How the albatross survives on salt water

Like us, animals are confronted with impure water and poisonous natural substances from time to time. Throughout their evolution, they have developed certain biological cleansing mechanisms to respond to such challenges.

If a shipwrecked sailor drifts across the ocean in a lifeboat for several days, the sailor will eventually die of thirst despite being surrounded by an endless supply of water. After all, our bodies aren't built to drink saltwater. Due to osmosis, the lower-saline fluid in our cells would flow continuously through our cell membranes toward the ingested salt water, drying out our bodies from the inside.

However, seagulls, penguins, and other birds often spend months living on barren rocks out in the ocean. Some birds, like the albatross, travel thousands of kilometers across the waves without once setting foot on solid ground. How do these animals find the freshwater they need to live?

Biological desalination

Nature has devised a brilliant desalination mechanism for sea dwellers. When an albatross drinks seawater, the fluid first enters its bloodstream. Above its eyes on the left and right are salt glands containing thousands of tiny capillaries called tubules. Each tubule is covered in a multitude of thin blood vessels. Desalination occurs as a countercurrent exchange: Following the concentration gradient, the salt travels from the blood vessels and through the membranes of the tubules,

which already contain a higher concentration of salt. The tubules store a secretion that consists of 95% salt. This salty secretion then flows through a duct toward the tip of the beak, where it is exhaled as a fine mist. Industrial desalination methods that utilize reverse osmosis resemble this type of natural water purification, using semipermeable membranes to retain the salt.

Marine mammals, such as whales, seals and dolphins, do not have salt glands. They satisfy their water needs through their diet and drink very little seawater. These mammals have adapted to cope with the overabundance of salt in their environment. Their kidneys are particularly long and flat, effectively ridding their bodies of excess salt.

Fig. 1 Koalas have developed specific mechanisms to handle their diet of toxic eucalyptus leaves.

Coping with plant toxins

Land animals also have biological tricks that help them deal with harmful substances in their diets. In nature, life is all about eating or being eaten. While animals can go on the attack or choose to flee, plants can't just run away. Grasses, bushes and trees have therefore developed a wide variety of defense mechanisms. Some plants, for example, protect themselves mechanically with thorns and spines. Many others are equipped with chemical defenses. Alkaloids, such as nicotine, caffeine and cocaine, are plant toxins that disrupt the growth of insects and poison vertebrates. To defend themselves, many herbivores produce mixed-function oxidases (MFOs) in their intestines or liver cells. MFO enzymes can neutralize a wide spectrum of toxins, greatly broadening the animals' diet.

Acacias, species of the rose family, and some types of eucalyptus defend themselves with hydrocyanic acid. Australian koalas (Fig. 1) have developed specific mechanisms to cope with their consumption of the fibrous eucalyptus leaves, which neither taste good nor are good for other animals. To avoid being poisoned, koalas first sniff the eucalyptus leaf carefully. Their sensitive noses seem to help them tell the safer leaves from the highly poisonous ones. Small amounts of poison can still be neutralized biochemically in their intestines. Occasionally snacking on soil also aids in the detoxification process. Koalas have also developed a biological solution to allow them to consume large amounts of the otherwise indigestible cellulose fibers: Their two-meter-long appendixes host special bacteria that break down cellulose with the help of enzymes.

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