Coral reefs; an introduction

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Coral reefs; what exactly are they? Read this article and step into the wonderful world of tropical coral reefs, supported by beautiful images from photographer Hans Leijnse!

Coral reefs; what exactly are they? Coral reefs have formed through the mineral deposits of billions of small invertebrate animals, called coral polyps. All of these polyps live in colonies, which can consist of one to many thousands of individuals. They are able to build houses made from calcium carbonate, called aragonite; similar to the bones in our body. They can retract themselves into their little homes when attacked by predators. Over millions of years, these animals have been able to create vast underwater mountains which we now call coral reefs.Figure 1, right: A diver is swimming towards a large Acropora colony at a reef in Raja Ampat, Indonesia.Coral polyps are similar to anemones, having tentacles, a mouth and an internal body sac called a gastrovascular cavity which is used to digest food. These polyps are sessile, meaning they cannot move; they catch nearby prey with their tentacles, which may be floating on the water currents or swimming towards certain death. After having caught a prey, their cnidocytes release tiny poisonous harpoons. These specialized stinging cells will paralyze the prey, after which they ingest it. Plankton; coral prey When corals catch prey, they are actually catching plankton. Plankton is the common name for all the microscopic organisms which float and swim in the ocean. We distinguish between phyto- and zooplankton; plants and animals, respectively. Some corals eat phytoplankton, such as many soft corals. Most stony corals, which build skeletons made from aragonite, mainly feed on zooplankton. Figure 2: Where the coral reef meets the forest; a sea fan (a Gorgonian coral) is growing on the reef, under a patch of trees located on an island at Raja Ampat, Indonesia. This sea fan grows perpendicular to the water current, which allows its polyps to efficiently catch plankton from the water. Plants live inside coralsCorals do not only eat plants; many are actually home to them. A group of algae from the genus Symbiodinium has formed a partnership with corals; these are called the zooxanthellae. They produce sugars by using the sun’s energy, just like higher plants do. We call this process photosynthesis, and it provides up to 95% of the energy corals need. Some corals receive their zooxanthellae from their parents, while others will have to reacquire them during their life. In the summer, temperatures sometimes get to high, causing the zooxanthellae to die off. As a result, the corals expel these symbiotic algae. This is called bleaching, and is now a common process on coral reefs worldwide. Global warming has caused summer temperatures to become higher, and or longer periods of time. The corals and the zooxanthellae have trouble with adapting to this fast changing climate. It is important that we try to slow down climate change by reducing the amount of greenhouse gases we produce. How it all starts Just like all other animals, corals reproduce by making eggs and sperm. Each summer, just after the full moon, they release their eggs and sperm in synchrony. This is a beautiful spectacle, and it only happens several days a year on a given reef. When an egg is fertilized, a larva develops after several days, not bigger than a grain of sand. During this stage, larvae of some species will ingest zooxanthellae, which will soon start producing food for them. The larva then seeks a suitable place to settle down on the reef, to start a new coral colony of its own. When the larva settles, it changes form – a process called metamorphosis. It has now become a primary polyp, having tentacles and a mouth. All of this happens in about a week, depending on the species.Figure 3: A larva from Stylophora pistillata; a stony coral common in the Red Sea. This specimen is only a fraction of a mm in size (photograph Dr. Keren-Or Amar).

Next, the primary polyp – as it is now called – will start dividing, thereby producing clones of itself. After several months, this polyp will have produced a new colony which is still small. Over the years, if the colony survives, it may grow out to become several meters in diameter. Old polyps die, and new ones are being created. Some corals grow over 15 cm per year (6 inches), whereas others grow much slower. Only the upper layer of the reef is alive; the major part below is merely eroded rock, although being porous and inhabited by other animals and bacteria. Different coral species create different sizes and shapes; each species is programmed to grow a certain way. Corals can be branching, plate-like or massive, such as brain corals. Other species, such a soft corals, look like waving trees. Abiotic factors such as light and water current can greatly affect coral shapes. Spawning groundsMany fish species use the reef as location for spawning their eggs and sperm, as their offspring will find a safe place to live in the porous reef. When they reach maturity, they will leave for the open seas, only to return again to spawn themselves. It is estimated that about 25% of the ocean’s fish species live, at least in part, on the reef. Figure 4: A school of snappers traversing the reef; these animals spawn in groups and release large amounts of eggs and sperm. This causes a feeding frenzy, as many other species will eat the eggs. Some of them will survive, and yield new offspring. High species diversityThe amount of species inhabiting the reef, called the biodiversity, is enormously high and comparable to tropical forests. This is because many species have adapted to a specific lifestyle; they have specialized themselves, often as symbiotic partner of another species. The most common form of symbiosis in the oceans is called mutualism, and there are many examples to be found. Figure 5: This symbiotic crab lives on the arms of a Crinoid, finding refuge against predators. It also receives extra food from the pinnula, transporting plankton to the mouth of the feather star. Fish such as gobies live together with pistol shrimp; these fish have keen eyes, and the shrimp are good burrowers. Cleaner wrasses remove parasites from the skins of many fish such as parrotfish, groupers, and surgeon fish; this provides the wrasses with food, and the receiving parties get a clean, healthy skin. Bangaii cardinals (Pterapogon kauderni) actually hide in between of a sea urchin’s spines (Diadema sp.) to stay safe from predators. Some sea horses, called pygmy sea horses, even live on a group of corals called gorgonians (figure 6). Figure 6: A beautiful example of species specialization: A pygmy seahorse (Hippocampus bargibanti), living on a Muricella gorgonian. The sea horse is perfectly camouflaged to protect it from possible predators. The dominant partnerships on the reef are zooxanthellae, the symbiotic algae which help give life to the reef, which have established partnerships with corals, but also with many anemones, nudibranches, jellyfish, Tridacna clams and foraminiferans. Different types of reefs Different types of reefs exist, based on their shape and

