Freshwater Favourites

This movie was originally shown at the meeting of the Postal Microscopy Society at Pool in Wharfedale, October 2011, and it was accompanied by a live commentary.

In lieu of the live commentary, I thought a few notes might be helpful.

The Collecting Sites

These are all in the UK. The first 13 are in the north-west of Scotland including Attadale Gardens, followed by Farnham Nature Reserve near Harrogate, Malham Tarn fen with its boardwalk and pools, the tarn itself, a Leeds garden pond, and lastly containers in my own garden.

Mosquito Larva

The larva is the second of 4 stages in the mosquito's life cycle.
It is very common in the summer months in small stagnant water bodies such as ditches, ponds, or abandoned containers where they can be seen hanging from the surface film of water.
They have been nick-named Wrigglers or Wigglers and you will see why when you disturb them.

You can see the head, large thorax, and 8-segmented abdomen. There are no legs.

In the UK the adults do not carry the malarial agent. Only the female inflicts bites on humans. This is to provide a meal of blood prior to egg laying. When larvae hang upside down from the surface of the water air enters through an air tube or

siphon and passes via two main tracheae to reach all the body tissues.

When the larva leaves the surface 5 tiny flaps at the tip of the siphon close thus preventing air from entering.

Arising near the siphon you can see 4 gill-like structures which have nothing to do with oxygen intake, but regulate the salt content of the body.

While hanging at the water surface, the larva creates a current of water with a brush-like fringe of hairs at its mouth and then filters out from this the microscopic organisms on which it feeds.

Tardigrades

Tardigrades, or water bears – so called because of their lumbering gait – are found on high mountains and in deep seas, at the equator and in polar regions. The most likely place for you to find them would be in damp moss or lichen. Some species are as small as 0.1mm long, others as large as 1.5mm.

Male tardigrades are rare, but the females do not need them to produce young! This type of reproduction is called parthenogenesis. The females produce eggs which develop without being fertilized.

There is a simple nervous system.

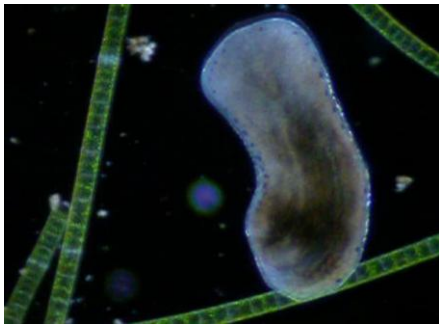
They have complex survival strategies which they use when circumstances are unfavourable. These strategies enable them to survive extremely low temperatures and as high as 151°C. After almost 10 years of desiccation they have revived when wetted. They can survive the vacuum and radiation of space, having been on the FOTON-M3 mission in 2007, and on the last

journey of the Space Shuttle Endeavour in May 2011. Many of those which survived space later produced eggs which hatched normally.

You can see the plump segmented body and 4 pairs of legs with claws at the end. The claws are important features for identification of species.

On the head you can see the complicated feeding apparatus which includes a sucking tube and a pair of sharp spines or stylets which are used to suck out the contents of plant cells.

Planarians



Planarians are unsegmented, flattened worms with a distinct dorsal and ventral surface. They have a simple digestive system without an anus.

You will see the dark pigmented eyespots at the front and, in this species, down the sides. These photoreceptors detect the light, enabling the planarian to move away to a shadier place.

The smooth gliding movement is very noticeable. This is brought about by a bed of cilia, or short hairs, on a thin layer of mucus.

They are capable of digesting their own body if there is no food available, thus shrinking in size.

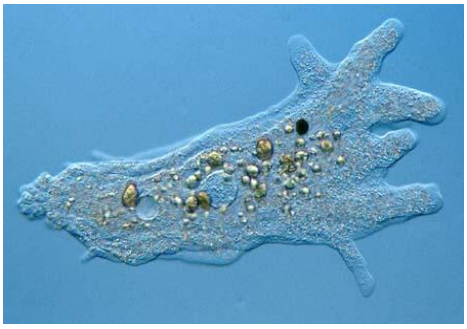
Their ability to regenerate is of great interest to scientists. If a planarian is cut in half, across or lengthwise, or if its head or tail or both are cut off, the missing parts are re-grown within a few days. Scientists would like to know more about how this happens in the hope that one day they might be able to help

people who, through illness or accident, have lost some part of their body.

Protozoa

These are organisms consisting of a single cell and yet they are far from simple. The cell has to carry out all the processes necessary for life, just as the bodies of more complicated creatures do.

