THE RICHES OF THE SEAS

8

THE SEAS ARE FULL OF LIFE, BUT THE DIVERSITY OF MARINE ORGANISMS IS CHANGING BECAUSE OF HUMAN ACTIONS AND GLOBAL ENVIRONMENTAL CHANGE

Caroline Hattam, Plymouth Marine Laboratory

Did you know that life began in the ocean some 3.5 billion years ago? And did you know that scientists estimate that there may be up to 10 million species living within the seas?

The marine environment is home to a stunning variety of beautiful creatures, ranging from single-celled organisms to the biggest animal ever to have lived on the Earth – the blue whale.

This chapter describes the multitude of life found in the seas, the uses we make of it and how marine life is changing because of this use and because of global environmental change.

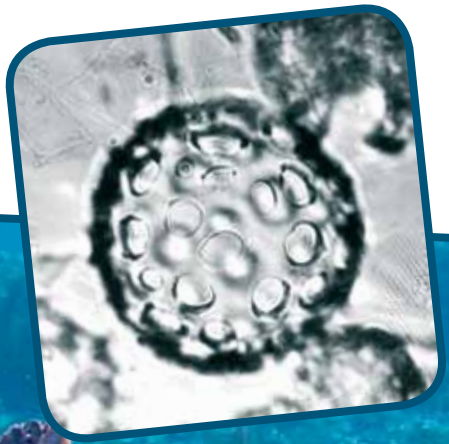
GALÁPAPOS CRAB.

THE UNDERSIDE OF A HORNED STARFISH, STARFISH ISLAND, PALAWAN, PHILIPPINES.
© Vince Ellison B. Leyeza (age 12)

EASTERN SPINNER DOLPHINS IN THE EASTERN TROPICAL PACIFIC.
© William High/NOAA Fisheries

MICROSCOPIC ORGANISMS (RADIOLARIA) UNDER POLARISED LIGHT. THESE FOSSILS WERE FOUND IN BARBADOS.
© Biosphoto/Gautier Christian

A GREEN TURTLE IN HAWAII, USA.
© Mila Zinkkova/Wikimedia Commons



MARINE LIFE

We know much less about marine biodiversity than we do about terrestrial biodiversity, but we do know a few interesting facts:

- There are 35 animal phyla (groups of animals such as arthropods and molluscs) found in the seas, 14 of which are only found in the sea.
- The marine environment is home to both the largest mammal on the Earth (the blue whale) and the biggest invertebrate (the colossal squid).
- The largest marine mammals are often dependent on the smallest marine life for food. For example, blue whales feed on krill. Krill are small animals that weigh about one gram each, and a blue whale needs to eat about 3.6 million of them every day!
- The fastest animal in the sea is the sailfish which can reach speeds of 100 km/h (imagine someone swimming at the same speed as your car the next time you are on the highway).
- The oldest known living marine creature is a deep water black coral found off the coast of Hawaii and is estimated to be over 4 000 years old!

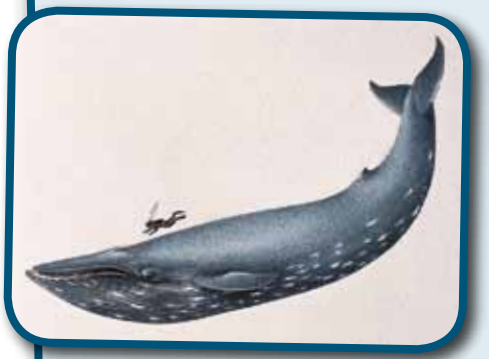
BLUE PARROTFISH

GIANTS OF THE DEEP

The marine environment is home to a number of giant animals, for example:

:: The **blue whale** is known to grow to over 30 m and can weigh as much as 181 tonnes (the same as almost 20 cars)!
:: **Giant clams** can grow to over a metre in size and may live for over 100 years.
:: The **colossal squid** is even bigger than the giant squid. Colossal squids weigh about the same as a small cow (about 500 kg) and can measure over 10 m.
:: **Giant isopods**, distant relatives of garden woodlice (also known as pill bugs), can grow to over 30 cm in length.

