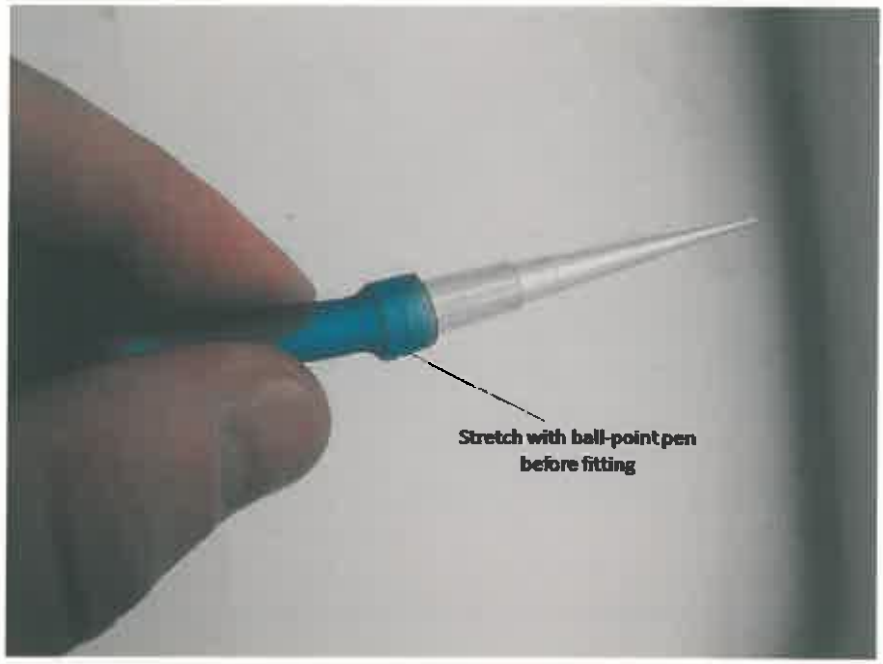
Basic equipment for mayfly vessels ready to assemble

Care! – the first step of preparing the vessels is to carefully cut off the conical top section of the plastic bottle using a pair of scissors before drilling a 7mm diameter hole in the screw cap. This should not be carried out by students. Additional help may also be required to fit the pipette tips (over page).

