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Invertebrates

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The spineless majority

When most people think of animals, they think of things like mammals or birds, or maybe lizards, frogs, or fishes. All these familiar animals, along with humans, are part of a group called vertebrates or Vertebrata. The most prominent characteristic of vertebrates is a rigid, jointed skeleton inside the body (endoskeleton) with a central spine or backbone (the vertebral column). But the furry, feathery and scaly animals we are so familiar with represent only a tiny portion of animal diversity. The vast majority of animals are invertebrates, animals without backbones like bugs, worms, snails, corals, sponges and many other obscure squiggly and creepy crawly things. In fact, 95% of the 1.4 million known animal species are invertebrates, and among invertebrates, arthropods (insects, crustaceans, spiders and relatives) are by far the most diverse group with more than 1.2 million living species.

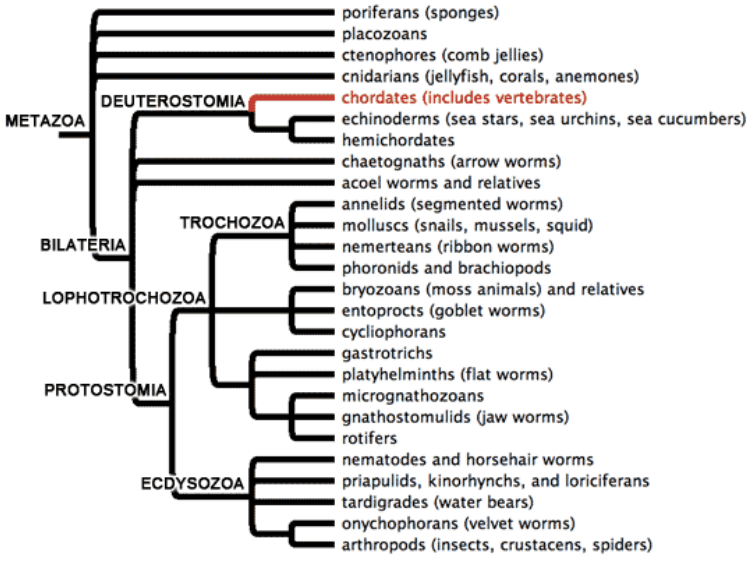
Why do most people know so little about invertebrates? It may be because most of them are relatively small. There are some really large invertebrates, like the colossal squid, which can weigh almost 500 kg (over 1000 lb), or the bootlace worm, which can be over 55 m (180 ft) long. But most invertebrates are small and some are so tiny that they are barely visible to the naked eye. Many invertebrates also live in

habitats that people don't see very often. For example under water in oceans, streams, and ponds, in the soil, in the canopies of trees, or as parasites inside other animals.

We are all invertebrates

Most biologists will tell you that invertebrates are an artificial group because vertebrates arose from invertebrate ancestors. This means that vertebrates are really just a very special group of invertebrates. Due to the bony skeleton and the fancy nervous system it can support, some of the largest, smartest, and most conspicuous animals have evolved in the vertebrate lineage. Vertebrates have conquered land, water, and air, and dominate the tops of many food chains; yet from an evolutionary perspective vertebrates are a fairly small twig on the animal tree of life, not even deemed worthy of their own phylum by most biologists.

The relationships among major groups of animals are the subject of lively scientific debates. Thanks to modern molecular phylogenetic analyses, our understanding of the animal tree of life has undergone a major shift over the last 20 years. Before they could analyze the genetic material of animals, biologists had to base their hypotheses of relationships solely on similarities in the body plans and developmental patterns of animals. This was a very difficult task, because most animal phyla arose in the very distant past, during the Cambrian radiation, more than 500 million years ago. Much evolution has happened since, modifying anatomy and developmental processes in diverging animal lineages, and obscuring characteristics shared among related groups. This is true particularly in animals that have taken up very specialized ways of life, like internal parasites which often experience a reduction or loss of major organ systems over time. While molecular genetic studies are also hampered by long periods of evolutionary divergence, they provide large amounts of data that can be subjected to advanced analyses taking into account patterns of molecular evolution. By using evidence from both genes and morphological forms, modern phylogenetics (the study of evolutionary relationships among organisms) slowly reveals the structure of the animal tree of life.



Relationships between the major groups of animals based on molecular and morphological data. Some of these relationships remain controversial, and the exact position of many animal lineages is still uncertain.

Although our understanding of animal relationships is not complete, we know that the closest relatives of vertebrates are marine invertebrates. Together with vertebrates, cephalochordates (lancelets) and tunicates (sea squirts and relatives) make up the phylum Chordata. Echinoderms (starfish, sea urchins and relatives) and hemichordates (acorn worms and pterobranchs) are united with chordates in the superphylum Deuterostomia. Several other predominantly marine groups have been placed in the Deuterostomia, for example, lophophorates (phoronids, brachiopods, and bryozoans), chaetognaths (arrow worms), and most recently Xenoturbellida. But most biologists now think that the lophophorates belong to the Protostomia, the sister group of the Deuterostomia, and chaetognaths may also be more closely related to protostomes. The relationships of xenoturbellids are still uncertain, but recent evidence links them to acoel worms.

The Protostomia are a large group that includes many marine, worm-like animals, as well as parasites and highly diverse, complex groups like mollusks (snails, mussels, squid and relatives) and arthropods (insects, crustaceans, spiders and relatives). Within protostomes, genetic data indicate two major subgroups, the Ecdysozoa (arthropods, nematodes and relatives) and the Lophotrochozoa, also sometimes called Spiralia (mollusks, annelids, platyhelminths and relatives). Within the Lophotrochozoa a core trochozoan group (mollusks, annelids, nemerteans, phoronids, and brachiopods) is well supported, but the relationships among the remaining phyla are still debated. Orthonectids and rhombozoans, enigmatic parasites of marine invertebrates may also be lophotrochozoans, but this hypothesis is not yet well supported.

Protostomia and Deuterostomia are the major subgroups of Bilateria (bilaterally symmetrical animals). Most multicellular animals (Metazoa) are bilaterians, but there are four predominantly marine groups that diverged at the base of the metazoan tree: cnidarians (jellyfish, corals, sea anemones and their kin), ctenophores (comb jellies), placozoans (very simple, marine animals), and poriferans (sponges). The relationships among these lineages and Bilateria have proven to be difficult to resolve. Sponges, placozoans, and comb jellies have at times been touted as “the first animals,” but which of these groups most closely resembles the ancestor of multicellular animals is not yet known.

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