Many of these giant creatures grow very slowly and take many years to mature and produce offspring. This makes them very susceptible to human activities and environmental change as they are slow to adapt.



BLUE WHALE AND A SCUBA DIVER.
© brianlean.wordpress/www.flickr.com

GIANT CLAM.
© Ewa Barska/Wikimedia Commons

GIANT DEEP SEA ISOPOD IN TE PAPA MUSEUM, NEW ZEALAND.
© Y23/Wikimedia Commons

COLOSSAL SQUID, GULF OF MEXICO.
© NOAA

MARINE HABITATS

Coastal areas are very productive and support large numbers of marine organisms. The number of marine organisms is often greatest in relatively shallow coastal areas because they are rich in nutrients and light. Many of these nutrients, which are food for marine life, come from the land. Some coastal areas are extremely diverse, for example coral reefs (see box: "Coral Reefs").

CORAL REEFS

Coral reefs are one of the most diverse ecosystems on the planet, containing very high numbers of marine species. Scientists have so far described 4 000 reef fish and 800 coral species. Coral reefs are also important for people and they provide income, food and a **livelihood** for more than 500 million people, mostly in developing countries. Corals are very sensitive to changes in sea temperature and there are fears that global warming will cause the death of many coral reefs.

GREAT BARRIER REEF, AUSTRALIA.

THE OPEN OCEAN CONTAINS SMALL POPULATIONS OF VERY MANY DIFFERENT SPECIES

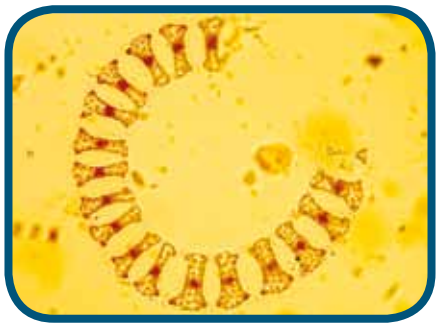
The open ocean has few nutrients available, so despite its enormous size, it is not home to dense populations of organisms, but the diversity of these organisms is very high. Here you find trillions of small single cell organisms known as phytoplankton (e.g. diatoms, dinoflagellates and coccolithophores) and larger zooplankton (e.g. copeopods and foraminifera). You also find many kinds of fish and whales.

Only a very small amount of light passes below 100 to 200 m, and no light reaches beyond 500 to 1000 m. This environment far below the surface is very stable, cold and dark. Many of the organisms that live in this part of the ocean have evolved special adaptations that help them to survive in this environment. For example, some organisms swim up to the upper zones of the oceans to feed at night. Others have developed special body parts called **photophores** which are bioluminescent (they produce light). Some fish have developed enormous mouths with very sharp teeth and their jaws can be unhinged to catch big prey.

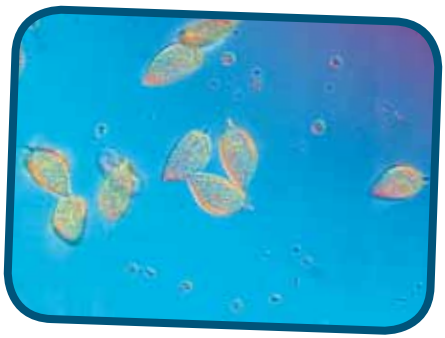
THE SEA BED PROVIDES AN IMPORTANT HABITAT FOR MARINE LIFE

We know much more about the creatures that live on the sea bed than we do about some of those that live in the water, mostly because the bottom-dwellers don't move very quickly and are easier to catch! In shallow, light areas, it is possible to find marine plants (e.g. seagrasses) and algae (or seaweeds) which look like plants but actually are not very closely related. In and on the seabed you can also find starfish, sea urchins, polychaete worms, sea cucumbers, anemones, sponges, corals and shelled animals such as clams, mussels and scallops... the list is almost endless.

DIATOMS.



DIATOMS.



DINOFLAGELLATES.

COCCOLITHOPHORES.

COPEOPOD.