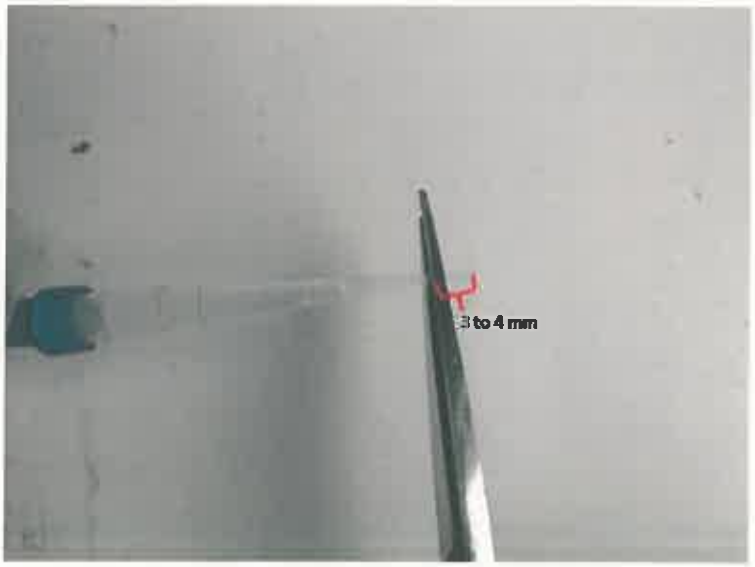
Esmée Fairbairn Foundation

Assembly

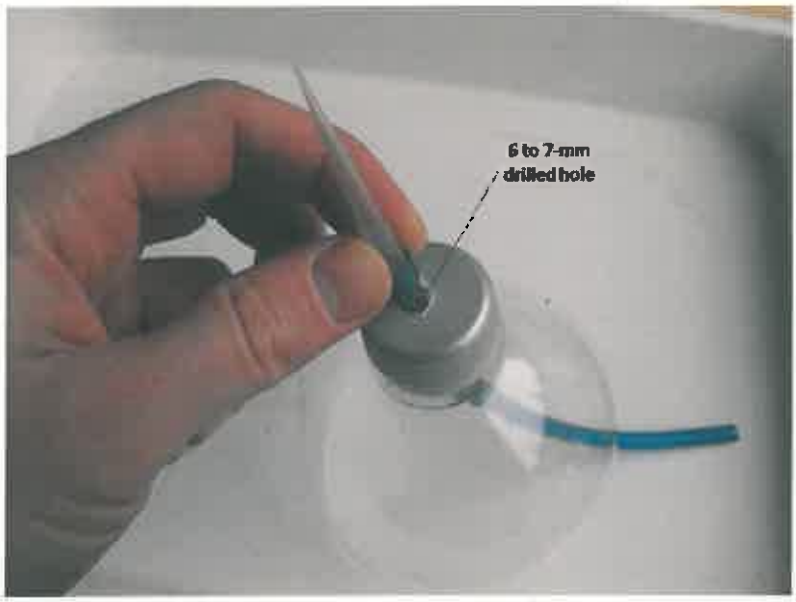
Cut a section of airline tubing approximately 20 cm in length and firmly push one end over the wide end of a plastic pipette tip. This process could be made easier by widening the opening of the airline tubing using the tapered end of the barrel taken from a plastic ball-point pen in advance.



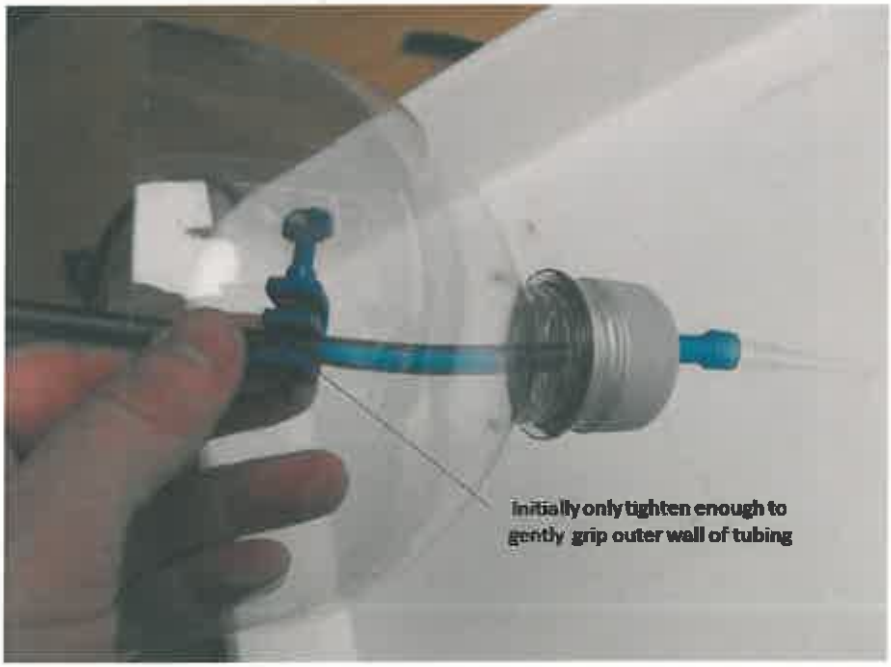
Now cut approximately 3 to 4 mm from the pointed end of the pipette tip (this is to allow sufficient air to bubble from the tip without requiring excessively high pressure)



The tubing can now be threaded through the drilled hole in the screwcap of the bottle (leaving the pipette tube on the outside of the cap



Now turn the conical section of the bottle over so that the pipette tip and screw cap are pointing downwards and attach a tubing clamp to the airline that is on the inside of the cone. Do not fully tighten the tubing clamp at this stage as it will cause a blockage when the air pump is switched on.



The substrate appropriate to your particular type of mayfly nymph (see table below) can now be added to the vessel as well as the river water (or bottled mineral water) up to a point about 5 cm below the level that the screw cap will sit. This water level should be marked on the side of the vessel. The conical section can be inserted into the main vessel and secured with the clothes pegs as shown below. The pipette tip must be below the water surface at all times – but should not rest on the bottom of the vessel. This height can be set by positioning the airline clamp the required distance from the pipette tip.