geological origin. Fringing reefs are the most common, and have formed in parallel to the coastline. The stony corals building this reef inhabit the waters between about 0 and 40 m of depth. Similar reefs are called barrier reefs, such as the Great Barrier Reef in north-east Australia. They can occur kilometers away from the shoreline. The third type reef may be the most spectacular and mysterious one; the atoll. Atolls are circular shaped reefs, thereby creating a laguna inside, which is often very shallow. They actually start out as fringing reefs around an island; when the island sinks because of tectonic plate movement, the reef continues to grow upwards. After tens of thousands of years, all that is left is the circular reef with a laguna inside. These reefs are reminiscent of pirate bays and treasure chests, and are amongst the most beautiful places on earth.

Figure 7: The Raja Ampat islands in Indonesia are amongst the highest species diversity areas on the planet. These islands include fringing, barrier and atoll reefs.

Coral reefs occur all over the world; in the Caribbean, the Red Sea, the Indian Ocean, around Indonesia and Australia and the Pacific Ocean. Coral reefs even occur around Europe in the North Sea, around Norway up to the pole circle, around the shores of the Unites States and even close to the South Pole! These reefs are not like the shallow, tropical and colorful reefs we all know; they are deep water reefs, and they have been found up to 3km (2.2 miles) in depth!Little is known about these mysterious reefs, and expeditions are now under way to find out which species live there. Much like the tropical reefs, these reefs are also home to important animal species. Figure 8: Corals appear all over the globe; here they are captured on film by divers, off the coast of Norway between Kristiansand and Stavanger. These soft corals often live on human made structures such as shipwrecks and rusty pipes. A delicate ecosystem A coral reef is like a tropical forest, and much like a forest cannot exist without its trees, a coral reef cannot exist without corals. When a coral reef dies, nothing much remains; fish, crabs, shrimp and even sharks disappear. This is because the coral polyps have two very important functions; they provide both food and shelter for many species. Because our earth is now warming up, tropical corals are in trouble. Their algae simply cannot withstand high temperatures above 30-32°C (86-90°F), and the corals expel them when they die. Each summer, more and more parts of coral reefs worldwide bleach and become completely pale. Corals cannot survive for long without their zooxanthellae, and they have to regain them before they starve to death.Figure 9: A bleached Acropora colony on the Great Barrier Reef, having lost its zooxanthellae. The colonies to the right of it have not bleached, because they harbor other types of zooxanthellae. Scientists have found that zooxanthellae type, also called clade, determines which corals are able to withstand higher temperatures (Photograph: Berkelmans & van Oppen, 2008).By catching enough plankton, and by absorbing nutrients from the water, many corals are able to survive the hot summers. But this will change in the near future, as we keep burning fossil fuels such as CO2, until the waters will become so warm that many corals will perish. The CO2 also makes the ocean more acidic, and scientists believe that within 150 years, coral reefs will start to dissolve as a consequence. Their skeletal houses are made up of calcium carbonate, and cannot remain intact in an ocean which becomes too acidic. Oceanic pH levels now hover around 8.2 during the day, and when this value hits the critical threshold of 7.5, coral reefs will start to dissolve. For this to happen, atmospheric CO2 levels will have to triple.

Next to global warming and acidification, pollution also is a problem. Many large cities flush their dirty sewage waters into the oceans, and reefs living nearby are greatly affected. They are poisoned by the wastes, and many algae will actually grow over the corals because the wastes act as a fertilizer, suffocating them. Overfishing is another threat for coral reefs, as large commercial ships use trawling nets; they sweep them over the reef to collect fish, while destroying large parts of it. This fishing method is both illegal and ineffective. In some countries such as the Philippines, fishermen even use dynamite to collect fish! When the dynamite explodes underwater, it may destroy several square meters of fragile reef, only yielding a couple of fish for the fisherman.Why reefs are important Yes, coral reefs are beautiful. But do they serve a purpose, next to housing many species? The answer is a definite yes. We even need the coral reefs, both today and in the future. First, coral reefs provide a habitat for a staggering amount of fish and invertebrate species. Many people are dependent on them worldwide; local people fish on the reefs to collect food for their families. Next, ecotourism and the ornamental trade are very important economical sectors in countries such as Australia and Indonesia. Even the Great Barrier Reef alone yielded an estimated gross of 10 billion USD in 2004, mainly from ecotourism. Finally, coral reefs worldwide protect the coastlines of 109 countries (think of the 2004 tsunami!). About one billion people are dependent on the reefs! You can help We may lose the reefs in the future, which would be a terrible loss to our planet. Fortunately, there are some things which you can do to help! First of all, try to minimize your CO2 production, also called your carbon footprint, by taking the bus instead of a car, by using energy-efficient light bulbs, by taking care of the reef when diving or snorkeling, by not polluting the ocean with garbage, by using an extra t-shirt instead of harmful sunblock, and by buying fish or corals which have been captive bred, maricultured or collected under strict guidelines. If we all do our part, the reefs might have a future again... Figure 10: A pair of clownfish (Amphiprion occelaris) occupying a Heteractis anemone. Would you want to lose this? All pictures in this article (unless stated otherwise) were kindly provided by Hans Leijnse (© Hans Leijnse), an expert dutch (underwater-) photographer. Have a look at his website. We thank Jan Korbijn for his ideas during the writing of this article. Unauthorized reproduction of these pictures is strictly prohibited.