

Quick guide

Tardigrades

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Tardi-what? Tardigrades, also known as water bears, are a little-studied phylum of animals. First discovered 230 years ago, there are at least 700 different species living on land, in fresh water and in the sea. The tardigrades represent a successful group of animals — in flourishing existence after about 600 million years of evolution — that could hold keys to the patterns and mechanisms by which animal body plans evolve.

What do they look like?

Tardigrades look like chubby, microscopic bears. Many species are transparent, and they are tiny — about a quarter to a half of a millimeter long. Under a microscope, a tardigrade looks a lot like a *Caenorhabditis elegans* in which someone has deviously expressed *Drosophila* leg genes, as they have a simple body plan and a pharynx that resembles a *C. elegans* pharynx, but they have four pairs of legs.

Where would I find one? Pick up a piece of moss and rinse it in some bottled water in a petri dish (soak the moss for a few hours if it's dry). Remove the moss and you can often find tardigrades in the water using a dissecting scope. They are also common in beach sediments.

Who cares about them? Almost everyone who has ever seen one, as their clumsy crawling is about as adorable as can be. Search for 'tardigrade' on the web and you'll find a peculiar culture of amateur microscopists who appear to be obsessed with tardigrades. In the 1960s, tardigrades were briefly in line to be groomed as biology's next big stars: when Sydney Brenner was looking for a new model organism for applying genetics to study development and neurobiology, he stopped briefly at tardigrades, but decided



Figure 1: Scanning electron micrograph of a tardigrade, by Diane Nelson.

they had too many neurons, before moving on to nematodes and eventually choosing the then little-known *C. elegans*.

What are they famous for?

Terrestrial tardigrades have been studied for their fascinating ability to perform cryptobiosis: a dried-up tardigrade — known as a tun — can survive for years without water, and can be spread around the world by the wind. The tun is resistant to extreme pressures, high temperatures and freezing. On re-exposure to water, the tardigrade rehydrates and comes back to life — a process that takes only a few minutes. They are common components of the moss faunas of the Arctic, where their abilities to be freeze-dried, deep frozen and resurrected make them suited to life in the brief polar summers.

What are they related to? Their position in the tree of life has been debated for many years, but recently a consensus has emerged that tardigrades are part of a great group of molting animals that includes *C. elegans* and *Drosophila*. This phylogenetic position is, of course, ideal for studying how development evolves, as one can take advantage of the vast amount of developmental information in both *C. elegans* and *Drosophila*.

What's known about how they develop? Very little is known about their development, in fact less than just about any other animal phylum. The three most important papers about tardigrade development were published between 1895 and 1929. These

studies give us some detail about what the embryos look like at various stages. For example, early cleavages appear to be complete, unlike *Drosophila*. There have been some recent transmission electron microscopy studies of embryos, but so far we have very little embryological information based on live embryos. This gap is currently being filled by generating a fate map and tracing cell lineages, and by working on methods, such as laser-ablation of specific cells, for studying how cell fates are specified (B. Goldstein, unpublished).

How about developmental genes?

Very little is known at the molecular level about tardigrades: sequences from only six genes have been deposited in GenBank, and most of these are housekeeping genes sequenced for phylogenetic studies. Molecular information will be vital to link developmental processes in tardigrades with those in flies and worms. Most of the Hox genes from a freshwater species were recently sequenced (A. Aboobaker and M. Blaxter, unpublished), and a program is underway to sample additional sequence.

Where can I find out more?

<http://www.nematodes.org/tardigrades.html>
Kinchin, IM: The Biology of Tardigrades.
Portland Press, London, 1994.

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