



TEACHER'S GUIDE

Tardigrades in Antarctica and in your School

Aims:

These teaching materials are intended to show how tardigrades can be isolated and examined easily in the school laboratory. (They provide an engaging and interesting variation on the usual use of school microscopes, such as cheek cell and onion epidermal examinations).

They will explain the features that make tardigrades so unusual and capable of surviving in the extreme Antarctic environment.

They will provide activities, links and information for further study.

Worksheets 1 & 2 – Protocols for isolating and examining Tardigrades in the laboratory

NOTES:

- There are two methods given. The second is likely to be more effective for finding nematodes in the sample. Comparing the two methods is also possible and could yield interesting discussion on the significance of the method used.
- Give yourself 24 hrs to set up the samples in advance whenever possible.
- Many old walls, roofs, trees, damp lawns etc. can provide suitable samples and ideally children should be encouraged to bring their own samples from a variety of sites.

Worksheet 2 – What is a Tardigrade?

A simple short information sheet about tardigrades.

Worksheet 3 – Indestructible Tardigrades.

A task based on their unusual properties.

Worksheet 4 – New Discoveries in Antarctica

Includes a simple task relating our discoveries to ecosystems.



ISOLATING TARDIGRADES IN THE LABORATORY - *Method 1*

Apparatus:

A small handful of moss (gathered from a wall, roof or other suitable site), beaker (e.g. 250 ml or smaller), deionised/distilled water, dissecting microscope and/or hand lens, Petri dish, standard lab microscope (with X4 and X10 objectives), fine glass pipette, glass slides and cover slips (slides with a drop well are ideal but not absolutely essential).

Method:

1. Soak a handful of moss overnight in just enough deionised water to cover the sample. Pour away excess water.
2. Squeeze the wet moss sample firmly into an old Petri dish or other suitable container.
3. In good light, use a dissecting microscope or hand lens to carefully examine the water. (A white tile placed under the sample can sometimes be helpful, as can the use of a desk lamp).
4. Tardigrades (also called “moss piglets” or “water bears”) are very easy to identify as they have four pairs of small clawed feet and are likely to be moving around actively.
5. Small Petri-dishes can be placed directly under the microscope. Alternatively, for a closer look, remove any interesting object in a drop of water using the pipette. Place it on a glass slide with a well and lower a cover slip over it.
6. Examine at X40 (i.e. with the X4 objective).
7. For a closer look use the X10 objective (but be aware that an active tardigrade is likely to disappear rapidly from view at this magnification).
8. Try drawing what you see with a sharp pencil. Tardigrades can usually be identified by the structure of their mouthparts, the hard exoskeleton and the position and claws of their eight legs.
9. Use a key or the identification sheet to try to identify any creatures that you find. (Other creatures that you might find include Rotifers, Nematodes and Mites).

Record your findings:

- Record each individual different organism you find.
- Record how many of each type you find.
- Identify each type as far as you are able.
- Compare what you have found with other members of the class.

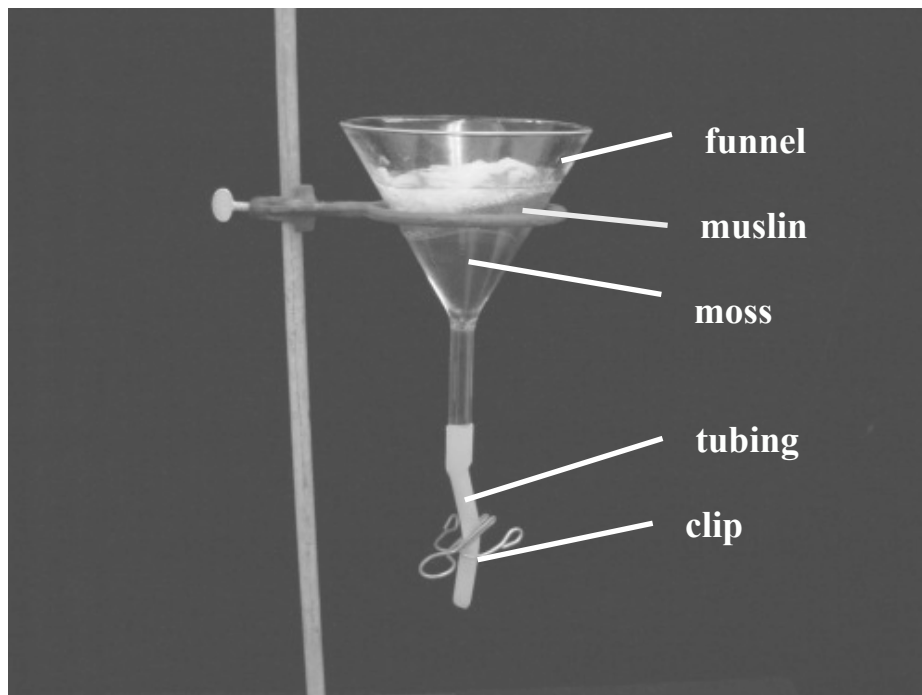


ISOLATING TARDIGRADES IN THE LABORATORY - *Method 2*

Apparatus:

Baermann funnel. (See picture)

A small handful of moss (gathered from a wall, roof or other suitable site), deionised/ distilled water, dissecting microscope and/or hand lens, Petri dish, standard lab microscope (with X4 and X10 objectives), fine glass pipette, glass slides and cover slips (slides with a drop well are ideal but not absolutely essential).



Method:

1. Set up the wet funnel as shown. Leave overnight. The organisms in the sample should make their way down into the tubing.
2. Open the clip to run the water into the Petri dish (or other suitable container).
3. In good light, use a dissecting microscope or hand lens to carefully examine the water. (A white tile placed under the sample can be helpful, as can the use of a desk lamp).
4. Tardigrades (also called “moss piglets” or “water bears”) are very easy to identify as they have four pairs of small clawed feet and are likely to be moving around actively.
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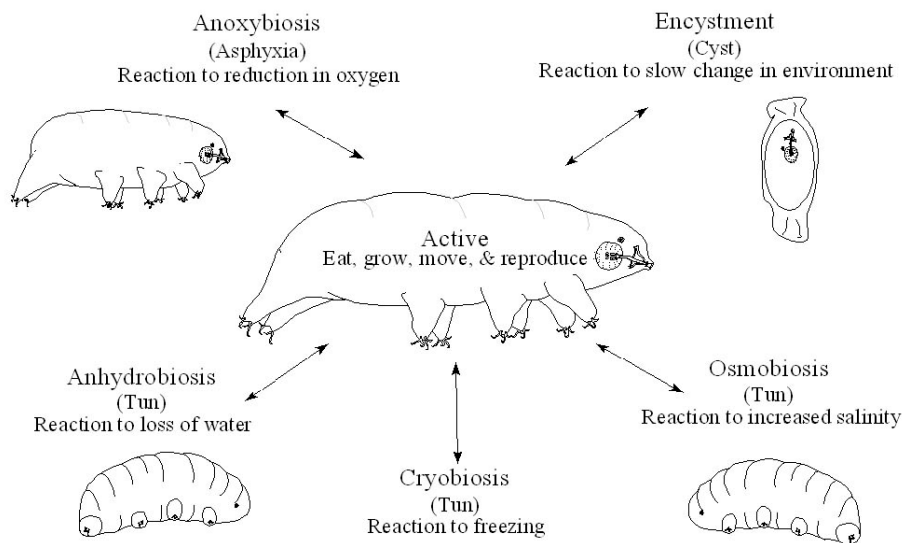
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WHAT IS A TARDIGRADE?

Tardigrades are microscopic water-dwelling segmented animals belonging to their own superphylum of Ecdysozoa. They are a bit like tiny arthropods. They have biting mouthparts with which they feed on plant material or bacteria or (in one example) on smaller tardigrades. They are very distinctive in appearance with a barrel-shaped body and four pairs of stubby legs with clawed feet with which they can move around actively. This has given rise to their common names of “Water Bears” or “Moss Piglets”. They are only between 0.3 and 0.5 mm long and so were only identified in the 1770s when microscopes were beginning to be more widely used. They have been found in virtually every terrestrial and aquatic environment on Earth.

In recent years their extraordinary durability and the discovery that they are one of the few creatures able to survive in the depths of the Polar regions have intrigued scientists. No one had looked for them in the Ellsworth mountains before the Fuchs Foundation expedition went there, although they were known in other parts of the Antarctic continent.





INDESTRUCTIBLE TARDIGRADES

(What makes tardigrades so unusual?)

When environmental conditions become harsh, tardigrades are able to shut down most physiological processes by extreme dehydration. They form a dried out structure called a “tun” and enter into a state called “cryptobiosis”. In this form tardigrades have been shown to possess the following extraordinary abilities:

- Anoxybiosis – The ability to survive without oxygen for many days.
- Low temperature – They have survived at minus 200 °C for over 20 months.
- Dehydration – They can lose more than 95% of their water content and still rehydrate successfully. Tardigrades have been identified as surviving in this state for more than 100 years
- High temperature – They have survived temperatures above 120 °C (well above that of boiling water!)
- High pressure – 1000 atmospheres pressure does not kill them.
- Radiation – They have survived apparently undamaged after exposure to ionising radiation 1000 times greater than that which would kill a human (and extreme levels of ultraviolet or X-rays).
- Vacuum – They can endure a vacuum so extreme that they would seem to be able to survive long periods in space.
- Environmental poisons – such as hydrogen sulfide, normally extremely toxic to living organisms, cause no damage.