Amoeba



You can see the cytoplasm of Amoeba rapidly changing from its fluid state or plasmasol to its more solid state, or plasmagel. The process is reversible.

You can see pseudopodia, or 'false feet' being produced and plasmasol flowing to form them. This is how the amoeba moves. It also uses pseudopodia for feeding. The 'false feet' surround the prey without even touching it, and then engulf it into the cytoplasm as a food vacuole.

Astylozoon

This is a free-swimming peritrich which uses the ring of cilia around its broad end to move, sometimes very fast indeed. It can be identified by the single 'spike' projecting from the other end. You will see 2 swimming joined together in the movie. What are they doing? Has one Astylozoon almost finished dividing into 2, or are 2 of them joining together?

Kerona

This is seen scuttling over the body and tentacles of a brown hydra in the video, though a green hydra is shown in the photo alongside. Kerona feeds mainly on bacteria found on hydra, while hitching a lift around the pond and having a place to call home. Despite the hydra having many nematocysts which are cells which fire miniature poisoned harpoons, Trichodina never gets caught as Hydra allows it to scuttle freely around its body and tentacles. Why does Hydra harpoon some small creatures and eat them, but not this one?

Paramecium

These organisms are about 0.25mm long and are sometimes called 'slipper animals' because of their shape, rounded at the front and more pointed at the back. The shape is maintained by a covering called a pellicle which allows the animal to be flexible.

They are covered in cilia which beat to bring about movement, enabling Paramecium to swim in a spiral through the water. In the film you can see Paramecium's ciliated oral groove where the beating of the cilia directs food particles, mainly bacteria, towards the cell mouth. At the same time you can see the protoplasm streaming around the cell (here it appears to move in an ant-clockwise direction). This is called cyclosis and by this means nutrients are distributed around the cell.

Halteria

Halteria is very small and is capable of lightning-fast movement making it difficult to film. It has a band of long cilia around it. In the clip you can see how it suddenly shoots away faster than an F1 car from the starting grid.

Frontonia

This Protozoan is larger than Halteria, and is covered in cilia. It has a contractile vacuole, or water emptying vesicle. In the film you can observe this filling up and emptying a number of times. You can also see radiating canals which carry excess water from all over the body to the contractile vacuole. Look for the mouth, or buccal cavity.

Dinobryon

This is a colony of single cells. The colony is fan-shaped and each cell lives within its own vase-like case called a lorica.

Each cell has 2 flagella, unequal in length. The longer flagellum can just be seen projecting through the open end of a lorica. The whole colony swims by the co-ordinated lashing of the flagella of the individual cells.

Spirostomum

This is easily recognized by its long, cylindrical body, covered with lines of cilia. Underneath the cilia are myonemes which enable the cell to contract faster than the eye can see. According to Jahn et al* it can contract its body to $\frac{1}{4}$ of its length in 6 – 8 milliseconds. This is said to be the fastest rate of contraction known in a living cell.

A group of Spirostomum will often contract at exactly the same time. It happens in the movie but is difficult to see because it happens so fast. How do they do this, all at the same time? – No one really knows.

** Theodore Jahn: How to Know the Protozoa 1979 Page 258*

Loxodes

Loxodes is easily recognized by means of its curved front end with a wide sub-terminal mouth which is clearly crescent-shaped.

Notice the many cell inclusions. The Muller's bodies have a sensory function, and the green algae have been part of its diet.

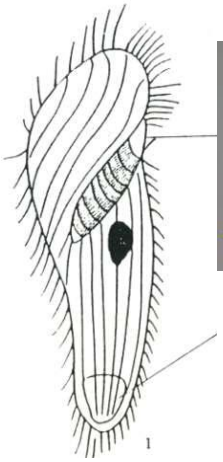
Stylonychia

Apologies for the misspelling of Stylonychia in the movie.
This is a very common protozoan, recognized by the 3 spiky cirri or bristles at the tail end. Movement is rapid and jerky – a case of 'now you see it, now you don't.'

Trachelius

Once you spot the short, tapering projection called the proboscis, you know you have got Trachelius in view. At the base of the proboscis is the mouth, though it is hard to see. Trachelius has many contractile vacuoles, and this sequence shows that it is not averse to squeezing through narrow gaps.

Metopus



The most distinctive feature is the twisted front end resembling the letter 'S'. Look for a collection of granules at the rear end.

It uses its adoral zone of membranelles at the front end for feeding, but surface cilia for locomotion.

