SSERC
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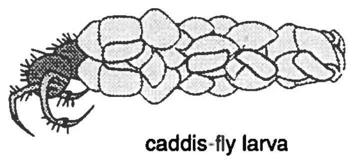
For teachers in Primary schools and of S1/S2 Science & Technology courses

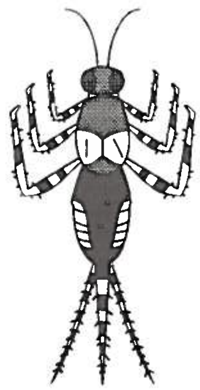
In this issue we look at a small selection of practical activities and investigations which may prove useful to illustrate one of the key features in the National Guidelines for Environmental Studies at 5-14. A major relevant attainment outcome for Science is *Understanding Earth and Space* and our chosen key feature - *the physical nature of the Earth, with particular reference to the roles played by water* . . . The first set of these activities provides opportunities for work outside looking at aquatic environments where some of the optical instruments discussed in Issues 2 and 3 should come in handy.



x 3

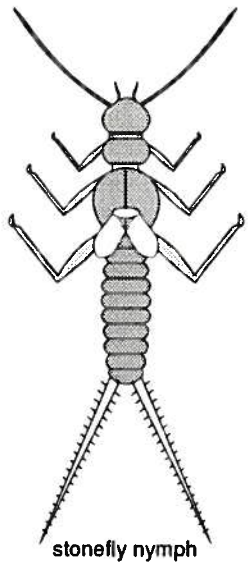
caddis-fly larva
or
Stenophylax

Fig. 1



x 3

mayfly nymph
or
Ephemerella ignita



x 3

stonefly nymph
or
Isoperla grammatica

Water, water . . !

What is it? One glib answer is to tag water with its scientific formula - H_2O. A scientist's definition would probably go on to describe pure water as the normal oxide of hydrogen. This is a colourless, odourless liquid, boiling point 100°C, melting point 0°C and a maximum density at 4°C of 1.00 gram per ml (or if you prefer, $1 gcm^{-3}$).

That is the definition of pure water, not the water of the river or loch or for that matter the tap. Most of us know it as the liquid we use to make our tea or coffee, have a bath or dilute our whisky. But how would we react if creatures such as those shown above were to be in the water we were drinking? Well, more than likely they were, once.

But, is it clean?

Water like air is something we cannot live without. Like air there seems to be an unending supply, and both are subject to many forms of pollution. In many instances we need specialised equipment and measuring instruments to detect and measure any pollution present in a sample. With water there is one simple technique we can use to detect if quality is good or not so good. It is an environmentally friendly method and needs no sophisticated tools. Unlike the adverts for washing powders or liquids this is truly biological. The minibeasts shown above can only live in unpolluted water, the water of our local reservoir or bubbling mountain burn.

Remember to chose study areas with care. If taking samples no one should be allowed to drink the water and hands should be washed as soon as possible after visits to ponds or rivers (see Section 13 of *Be Safe!*). Minibeasts do not make good pets, unless you have an established aquarium return them to their natural habitat.

The selection of minibeasts shown in figure 2 on the next page gives a simple approach to water quality. Those at the top are from an unpolluted sample, as we run down the page the water is becoming more and more polluted.

Eventually only the least environmentally demanding of creatures can survive. Of course in the river or pond the minibeasts would not be distributed with such an obvious split, some like the leech can be found in clean water as well as polluted water. Generally speaking mayfly, stonefly and cased caddis are found in clean water, while worms and rat tailed maggots and midge larvae are found in polluted water. Try a few samples from a local pond or stream. This should be carried out by the teacher and the sample taken from the bottom, include stones and mud. To view what has been captured empty the net into a large white pie dish. Minibeasts will show up against the white background. A hand lens will be needed to see some of the beasties, x 2 magnification should provide sufficient power.

Books and kits worth considering include :

Adventures with Small Animals (ISBN 0 7195 3930 7) and *Outdoor Biology* (0 7195 2019 3) both by Owen Bishop, pub. John Murray and the *Stream and River Pollution Set* K51150/3 from Philip Harris. Also excellent was the old *Streamwatch Kit* with its posters and identification cards. As far as we can tell this is no longer sold, anyone out there know differently?