This excellent site on the internet will tell you all about how to collect, identify and study tardigrades:

<http://pathfinderscience.net/tardigrades/index.cfm>

This site has lots of interesting and useful information too (including a rather sweet video!):

<http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmay99/dwbear.html>

There is lots of information in Wikipedia too:

<http://en.wikipedia.org/wiki/Tardigrade>

You may be able to find many other sources of information with a little searching.

YOUR TASK:

What are the extreme physical conditions that a tardigrade might have to endure in Antarctica? Discuss this with your laboratory partner. List these down the side of a page in your notes. (Leave two or three lines between each one)

For each of the conditions that you list, find the property above that would be useful to a tardigrade in Antarctica in surviving that particular problem. Write the “solution” to the problem alongside the environmental challenge you have identified.



NEW DISCOVERIES IN ANTARCTICA

Two of the four teachers who went to Antarctica in November and December of 2007 were Biologists. Amy Rogers was looking for Lichens; one of the few types of living thing able to survive in the harsh environment of the Ellsworth mountains. Ian Richardson was looking for lichens too, but he wanted to bring samples back as material to examine for creatures like tardigrades (and anything else that might be present).

In the end, with help from scientists at the British Antarctic Survey, we identified at least twelve varieties of lichen. Some of these were very colourful. *Xanthoria elegans*, for example, is a vivid brick red/orange and *Candelariella flava* is a bright, almost fluorescent, yellow. Most are a dark grey or black, like *Pseudephebe minuscula*. Does your knowledge of Physics help you understand why many of these Antarctic lichens are black or grey?



Pseudophebe minuscula



Xanthoria elegans



Candelariella flava

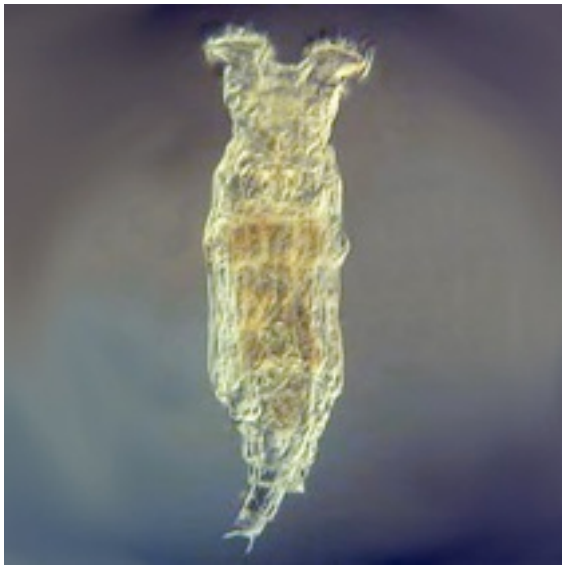


We also found three distinct types of animal living in the lichens. These were:

Bdelloid Rotifer (this would feed on tiny algae and bacteria)

Echiniscid tardigrade (this would feed on the lichens)

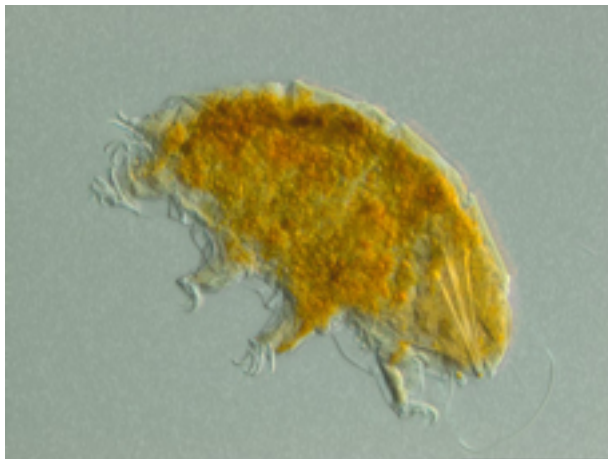
A big predatory *Milnesium* tardigrade (this would feed on the other two!)



Bdelloid rotifer sp.



Milnesium sp.



Echiniscus sp.

Can you construct an ecosystem from these simple members?