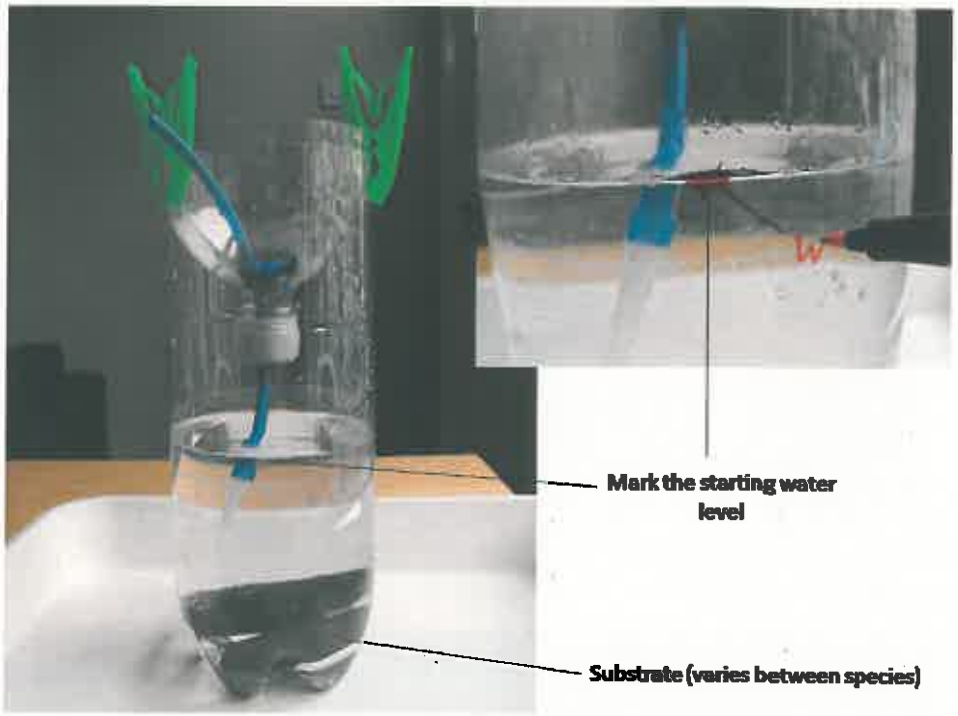
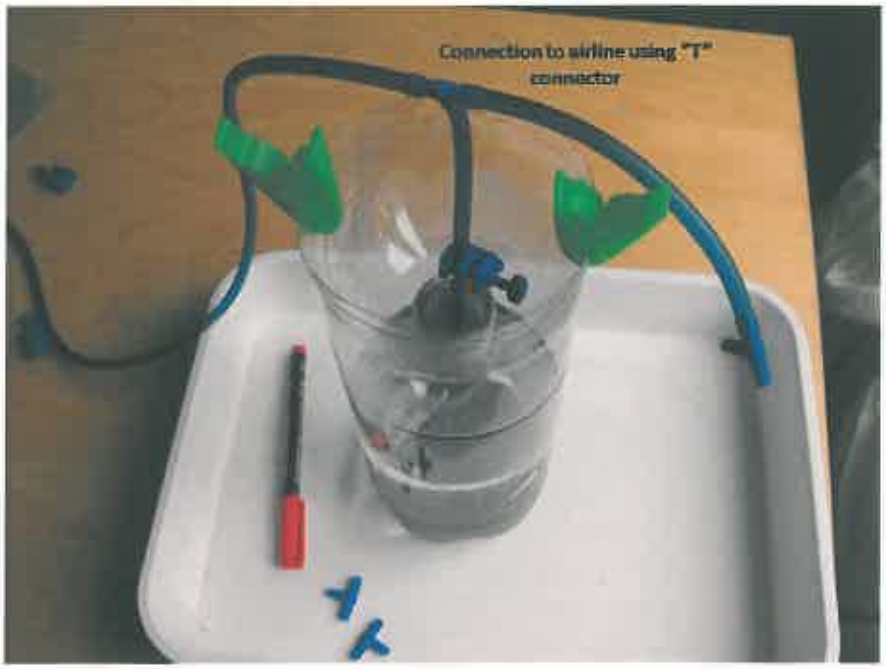