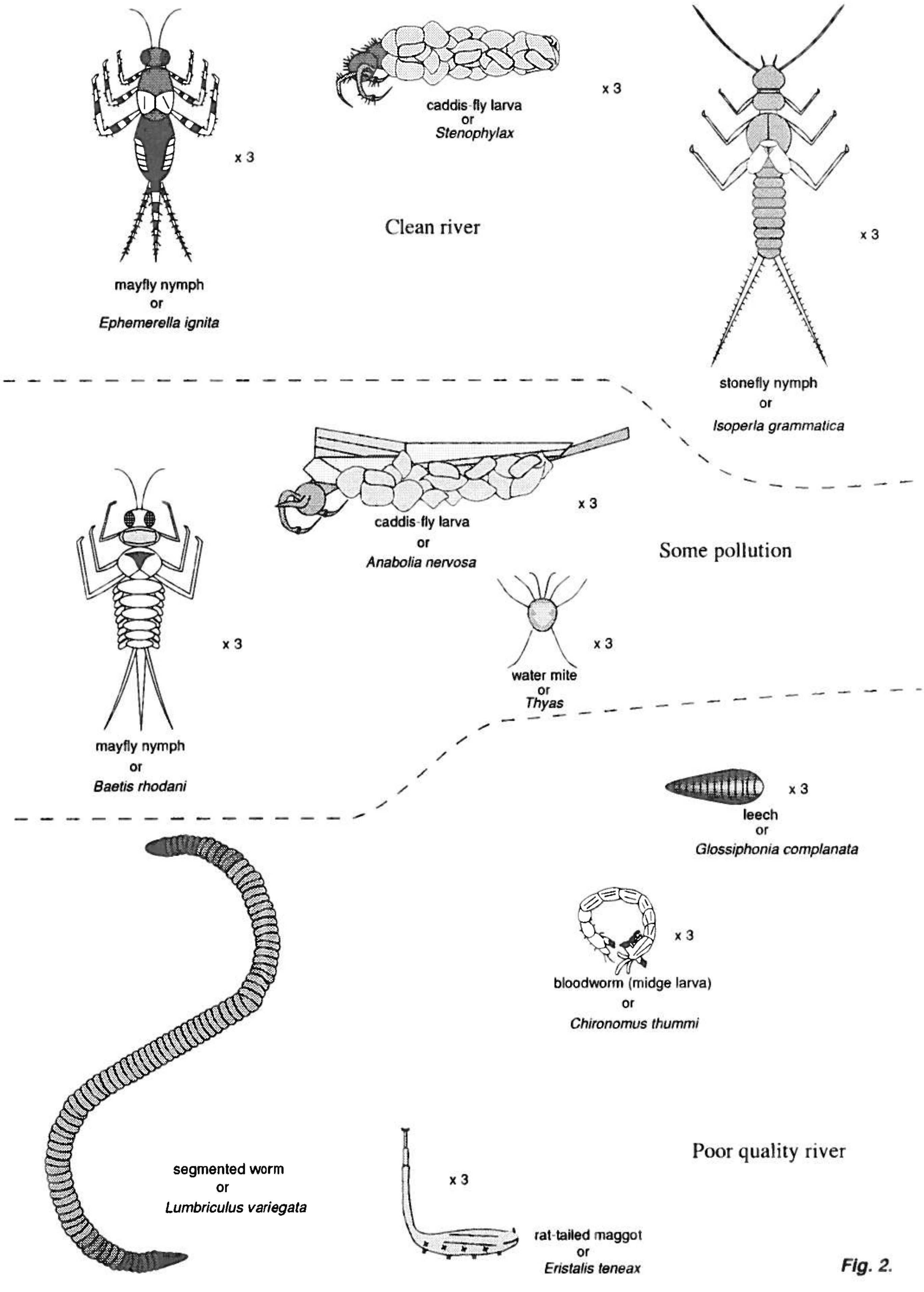

mayfly nymph
or
Ephemerella ignita
x 3
caddis-fly larva
or
Stenophylax
x 3
Clean river
stonefly nymph
or
Isoperla grammatica
x 3
mayfly nymph
or
Baetis rhodani
x 3
caddis-fly larva
or
Anabolia nervosa
x 3
Some pollution
water mite
or
Thyas
x 3
leech
or
Glossiphonia complanata
x 3
bloodworm (midge larva)
or
Chironomus thummi
x 3
segmented worm
or
Lumbriculus variegata
x 3
rat-tailed maggot
or
Eristalis teneax
Poor quality river

Fig. 2.

What, a gas?

Suppose we were to ask pupils the question - from where does water come? (pretentious pedant - moi?) Likely answers could be, the tap in the kitchen or bathroom, the river or the sea, rain or snow, reservoirs or from under-ground lakes. One of the ways that water is cycled through the atmosphere is by evaporation. The water is held in the air to become clouds, which eventually return the water to the Earth's surface as rain, hail or snow.

A simple pupil activity to show evaporation of a liquid is to half fill two wide mouthed glass containers with water. Large Pyrex pudding bowls would be ideal. Cover one with kitchen foil, leave the other uncovered (Fig. 3.) Mark the level of the liquid on the outside of the bowl with an indelible pen or pencil. Stand the bowls on a window sill or near a heater.