Mites

Most species of mites are found on land, but some live in freshwater and marine environments. Some are brightly coloured.

The body is unsegmented and there are usually 4 pairs of long, jointed legs in the adult. The life cycle consists of egg, larva, nymph and adult. We see the adult in the film. Most mites have a pair of sensory organs at the head called palps. They feed using needle-like piercing-sucking mouthparts. The mites in the movie would feed on larvae and crustaceans found in the water.

Zoochlorellae

Zoochlorellae are one-celled green algae living with a host in a mutually beneficial relationship called symbiosis.

The green cells use the carbon dioxide produced by the host in respiration, while the host uses the oxygen produced by the green cells in photosynthesis.

The film shows 4 examples of this symbiotic relationship in which the zoochlorellae are passed from one generation to the next in the cytoplasm.

Ophrydium

This is a colonial, sessile, ciliate protozoan with individual cells embedded in a gelatinous mass. These 'jelly balls' form visible green patches usually on rocks or towards the edge of freshwater areas. The green colour is due to the presence of the zoochlorellae. Notice the ability of adjacent cells to act in unison and contract simultaneously and more rapidly than the eye can see.

Vaginicola

This protozoan is always enclosed in a case or lorica. Writers suggest that double occupancy of a lorica is unusual but I have always seen two of unequal length in the same case.

Climacostomum

This again is a protozoan. It has an obvious adoral zone of membranelles curving round the front end of the cell and used for feeding. The symbiotic green algae can be seen scattered throughout the cytoplasm.

Green Hydra

Hydra viridissima is the only European species that has zoochlorellae in its body.

It can move through the water but is usually found attached to some object in a pond by means of a disc at its base. There is a ring of 6 – 8 tentacles surrounding the mouth which lies at the top of the oral cone.

The vivid green colour is imparted to the hydra entirely by the algal cells, the zoochlorellae, living within it.

Rotifers

Rotifers are delightful little many-celled animals with complex and highly organized bodies. They are truly ubiquitous, and are fascinating to watch and study.

Pterodina, also called Testudinella

Notice the very translucent lorica, compressed and almost round in outline. The head bears the corona, or wheel organ, which is highly ciliated to enable it to move and feed. Clearly seen is the mastax – a pair of jaws which grind up food particles.

Brachionus

The lorica usually has 6 spines at the anterior end. The foot is long, very mobile and annulated. It has 2 toes at the end. This example illustrates its ability to get rid of undigested food.

Rotifer citrinus

This sequence shows the distinctive pair of red eyes located in the retractable proboscis which is in the centre of the corona.

Water Current

This sequence demonstrates the strength of the current of water generated by the corona.

Keratella

This rotifer has 6 anterior spines plus a dorsal surface clearly divided into polygonal facets with a characteristic dotted appearance.

Another Rotifer

This is included to show that each corona creates its own circular current, outside of which the water is stationary.

The 7 Characteristics of Living Organisms

Feeding

Here is Pterodina going to some food and *apparently* licking or testing it first!

Respiration

For aerobic respiration oxygen has to be absorbed into the body. This mayfly larva with 4 pairs of double gills appears to be facilitating this, though in fact what these gills do is to create a current of water over the surface of the body which itself absorbs the oxygen.

Excretion

This is the process of eliminating the waste products of metabolism from the cell or body. In many protozoa the contractile vacuole serves this function. It receives and then expels waste gases dissolved in the water.
Not visible here is the re-sealing of the pore at the end of each expulsion.

Growth

Most animals increase in size in the early part of their life. This is demonstrated here by the crustacean Cyclops with two early stages before the egg-bearing adult.

Movement

Here are 2 examples of the ability of protozoans to move apparently effortlessly through water. They have control over the long proboscis which is used for feeding. In the first case, Dileptus, the proboscis sweeps food particles towards the mouth which is at its base. In the second case, Lachrymaria, the mouth is at the distal end of the flexible 'neck'.

Reproduction

First a rotifer is seen with a young one inside its lorica. This has developed from an egg. Look for the smaller mastax and eyespots of the juvenile rotifer. Rotifers are usually females, males being small, short-lived and scarce!

Next is a Daphnia species which uses antennae for swimming. Daphnia frequently have a large number of eggs in a dorsal brood pouch.

Irritability

This is the ability to respond to a stimulus, seen here in the peritrich Carchesium. Peritrichs are protozoa with a wide 'mouth' surrounded by cilia. Carchesium is colonial, many being found together. Notice on the screen the left hand bell-shaped individual suddenly retracting on its stalk in response to some stimulus.

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