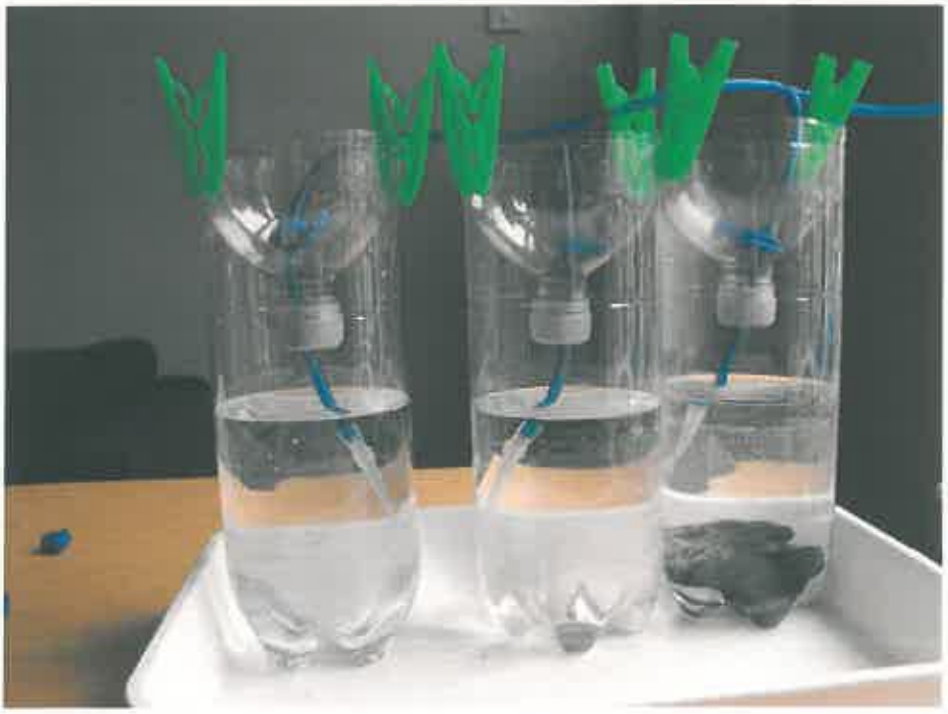
Table of substrates for each mayfly type.

Mayfly "type"	Families	Substrate
Burrower	Ephemeridae, Caenidae	River Sand/gravel
Agile Darter	Baetidae	Pebbles/water crowfoot
Stone Clinger	Heptageniidae	Pebbles
Crawler	Ephemerellidae	Gravel/Sand/water crowfoot

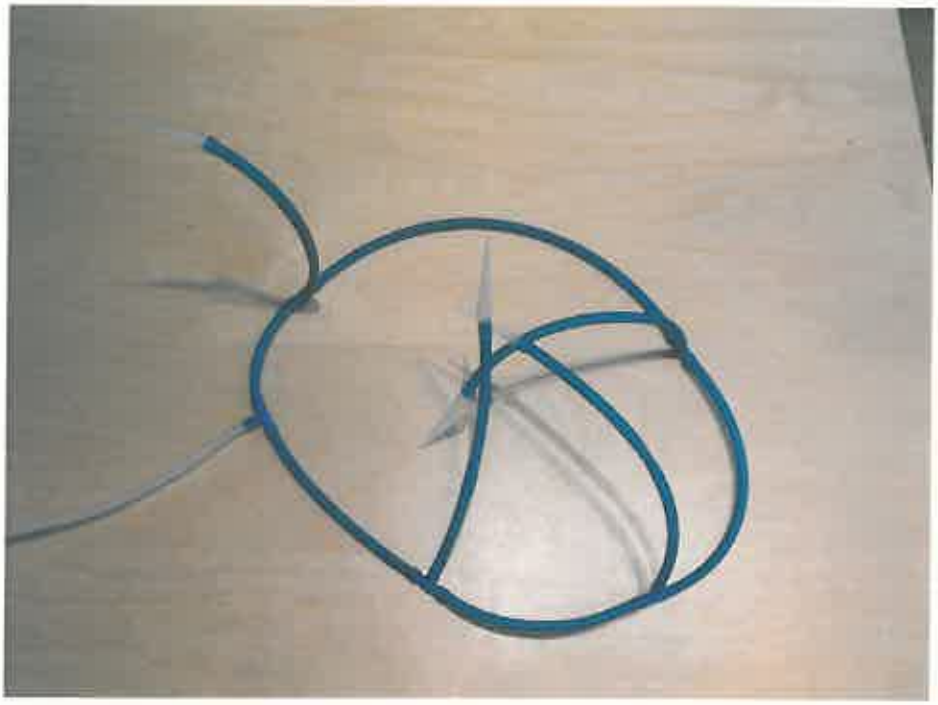
Several vessels can now be connected to each other and to the main airline using the plastic "T" connectors to join lengths of airline tubing together as shown below