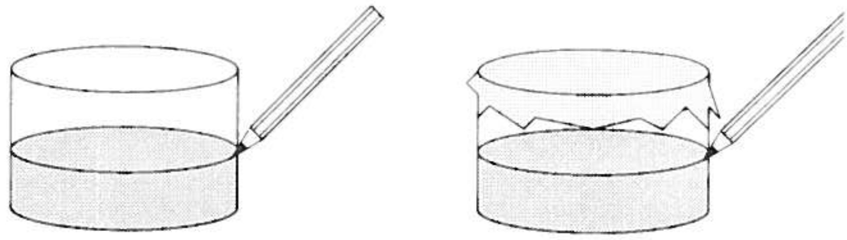


Fig. 3

Observe what happens to the level in each of the bowls. Are there any other noticeable signs? Make a record of the levels over an agreed time period. Does the temperature of the surrounding air make any difference? What happens if we try the same experiment with the bowls outside? Try a warm sunny day, a cloudy and a windy day. Are there then differences in the evaporation rates?

Keep cool!

A home made refrigerator provides further fun with evaporation. Suppose we pose the question -

How can we keep our milk bottle or our drink can cool if we don't have a refrigerator?

For this activity we need a bowl or basin, a small bottle, a terracotta flower pot and a stone. Half fill the bowl with water, place a bottle with water in the bowl, put the flower pot over the bottle. The stone is used to seal the hole in the top of the flower pot, To help speed up the process it is a good idea to pre-soak the flower pot in water. Fig 4 shows the method.

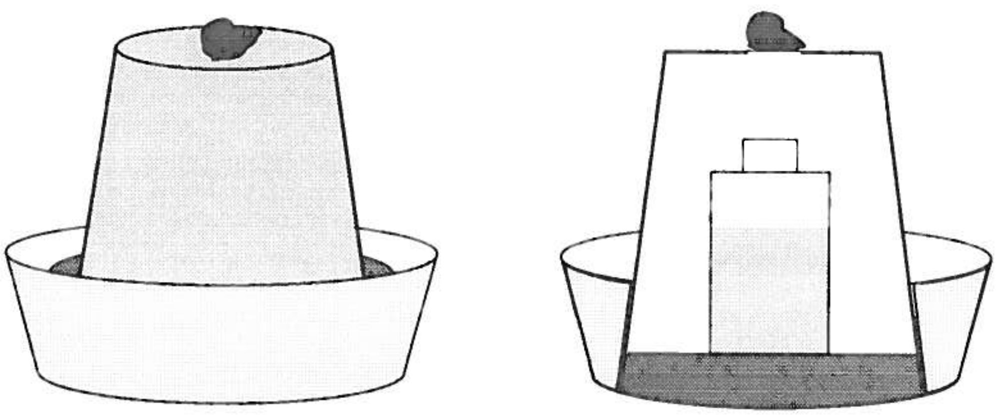


Fig. 4

If we leave the flower pot fridge for an hour or so we should feel that the bottle is much cooler. But this is a subjective judgement, to be more scientific we should devise a more objective (fairer) test. One way would be to measure and record the temperature of the water in the bottle at the start of the experiment and perhaps take readings over an agreed period of time. How long does it take for the temperature of the water under test to drop by over a degree? How cold does it get (what is the lowest temperature reading)? Does it keep getting colder? The big question - what makes it get colder?

The reason our mini fridge works is that as water evaporates from the sides of the flower pot it also takes away some of the heat, leaving whatever is inside cooler[1]. The Egyptians knew of this method of keeping food and drink cool and in the not too distant past earthenware butter and milk coolers were to be found in most kitchens in Britain. In the majority of the world - areas where electricity is not available - such earthenware coolers are in common use. Remember this is not a proper refrigerator, do not use dairy products, stick to soft drinks in cans. If investigations are carried out with a water sample which will be tasted, ensure the water comes from a proper drinking supply.

1 Not an explanation to give the pupils but - as a liquid changes into a gas the particles require extra energy at the moment they burst out of the surface and escape as freely, randomly, moving gas particles. It is the removal of this energy as heat (called "latent heat") which does the cooling.

It droppeth from . . ?

We have already hinted at some of the likely answers, but another simple experiment will begin to show how water is returned from the air. Fill a glass with water and place it in the refrigerator for a few hours, remove it and stand in a saucer. If this is done in the classroom it should take no more than a few minutes for a thin film of water to form on the outside of the glass (Fig. 5). The warmer air of the classroom contains water vapour and this condenses on the cold sides of the glass. This can sometimes be seen on the inside of the windows on a frosty morning. Is it seen anywhere else?