THE **DEEP SEA**

The deep sea is full of weird and wonderful life. It is not a flat, barren place but contains a number of **biodiversity hotspots**, areas of high species diversity and habitat richness, such as:

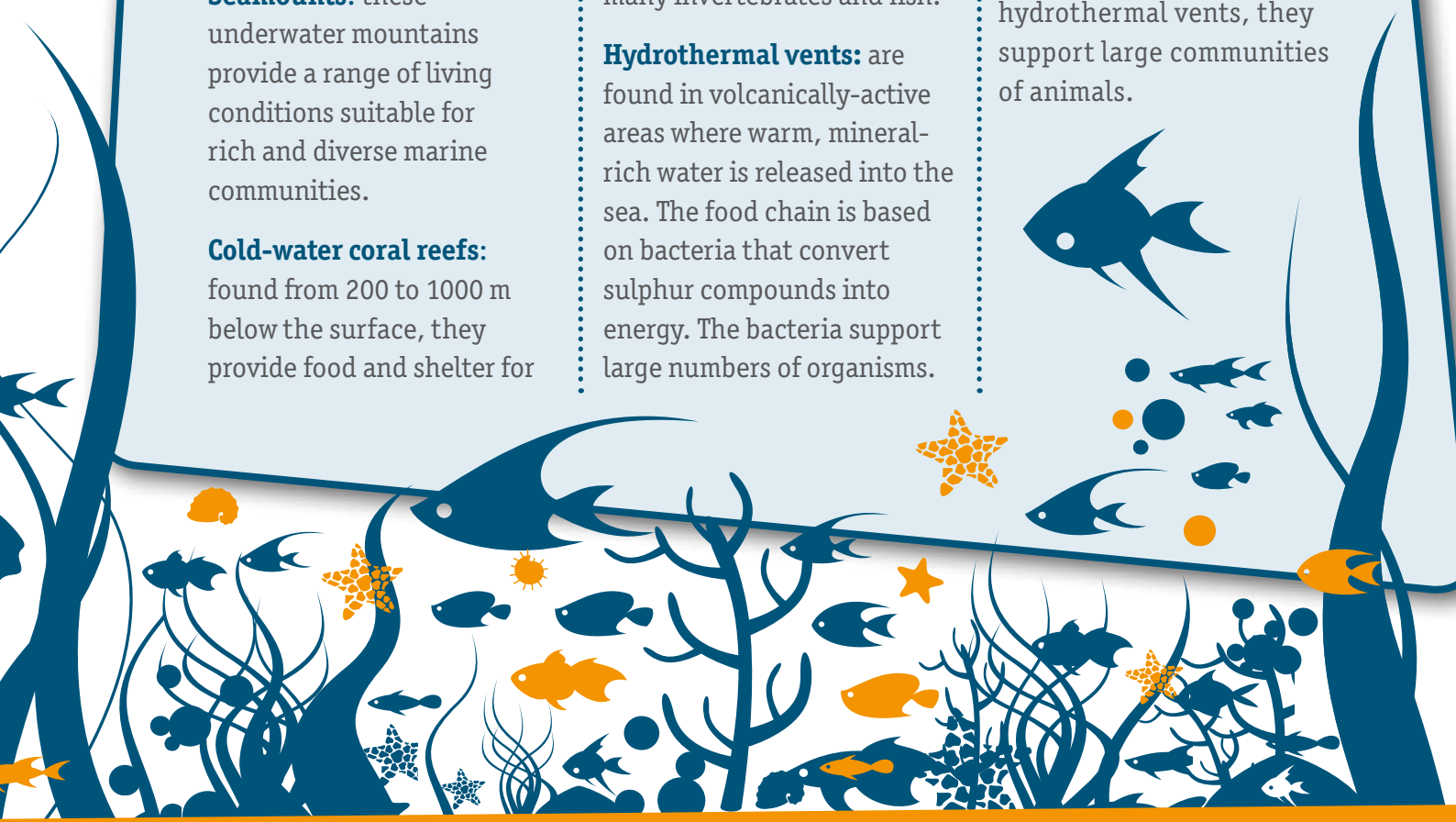
Seamounts: these underwater mountains provide a range of living conditions suitable for rich and diverse marine communities.