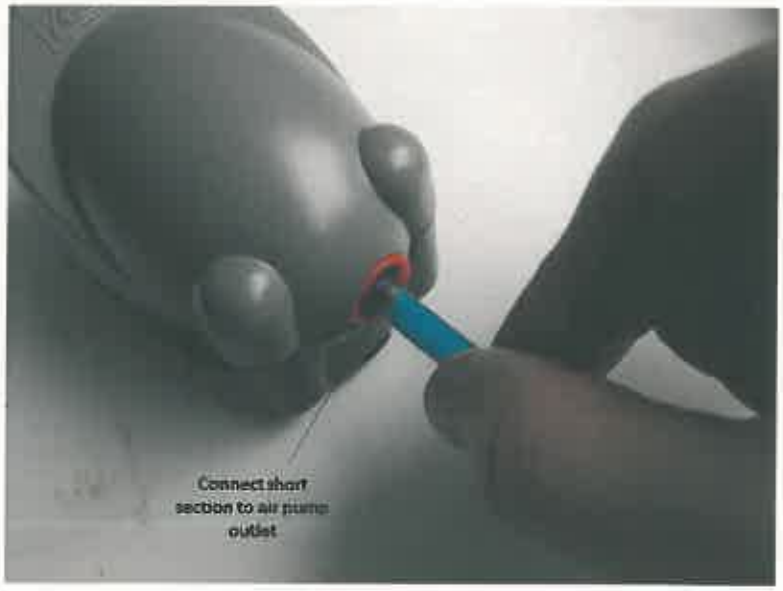
Here's what three vessels look like when they are joined together (below). Please see the subsequent photo that shows how to link vessels in an "air line ring".



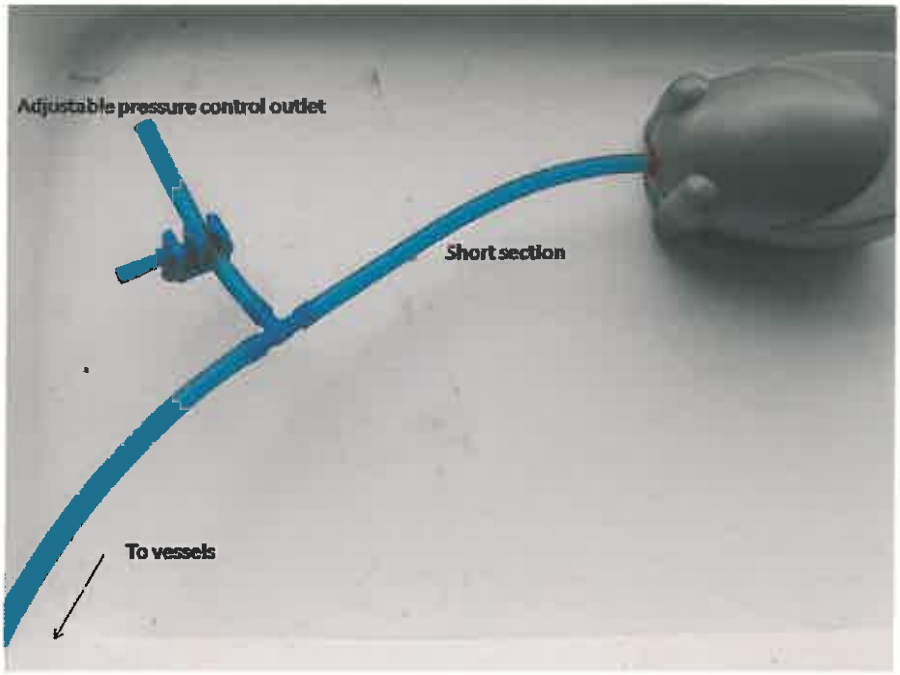
Here is an example of an airline ring. The white tubing to the left is connected to the air pump. It is best to set up the bottles with the (vertical) pipette tubing lengths in place before measuring and cutting the connecting "ring" tubing sections that link each bottle together (via the "T" connectors).



To complete the basic assembly, firstly connect a short (approximately 20-cm) length of airline tubing to the outlet of the aeration pump.

