

Roly-Poly Lifestyles

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Although you may think that you don't know what isopods are, in fact you've probably crossed paths with them on many occasions. You may know the terrestrial isopods by other names; what people call sow bugs, pill bugs, roly-polies, or, in the British Isles, woodlice, are all isopods. These lower-profile relatives of crabs, lobsters, shrimp, and other crustaceans inhabit deserts, forests, caves, grasslands, greenhouses, city sidewalks, and even your backyard. You can find them in nearly every environment on earth. Marine species live in brackish water and in oceans at depths ranging from the intertidal to the deep sea. Freshwater isopods live in streams, lakes, wells, hot springs, and subterranean groundwaters. The list of species currently numbers more than 10,400

and continues to grow as scientists discover new ones.

Like other crustaceans, isopods possess two pairs of antennae, mandibles, three body parts (head, thorax, and abdomen), and compound eyes. Yet, they are distinguished from their relatives by their unstalked, or sessile, eyes and their seven pairs of legs; most other crustaceans have five pairs of legs (although adult isopods in the advanced family Gnathiidae have only five leg pairs). The seven leg pairs of isopods are similar in structure and function, and it's this similarity that gives rise to the name of the class—*iso* meaning "same or equal" and *poda*, "foot."

An isopod starts life as an egg in a mass carried in the brood pouch on the underside of the female's abdomen.



The marine isopod *Cirolana kokoru* is a carnivorous scavenger of intertidal rocky shores in New Zealand. Photograph courtesy Niel L. Bruce, © NIWA.



Living in conditions about as far removed from oceans as any isopod gets, the social-living desert wood louse (*Hemilepistus reaumuri*) excavates burrows up to a foot (thirty centimeters) deep to survive aridity. Photographed in Algeria by Edward S. Ross.

Here the immature forms of most groups undergo direct development. Because they do not go through a larval stage, they emerge looking like miniature adults. In some marine forms, there is parental care after hatching. Parents (primarily mothers) guard the newly hatched young and seek out the protection of sponges or the holdfasts of kelp where they make burrows, raise a brood, and fight off intruders. Parental care is not restricted to aquatic forms; the desert isopod *Hemilepistus* creates a single-family burrow in the sand to house its offspring.

Not all guarding behavior is necessarily parental in nature. In several species of the brackish-water genus *Iais*, it is common to find an adult male carrying an immature female beneath his abdomen by clasping her with his modified legs. But this is not parental care—it's mate guarding. The male is keeping this young female to himself until she

matures to reproductive age and is ready to be mated.

The fossil record shows that isopods existed 325 million years ago in the Paleozoic era. Modern species in the suborder Phreatoicida appear to be largely unchanged since that time and likely represent an early offshoot from the original ancestral line. Phreatoicids, familiarly known by the affectionate scientific mispronunciation "frier tucks," were once marine but are found now only in freshwater refugia in Australia, Tasmania, and South Africa. Isopods are thought to have originated in shallow marine waters and subsequently to have radiated into the deep sea, and then to have colonized land as the only truly air-breathing crustaceans. The suborder Oniscida contains all of the terrestrial isopods that can exist independent of bodies of water; they are able to do so because they can breathe air through leaf-like appendages on their abdomens.



The common pill bug (*Armadillidium vulgare*) is a regular inhabitant of gardens across Europe and North America. When disturbed it rolls into a tight ball for protection. Photographed in California by Edward S. Ross.

Wherever they are found, isopods lead lives similar to those of their more distant relatives, the insects. The more primitive aquatic and terrestrial groups tend to be plant-feeders or scavengers on plant matter. The advanced suborders whose members live mainly in marine environments include omnivores, carnivores, predators, commensals, and highly modified parasitic forms. It has even been suggested (though not proven) that some isopods may serve as pollinators, spreading the pollen of seagrasses as they crawl over the plants.

Marine species show the greatest diversity in morphology and size. The smallest are the parasitic forms, as small as a fiftieth of an inch (half a millimeter) in length. One whole suborder, the Microcerberidea, contains only tiny marine species, approximately a sixteenth of an inch (a millimeter and a half) long, that live between grains of sand or in sediment. In contrast, species of

Bathynomus of deep Caribbean waters can reach a length of nearly twenty inches (half a meter). *Bathynomus* is a predator and has been observed attacking and eating fish when hauled up together with them in fishing nets.

Marine isopod families are found in all latitudes of the world's oceans and are adapted for living in sponges, on algae, inside seagrasses, on coral reefs, in mangrove roots, in coral rubble, and in sediment. Species in the family Cymothoidae are ectoparasitic and live externally on or in the mouths or gill chambers of fish. The suborder Epicaridea are the most highly modified group and are exclusively parasites of other crustaceans, including other isopods.

In the family Bopyridae, the female is grossly inflated and distorted, with greatly reduced appendages; the male is tiny in comparison and clings to the underside of the female's body. These types are host-specific and live on the

surfaces or in the branchial chambers of crabs, hermit crabs, and shrimp. When the larva-like forms emerge, they attach to an intermediate host. After molting they seek out an appropriate host. The first larva to arrive on the host develops into a female, which is then able to hormonally control the development of the second larva to arrive so that it becomes a male. Other smaller epicarideans are internal parasites, like the superfamily Cryptoniscinae, in which the female is reduced to a sac, generally without appendages. These feed on the blood of their hosts, which are marine crustaceans such as ostracods, barnacles, cumaceans, and amphipods.