Cold-water coral reefs: found from 200 to 1000 m below the surface, they provide food and shelter for hundreds of different species, including commercially important fish.

Deep sea sponge fields: these are found in clear, nutrient-rich waters and provide a living space for many invertebrates and fish.

Hydrothermal vents: are found in volcanically-active areas where warm, mineral-rich water is released into the sea. The food chain is based on bacteria that convert sulphur compounds into energy. The bacteria support large numbers of organisms.

Gas hydrate vents and cold seeps: these are areas on the sea floor where hydrocarbons and mineral-rich cold water escape into the sea. The bacteria found here use methane to produce energy and, like hydrothermal vents, they support large communities of animals.



HOW WE USE MARINE BIODIVERSITY

Humans are dependent upon marine biodiversity in more ways than you think!

When you think of how we use marine life, you probably think of fish and shellfish for food. Although the oceans are important sources of food, they also provide many other important benefits, such as:

From left to right:
MANGROVES, GALAPAGOS.
© Reuben Sessa

COASTAL RECREATION, LYME REGIS, UK.
© S. Boyne

STUDENTS ON PRAPAS BEACH, THAILAND STUDYING TAXONOMY.
© PML

EXAMINING MICROSCOPIC MARINE ORGANISMS IN THE LAB.
© scalefreenetwork/www.flickr.com

FISHING TRAWLER SURROUNDED BY GREAT CRESTED TERNS.
© Marj Kibby/www.flickr.com

- **The balance of our climate:** some marine organisms (e.g. phytoplankton) take up carbon dioxide from the atmosphere. Others produce gases, such as dimethyl sulphide, which can help form clouds that reflect the sun's rays and cool the planet.
- **The breakdown and removal of waste and pollution:** bacteria in sea water can break down organic waste (e.g. sewage), some can even breakdown petrochemicals and have been used to help clean up oil spills. Larger marine animals eat organic and inorganic materials (e.g. metal compounds) and can bury them within the sea bed.

- **The reduction of damage from storms:** the presence of salt marshes, coral reefs, mangroves and even kelp forests and seagrass meadows can reduce the amount of energy in waves, making them less destructive when they reach the shore.
- **Recreation:** millions of people use the marine environment for recreation and many are drawn to it because they can see marine life (e.g. dolphins, whales, sea birds, seals and manatees). Coral reefs are also a popular tourist attraction and are estimated to generate US$ 9.6 billion worldwide for the tourism industry.
- **Learning experiences:** some schools and youth groups take young people on field trips to the beach to learn about marine life. Has your school taken you?

- **New medicines, biofuels and other products:** many pharmaceutical and biotechnology companies study marine life in the search for new compounds that may be useful for people. So far more than 12 000 potentially useful compounds have been found in marine organisms.
- **Our heritage and culture:** the sea and sea life appear in many folk tales, novels, poetry, songs and works of art. Can you think of any?
- **Our health and well-being:** many people find being near the sea to be relaxing and inspirational, and seeing marine life adds to the enjoyment. Doing exercise on the beach or in the sea is being promoted as a way to improve our health and well-being.

SEAWEED SURPRISES

Did you know that you've probably already eaten some seaweed today? It's in your toothpaste! And maybe you've put some on your face and hair as it's found in many shampoos and cosmetics such as creams and lotions. It's also used as a fertiliser, animal feed, in medicines, gums and gels. Maybe you've used it in a science lesson at school as a medium called agar on which to grow bacteria. Perhaps in the future you'll also be using it to fuel your car as scientists are already using marine algae to produce biofuels.

THREATS TO MARINE BIODIVERSITY

Marine biodiversity faces a number of threats that are causing changes in the mixture of species, where they are found, and in some cases, extinction. The IUCN lists 27 percent of corals, 25 percent of marine mammals and over 27 percent of seabirds as threatened. Particular threats include over-fishing (see box: "Fishing Down the Food Chain"), pollution (see box: "Pollution and Dead Zones"), climate change and ocean acidification and invasive alien species.