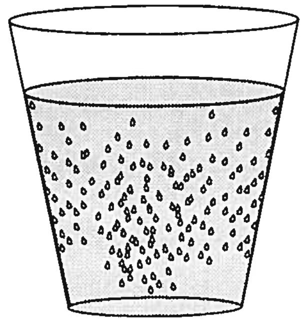


Fig. 5

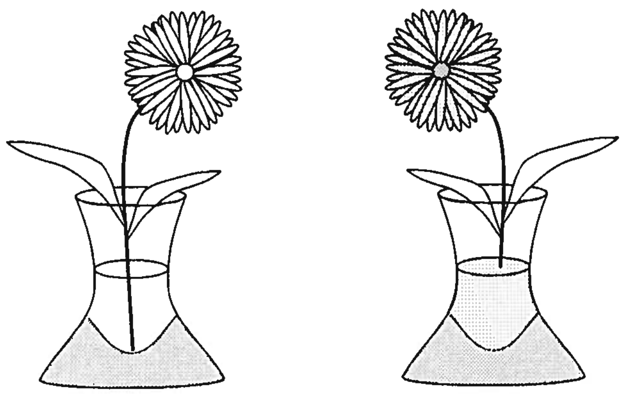


Fig. 6

Evaporation from rivers, lakes and puddles is one way that water gets into the atmosphere. Are there any others? Why do the windows of the car sometime 'steam up' on a wet day? Why are the class room windows often covered with moisture? The answers from the class could be interesting. Some will no doubt realise it could be from 30 people breathing in the enclosed space of the classroom. Now people breathing is not quite enough to replace the water content in the atmosphere to allow the rain to fall. Where else could it come from ? Could it be trees and plants? Is this one reason scientists are so worried about the destruction of the rain forests?

We all know we have to water plants but what happens to that water?

The water is used by the plant roots to take nutrients from the soil to the leaves where the plant makes its own food. Some of the water is retained by the plant, the rest, you've guessed, is returned to the atmosphere. Figure 6 shows an interesting experiment. In one vase the flower is in ordinary tap water, in the other the water is coloured with a food dye. Choose white or light coloured flower heads and much darker food dyes. After a couple of days the flowers will assume the colour of the dye. This shows that the plant takes water from the vase up to the flower head. On a warm day much of this water will be lost through evaporation[1]. Does the colour change happen more quickly in sunlight or in shade? Does the colour of the dye make a difference? Does the type of plant we use make a difference? This investigation may also give an opportunity to discuss methods plant use to try to stop excessive fluid loss.

Finally how do we measure the amount of rain that falls? Here is one way.

This design uses old lemonade bottles. Carefully cut the top portion from the bottle as shown in figure 7. Invert it into the remaining part and glue a small ruler to the side. We now have a simple rain gauge.

If the gauge is to be placed on a roof it will need to be placed in a tin with a hole in the bottom, weighted with sand or stones. If it is to placed on the ground it will need to be put in a shallow hole to make sure it is not blown over (Fig. 8).

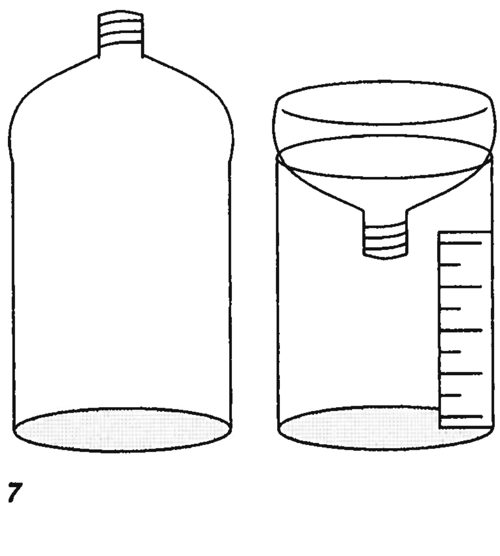


Fig. 7

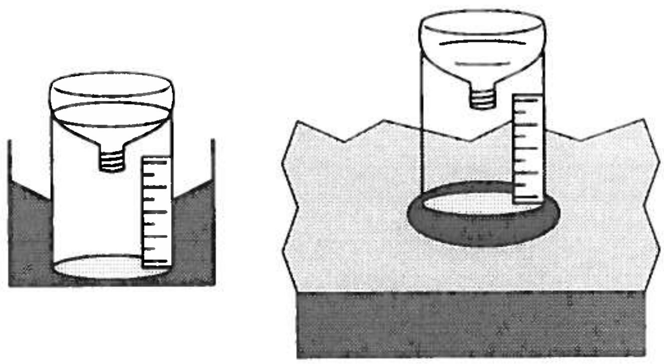


Fig. 8

1. In this case given a fancy name by biologists who call it *transpiration*.