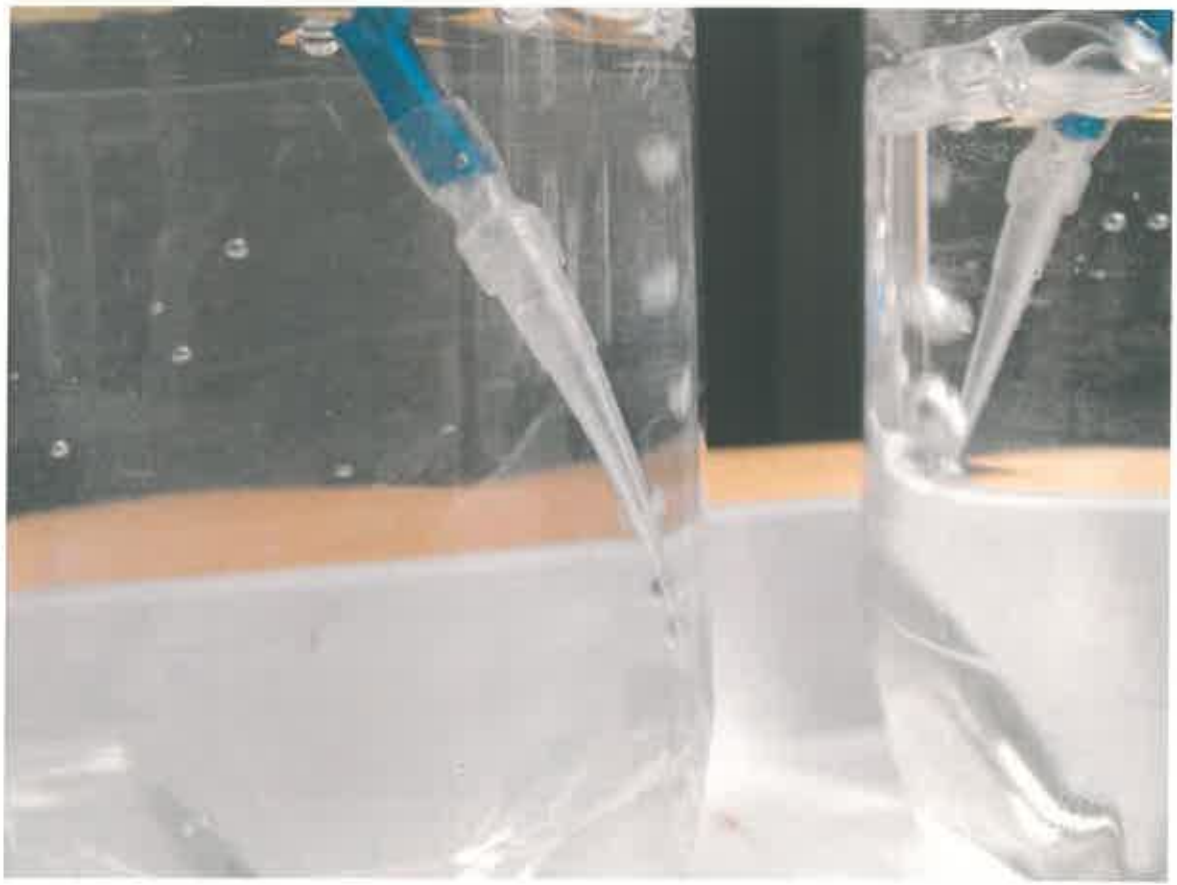


Next, use a "T" connector to introduce a short open-ended side branch (10-cm) with a tubing clamp so that the flow of air entering the aeration system can be regulated (below)



Important – the air pump must be (securely) positioned ABOVE the level of the water in the vessels. This is to avoid the possibility that, during a power cut, the water could siphon out of the vessels via the aeration system. As an alternative, a simple one-way valve could be fitted to the system.

Before switching on the air supply – the pressure control outlet should be fully open (along with the individual clamps for each bottle). Switching on the air supply should be followed by gradually tightening the pressure control outlet until air begins to flow to the vessels.



The flow to each individual vessel can now be equalized by adjusting the individual vessel airline clamps. Bubbles should be continuous but not "boiling" violently like a kettle! The bubble stream should be approximately equal for all vessels and should be just sufficient to cause a gentle circulation of water.

Assuming that the water in the vessels is equal (± 2 °C) to the water that the nymphs are supplied in (and the appropriate substrate is in place), the vessels are now ready to receive the mayfly nymphs. Two nymphs should be placed in each vessel.

See "Maintenance and Care" and "How to look after your mayflies" for subsequent instructions.