The Mediterranean region, and the Balkan Peninsula in particular, is the epicenter of terrestrial isopod diversity. Because a number of dedicated European specialists have collected and classified animals in this area over the past 150 years, its “hotspot” status may be real or partly an artifact of collecting effort. Still, new species continue to be described in this region. This is not the case for North America, however. So far, only about 115 different terrestrial isopods (oniscideans) have been found in the United States (excluding Hawaii) and Canada. This could be due to lack of specialists, absence of collecting effort, paucity of fauna, or maybe all three. About two-thirds of this number are considered native to North America and are usually found in caves or on seashores. Many of the most common oniscideans in the United States (including our backyard pill bugs) are widely distributed and have probably been introduced from Europe. A majority of these introduced species are concentrated in the northeast and northwest

states, possibly a result of the transport of their ancestors into harbors by human immigrants.

Freshwater isopods include several families, some of which are very restricted in their distribution. One suborder distinguished by its unique segmentation was first found in wells in northern Venezuela. These blind animals, isolated for millennia from other isopods, display very unusual morphology, characterized by reduced first and second abdominal segments as well as a completely fused posterior appendage. They are, in fact, so different from other isopods that systematics placed them by themselves in a new suborder, Calabozoida. Another isolated species, a freshwater cave species discovered in eastern Brazil in 1998, also belongs to this unusual suborder.

Endemism, or restriction in distribution to one particular locality, is extremely high in isopods that live in hot springs in the southern United States



Known as a rock louse or sea slater, *Ligyda occidentalis* is the only marine isopod regularly found above the high-tide line on rocky shores in California. This is an inhospitable zone, heavily influenced by wave splash and salt spray. Photograph by Edward S. Ross.

and Mexico. Each spring or well may contain just one species, which may be found nowhere else in the world. The ancestors of these isopods likely were marine and lived in the embayment that covered most of Mexico and parts of Texas and New Mexico during the Mesozoic era. As the waters receded during the Cretaceous period, the climate became drier. Stranded, they may have adapted to freshwater environments and later some adapted even to the inimical conditions of hot springs.

Although some isopods can paddle around briefly and a few can tread the water columns of the ocean by means of very long appendages, isopods are

generally bottom-dwellers that move by crawling. Therefore, the ranges of aquatic species tend to be restricted, although there are cosmopolitan marine types such as *Idotea* that can float around on rafts of seaweed. Others have been found in places far from their origins, possibly because they were transported in the ballast water of oceangoing ships.

This lack of mobility can, due to loss of habitat or pollution, lead to endangered or threatened status for some species. Worldwide, there are forty-two isopods on the IUCN Red List of Threatened Species, up from twenty-seven in 1988. Eight of these are listed as endangered, and seven are designated as crit-



Listed as threatened under the Endangered Species Act, the Madison Cave isopod (*Antrolana lira*) is restricted to deep lakes in a single cave in Virginia. Photograph © 1993 by Susan Middleton and David Liittschwager.

ically endangered. In the United States there are eight Red List species; six are freshwater cave isopods from Virginia, Kentucky, Oklahoma, and Tennessee, and two are found only in hot springs in Texas and New Mexico.

The last of these is the Socorro isopod (*Thermosphaeroma thermophilum*). Also protected as endangered under the Endangered Species Act, this isopod is a modern conservation success story. Because of habitat destruction, it went extinct in the wild, but a captive population at the University of New Mexico enabled scientists to restock the one thermal spring in which it had lived, located in Socorro County, New Mexico. In 1989 the state received a federal grant to develop a recovery plan and build a permanent habitat, where the isopod is a local attraction and enjoys some protection. Still, as habitats shrink and pollution expands, other species will be lost to science before they are discovered.

A few isopods affect humans in a negative way. For centuries humans have placed wooden pilings in water to build wharves, docks, and even platforms for cities. Such isopods as *Limnoria tripunctata* (also known as gribbles) have been chewing on wood for much longer. Shipworms and gribbles are the main reasons why pilings must be treated with creosote. These isopods are significant pests in places such as Venice, Italy, where they have contributed to the instability of the city's foundation.

Why are isopods worthy of our attention or even our acknowledgment? Oblivious to human beings, the isopods under the garbage can or in the woodpile (just like their relatives in the sea) are busily engaged night and day in the immense job of recycling nutrients and



A female sow bug produces eggs that she carries in a pouch beneath her body until they hatch. After hatching, the young sow bugs may remain in the pouch for several weeks before gaining their independence. Sow bug and young, photographed in Tunisia by Edward S. Ross.

carbon compounds. They feed on plant and animal matter, breaking down detritus and organic material, returning nutrients to the soil or substrate, becoming food of larger animals in the process. Completely beneath our usual awareness, they instinctively carry on the myriad actions and interactions that help maintain the web of all life.

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