

## Biodiversity and adaptation

### Adapting in order to survive

Ecologists believe that every animal has its own “profession”, which consists in finding the perfect correspondence among the species and its own ecological segment (i.e. the position of each species in an ecosystem). It would be absurd to think of finding an organism that has not “adapted” to its own ecological segment, in fact the penalty for this would be its rapid extinction.

By adaptation, we mean any structure, any physiological or behavioural process, that makes an individual, an animal or a vegetable more adapted to survive and reproduce itself than other individuals of the same species. By adaptation we also mean the evolutive process with which a new character is consolidated through natural selection. Adaptation can increase the efficiency in finding or using some fundamental resources such as light, air, food, etc.; or it can allow the organism to support determined conditions such as high or low temperatures, the absence of light or to help its defensive capacity.

### The shark: a perfect machine

Incredible examples of adaptation can be found, in particular, among the sea organisms, that must live in a context such as water. You surely must have looked underwater with a mask, and surely you must have noticed how difficult it is to see far away. In fact visibility in the sea depends on a number of factors such as: the temperature of the water, the sea bottom, the plankton organisms and the suspension of various elements. Now imagine you live in this strange ecosystem and you are a large predator that must find food. In the depths of the sea very little light penetrates and often the suspension of a number of organisms makes it difficult to see clearly, but you are a famished shark that is looking for a succulent prey. Everything is very dark, yet you notice that the prey you want is there, and with a rapid stroke you capture it between your teeth! Good eyes surely are not enough to be an efficient predator and therefore nature has had to “invent” really particular adapting strategies in order to survive. In fact sharks have two senses more than us humans: the **lateral line sensory organ** and the **Ampullae of Lorenzini**.

The lateral line sensory organ consists of a series of small channels along the shark’s sides, under the skin surface, that contain tiny sensory hair like structures that are sensitive to the water movements around the body provoked by waves, prey or predators. Therefore this organ allows the sharks to identify objects that are moving (even without seeing them!) and to pinpoint their position remarkably precisely. In fact, every moving body in the water produces vibrations that are transmitted in the environment, spreading out like concentric rings that form on the surface of a lake after a stone has been thrown into it. These vibrations differ, depending on the size of the animal and its state of health. And this is the reason why sharks almost magically appear in a few seconds when a fish is captured or wounded!

However, the sharks’ adaptation to life underwater does not finish here, in fact they have another important sensory organ, the Ampullae of Lorenzini. This organ consists of small pores in the area of the shark’s head, with ampoules that are filled with a conductor gel, connected with nerve fibres. The sensory cells can distinguish very weak electrical fields generated by other animals at a close distance (20-30 cm, maximum a few metres). In fact all living organisms have an electric potential (in fact, electrocardiograms and encephalograms are based on this phenomenon). So thanks to this very particular organ sharks become like metal detectors, and can locate magnetic fields generated by their prey, that may be perfectly hidden or mimetically invisible, but will certainly not be able to inhibit the electricity of their body. For this reason not even a sole, that remains perfectly hidden under the sand is safe! The Ampoules of Lorenzini are an organ that is so sensitive that it can capture magnetic fields ranging from 0.01 to 0.0005 microvolt per centimetre, which means that a battery that we consider completely dead, could be an enormous source of energy for a shark.

### Sea mammals : perfect apnoea swimmers

For how long can you hold your breath? If you are good you may even hold it for a minute or two. However some sea animals can reach an hour or more. This is the case of cetaceans that are mammals, and breathe with their lungs, and

therefore must reach the surface in order to breathe exactly like us humans. However particular mechanisms help them to prolong the time of apnoea (i.e. their capacity to hold their breath), specially in species such as the sperm whale, that feed on giant squid, which can be found at great depths. In fact the sperm whales can reach depths below 2000 metres (a scuba diver with an oxygen supply generally does not exceed a depth of 40 metres when diving for fun) with apnoea lasting up to two hours. They have a high haemoglobin density (the protein that is present in the red blood cells that enables the transportation of oxygen), in the blood and myoglobin (a protein that is present in the muscles that can store oxygen) in the muscles : a high dose of these proteins therefore, means a great amount more of oxygen that is stored and therefore their capacity to hold their breath will be longer. These sea mammals are also able to slow down their heartbeat and to cut away less important organs from the blood stream, so as to supply oxygen where it is most needed, for example in the brain.

## Everyone at the barber's shop: cleaning stations

To live in the water does not necessarily mean being clean! Fortunately there are sea organisms that, during the course of evolution, were transformed into real "cleaners" of other fish. These animals live in a place known as the cleaning station, where other fish stop by in order to be completely cleaned from external parasites and remains of food, as if they were at the barber's. There is a symbiosis in these areas, because the cleaners and the barbers both draw advantage from this : there is relief for the "clients" which also avoid getting any sickness, and food for the "barber". In these particular areas the cleaner fish have learnt to perform a dance that distinguishes them from other fish, and also their colouring is quite recognizable: when a client comes near, the cleaner fish begin to wiggle about using only their side fins, so as to show their intention to the client and to avoid becoming the prey of the bigger fish. And here also the cleaner shrimps can be found, which have the same function as the "barbers" and they too have a particular colouring and dance in order to be recognized. The fish that need cleaning, once they have recognized their barbers, remain perfectly still while they receive these services and they also open their mouths and gills in order to allow access into the more important areas. And in this way the leftovers of the last meal are removed and also the parasites that are encrusted in the gills and on the skin. Often the "barber shops" are places that are easy to recognize because of their particular appearance: a large solitary madreporite in the middle of the coral reef, a large flat coral. The clients memorize the place and return every time they need, without ever leaving a tip!