Climate change is leading to changing ocean temperatures, which in turn, cause species to migrate. In the northern hemisphere, some cool water species are moving north, while in the southern hemisphere cool water species are moving south. Warm water species are expanding their distribution into areas where cool water species once lived.

Climate change is also affecting the pH (or level of acidity) of the sea. As more carbon dioxide (CO_2) enters the air, more CO_2 is absorbed by sea water through a natural chemical reaction. This is causing the sea to become more acidic. The full effects of this are not known, but scientists think that it will affect the building of shells or calcium-rich structures (such as corals) and reproduction in many species.

The combined effects of over-fishing, pollution and climate change are making it much easier for non-native species to establish themselves in new areas. Many of these alien species are not problematic, but some are; they are said to be invasive. Invasive alien species can be very dif ficult to eliminate of and may out-compete native species causing the whole ecosystem to change. Ships are the main culprits in the spread of invasive alien species, transporting them unintentionally on their hulls or in their ballast water.

FISHING DOWN THE FOOD CHAIN

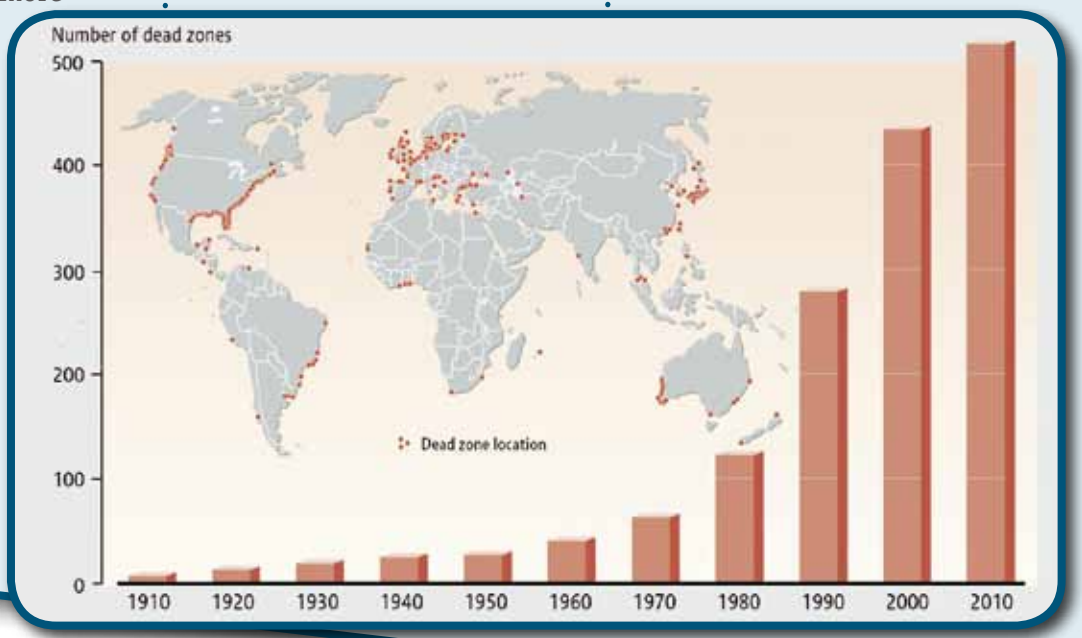
Most of the fish we prefer to eat are large, slow-growing species (e.g. cod, tuna and snapper). As their numbers are falling, fishers are changing the species that they catch. They are increasingly catching smaller fish (e.g. mackerel and sardines) that are closer to the bottom of the food chain. These smaller fish may be the prey of the larger fish, so removing these smaller fish threatens the recovery of the larger fish. An example is cod fishing in Norway. As cod numbers decreased, fishers started targeting pout. Pout feeds on krill and copeopods. Krill also feed on copeopods, as do young cod. As the pout were caught, krill increased causing copeopods to decrease. The young cod then found it difficult to find food, making the recovery of the cod population even more difficult.

POLLUTION AND DEAD ZONES

Pollution enters the marine environment through a number of routes. It may come from ships as they move around the oceans, from the land (e.g. from industrial outlets, sewage outfalls and runoff from roads) and from rivers. It includes rubbish, sewage and many different chemicals, such as fertilisers, oil and medicines.

