

The deep sea

The deep sea (below 1km) is by far the largest ecosystem on our planet and yet amongst the least well known. About two thirds of the earth's surface is covered by the marine environment, of which 90 per cent is deep sea. Despite this, mostly owing to its remoteness, less than a soccer-field sized area has been studied in sufficient detail to reveal the mostly small organisms inhabiting it.

The absence of sunlight entails the lack of plants and algae which elsewhere form the foundation of life. So in order to maintain their metabolism deep-sea organisms have to rely on other sources of energy. These stem from inhabitants of the narrow photic zone near the sea surface eventually falling to the deep-seafloor, from tiny single-celled algae and plankton fecal pellets to whole whale carcasses.

Not all life there is dependent on the fall of material from the surface though. A specialized deep-sea community completely independent of light was discovered in 1974 near submarine hot springs, the so-called hydrothermal vents. In such communities chemosynthetic micro-organisms are the primary producers by oxidizing sulphuric compounds. The giant worm *Riftia pachyptila* has reduced its digestive tract and relies on symbiotic chemosynthetic bacteria stored in its body instead that make up for half of the worm's weight.

In comparison to other marine habitats, one of the defining characteristics of the deep sea, however, is the scarcity of nutrients, and hence the biomass of animals per recorded area is typically low.

Of the larger animals, sea cucumbers and brittle stars are particularly numerous and speciose. Also of note are the giant scavenging *Eurythenes* and *Alicella* amphipods growing to more than 14cm. These are attracted by the odour of bait in spectacularly large numbers. The majority of animal species, however, are significantly smaller than their relatives in shallower water and can only be retained by sieves with meshes of 1mm (macrofauna) and 0.06mm or smaller (meiofauna).

The single largest source of the deep-sea water masses is the Southern Ocean around Antarctica where cold and saline surface waters begin to sink due to its high density. The descent of the Antarctic bottom water (AABW) into the deep sea and equivalent waters from the Arctic is part of a global hydrodynamic circulatory pattern (conveyor belt) and is the primary reason why the deep sea, except in enclosed basins such as the Mediterranean and the Red Sea, is cold (1-4°C) and well oxygenated.

This continuity of water masses between the Antarctic shelf and the deep sea is closely mirrored by faunal distribution patterns. While the deep-sea fauna is composed rather differently compared to shallow waters at lower latitudes, this distinctness fades at high latitudes. Around Antarctica typical deep-sea taxa are found colonizing shallow waters on the continental shelf (polar emergence) as well as shelf species descending into the deep sea (polar submergence). This faunal exchange is further facilitated by the fact that the continental shelf around Antarctica is at a much greater depth (500m) than elsewhere (200m) due to the enormous weight of the ice shield on the continent.

The unexpectedly high biological diversity in the deep sea continues to be debated because it is difficult to understand how so many species could evolve and can co-exist today in a habitat that appears rather homogenous. Although records of benthic storms, submarine tides and debris flows help overcome the idea of physical stability of the environment, the few ecological studies carried out so far have failed to demonstrate the degree of specialization that would traditionally be associated with the co-existence of so many species.

The number of species in the Antarctic deep sea is of importance for answering the question whether there are indeed fewer species living in polar than in tropic latitudes and if so, what processes might be responsible. This trend is well established for terrestrial habitats but is far less evident or even absent for the marine realm especially on the Southern hemisphere.

Although hydrostatic pressure is not *per se* stressful for organisms permanently living in the deep-sea, it requires physiological adaptations because the equilibria of biochemical reactions may be shifted, sometimes dramatically, compared with shallower depths when the catalysed reaction involves changes of volume of the reagents.

Experimental deep-sea mining for ferromanganese nodules has been carried out but is in its infancy still. It is currently under investigation if the disposal of carbon dioxide in deep-sea sediments on an industrial scale can lessen the effect of global warming, but concern about the environmental consequences exists. Disposal of used equipment and waste into the deep sea is a reality, although subject to debate (Brent Spar). To date, the Antarctic part of the deep sea south of 60 degrees South latitude is environmentally protected since 1959 under

the Antarctic Treaty as "...a natural reserve, dedicated to peace and science".

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Further reading and references:

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