How to look after your mayflies

1. Look at each vessel and check that the air is bubbling in every bottle every day

2. Check the water level each day and keep it topped up to the marker every day

3. Check the water temperature against your "water temperature check" chart every day

4. Add frozen coolpacks to the base tray whenever the temperature is too high!

5. Put any thawed coolpacks back in the freezer

6. Check to see if any mayflies have hatched every day if they have – transfer them gently using a paint brush to the special box which will be kept in the fridge until release day



7. Add the correct food once per week
(your teacher will supply the right food for your mayflies)

Maintenance and care

Using pre-printed recording sheets each day (example lab record sheet supplied) helps to prompt the required regular care duties as well as record observations and actions. The duties of primary importance for all mayfly families are:

Nymphs

- Check and maintain constant aeration
- Ensure temperature does not exceed a maximum of 21 °C (ideally temperature would be 15 – 18 °C)
    - Take water temperature with a thermometer each day
    - Temperature may be reduced by adding cold tap water to the tray that the mayfly bottles are standing in and adding one or more frozen "cool packs" to the tray of water
- Replace water lost from the bottles by evaporation (check the starting water level marked on the bottle) with either:
    - Bottled mineral water at the same temperature as the mayfly vessel water
    - Tapwater that has been aerated in a bucket for at least 12 hours (this drives off the toxic dissolved chlorine †) at the same temperature as the mayfly vessel water
- Feeding:

Ephemeridae	Either: • Plant detritus collected from the native river OR • experimental feeding with roughly blended fresh spinach (blanched in hot water) at ~ 1 teaspoonful per vessel per week
Ephemerellidae, Baetidae, Heptageniidae	Algae-covered pebbles from native river (replaced with fresh ones once per week if required) **N.B. pebbles can be rotated between a bucket containing river water and the mayfly vessels to allow algae to re-grow when not being grazed)**

† This can be incorporated into part of a physics lesson examining aqueous solubility of gases and/or geography modules considering the water cycle and addition of chlorine to sanitise drinking water

Sub imagos and imagos

A

B

Figure 1: A twig "perch" for adult mayflies (A) and how to gently transfer an adult mayfly (B) when from one vessel to another (a small aquarium net may be useful for catching "escapees" too)

- Provide a twig or some mesh that protrudes above the water line for emergent mayflies to climb up and settle on (Fig. 1A)
- Check each day for emerged mayflies and remove any sub-imagos from the bottle and place in a small plastic or cardboard box (with air holes) in the fridge until "release day" (Fig. 2). Flies can be kept for up to a week in these conditions, and may moult to become imagos during this time
    - Adult flies can be transferred by gently encouraging the fly to walk onto a soft paintbrush (Fig. 1B)
    - Any mayflies that make a bid for freedom can be recaptured using a soft meshed aquarium net

Figure 2: A clean takeaway food box (with airholes punched in the lid) for adult mayfly storage.

- Try to identify whether each sub imago is male or female and record the date that each emerge
- When a suitable number of adult flies have emerged (and are stored in the fridge) a release day should take place at the native stream
    - Adult mayflies should be placed in bankside vegetation
    - Surviving nymphs that have not hatched by the end of the project should be gently released into their native river (and NOT into a river system different from their place of collection – as diseases such as crayfish plague could be introduced)
    - The river should be observed to see if naturally resident mayflies are hatching during the visit
    - Pupils should try to list as many species as possible that they can see feeding on the mayflies during a hatch and draw these as links in a food chain (divided between aquatic and terrestrial predators)
    - Factual descriptions and poetry activities should be based on observations and inspiration taken from the visit to the waterside
    - The social responsibility for ensuring habitat and water quality continue to support mayflies, fish and healthy flora should be highlighted during waterside visits

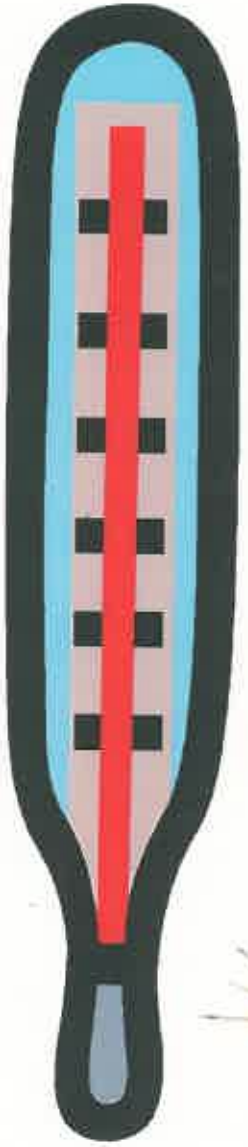
Vessel Number: **Mayfly Laboratory Record Sheet** Page: of

Starting conditions:

Nymph family (highlight)	Body shape (paste photo)	Feeding strategy (highlight)	Behavioural group (highlight)	Number of nymphs added to vessel
• Baetidae • Heptageniidae • Ephemeridae • Ephemerellidae		• Grazer • Collector	• Agile darter • Stoneclinger • Burrower • Creeper	

Daily records:

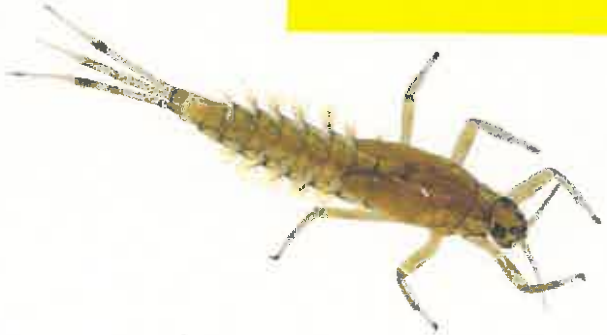
	Mon	Tue	Wed	Thur	Fri	Sat	Sun
Observation Date							
Aeration OK (Y/N)? Note repairs							
Water topped up? (Y/N)							
Temperature (°C)							
Coolpack required? (temperature ≥21 °C)							
Mortalities (plus notes)							
Food renewed? (Y/N)							
Imago emergence? (Y/N plus number)							
Additional notes							
Recorder's Signature:							



20°C
19°C
18°C
17°C
16°C
15°C

TOO HOT!

OK



Water temperature check

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Why bother about mayflies?

Mayflies are part of a delicate freshwater ecosystem and the presence of a variety of mayfly families along with wild trout indicates a stream that is in good health (unpolluted water and good habitat). But why should we value healthy streams and rivers? In other words;

CLASS DISCUSSION TOPIC "Do we care about freshwater ecosystems?"

Why not build over all rivers and make more houses, shops, cinemas, roads etc? Of course we need these things; but why should we make sure that building them **does not** destroy freshwater ecosystems? Discuss whether the class agrees or disagrees with the following statements:

Freshwater ecosystems have direct benefits to humans:

- Mental wellbeing from attractive surroundings and appreciating nature
- Part of drinking water supply – water from healthy rivers is cheaper (and requires a smaller carbon footprint) to make it safe to drink
- Healthy plants and trees regulate carbon dioxide levels (control global warming)
- Invertebrates can be vital to human survival – e.g. bees pollinating crops that we depend on; when that balance is disturbed/destroyed it can have unpredictable consequences for humankind
- Rivers in towns have significant cooling effect – help to counteract heatwave conditions that will be more common with global warming (remember the 52,000 European deaths due solely to the heatwave of 2003)

Humans have a moral obligation to protect freshwater ecosystems:

- Humans are the only species that truly understand the consequences of their actions
- The background rate of species extinctions has been accelerated by humans to the highest levels in the history of the planet
- Given that we know there are things that can be done to protect sensitive habitats and species, should we ignore the problem of species extinctions?
- In order to protect, we have to identify and understand the wildlife that currently exists
- The animals and plants in an ecosystem are all linked by complex interactions and depend upon each other
- **Learning about** (e.g. by mayfly in the classroom) the requirements of especially sensitive creatures like mayflies and wild trout – and **providing for** those needs - helps to protect all plants, trees and animals in and around rivers

Quotation "The true meaning of life is to plant trees under whose shade you do not expect to sit" Nelson Henderson (soldier in the Great War, originally from Ireland, and one of the pioneer settlers of Manitoba, Canada).

Discuss what Henderson might have meant by this statement (spoken to his son on his graduation day).

Amazing mayfly facts

- **Mayflies have been around for more than 300 million years – since far before the dinosaurs existed!**

- **Mayflies are very important because:**

  - **Many other creatures and their young survive by eating mayflies**

  - **They warn us of pollution because they need clean water to survive**

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Primary 6 activity ideas

- Make a collage of a stream (including the stream-bed and surrounding bankside vegetation) with different habitat types:
    - Smooth cobbles
    - Weed
    - Gravel
    - Silt
- Match cut outs of various nymphs to the correct microhabitats in the collage (see Teacher's Introduction for table of families and their preferred microhabitats)
- Include birds, fish and spiders as predators on the collage
- Include adult mayflies (sub-imagos and imagos) on the collage
- Include bankside vegetation and make sure adult mayfly pictures are placed in the vegetation and on the water surface as well as flying through the air
- Include birds' nests and chicks being fed mayflies by parent birds
- Emphasise the "circle of life" aspect to these food chains and lifecycles
- Include representations of pollution (e.g. chemical spills, discarded containers etc.) and an absence of living creatures in that area of the collage (dead fish and invertebrates may also be included in this area)
- Have younger primary classes visit the Primary 6 "mayfly in the classroom" aquaria and make/colour in items for the collage