Pollution carried in rivers is becoming particularly problematic and in some cases, where river water containing high levels of fertilisers reaches the coast, it is leading to "**dead zones**". Dead zones are becoming much more common in coastal waters around the world. About 200 have been identified so far. Some come and go with the seasons, but others are permanent. The most well-known is found in the north of the Gulf of Mexico where the Mississippi River meets the sea. At its largest it covered 22 000 km^2.

Dead zones appear when fresh water carrying lots of nutrients meets the sea. The fresh water floats on top of the salty water and prevents oxygen moving down. In the spring and summer, phytoplankton grow and multiply rapidly because of the high level of nutrients. Some of the phytoplankton are difficult to digest and may produce poisonous substances. This means less food is available for other marine life. As the phytoplankton die, they fall to the seafloor and are broken down by bacteria. This process needs oxygen. As no oxygen can get through to the seabed, the oxygen already there gets used up quickly and the seabed is said to become **hypoxic** (almost no dissolved oxygen is present). Marine animals and plants, like those on land, need oxygen to survive. Those that can move leave the area, but those that cannot are left to die.



THE NUMBER OF MARINE DEAD ZONES HAS INCREASED OVER THE DECADES.
Source: GBO-3, 2010

WHAT IS BEING DONE?
Save the seas and we'll save the planet

Internationally a number of pieces of legislation aim to protect marine biodiversity, for example:

- The Ballast Water Management Convention which, when it comes into action, will aim to reduce the introduction of invasive alien species by ships.
- The Convention on Biological Diversity aims to protect all biodiversity, including that found in the oceans.
- International fisheries legislation and codes of conduct (e.g. FAO's Code of Conduct for Responsible Fishing and the European Union's Common Fisheries Policy) aim to encourage sustainable fishery management.

Individual countries are also acting:

- Increasing numbers of marine protected areas are being created by many countries around the world, but currently only 0.7 percent of the marine environment is protected globally.
- Aquaculture or fish farming is being encouraged as an alternative to wild capture fisheries and new approaches to aquaculture may improve its environmental footprint (see box: "Multi-Culture Aquaculture").

Local people are also making a difference:

- They are getting involved in beach cleaning, coastal surveys and pollution campaigns.
- They are reducing their use of plastic bags that often end up being swept out to sea.
- They are encouraging sustainable fishing by only buying fish that carries the Marine Stewardship Council logo.

MULTI-CULTURE AQUACULTURE

Instead of just farming one species of fish, some fish farmers are diversifying to include shellfish (e.g. mussels) that can filter out organic waste from the water (e.g. fish faeces) and seaweeds to use up the excess nutrients that leak out of fish farms. The fish farmers can then sell not only the fish, but also the shellfish and the seaweed!

Perhaps you could do the same.

:: **Do a project at school about some of the things you have learned here, or even get your school to organise a beach clean-up.**

:: **Make biodiversity friendly choices when buying products or eating food derived from oceans, for example by selecting certified productions, such as those with Certified Sustainable Seafood labels (www.msc.org).**

:: **Most importantly, you could spread the message about how important marine biodiversity is and how we need to protect it.**

LEARN MORE

If you would like to find out more about marine biodiversity, try these links:

:: The European Environment Agency's 10 Messages for 2010: Marine Ecosystems: www.eea.europa.eu/publications/10-messages-for-2010/message-4-marine-ecosystems.pdf

:: Global marine biodiversity trends: www.eoearth.org/article/Global_marine_biodiversity_trends#

:: The IUCN's marine programme: www.iucn.org/about/work/programmes/marine

:: Marine biodiversity: www.eoearth.org/article/Marine_biodiversity#

:: UNEP-WCMC's report Deep-sea biodiversity and ecosystems: A scoping report on their socio-economy, management and governance: www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/28.aspx

:: World database on marine protected areas: www.wdpa-marine.org/#/countries/about

:: World register of marine species (WoRMS): www.marinespecies.org/about.php