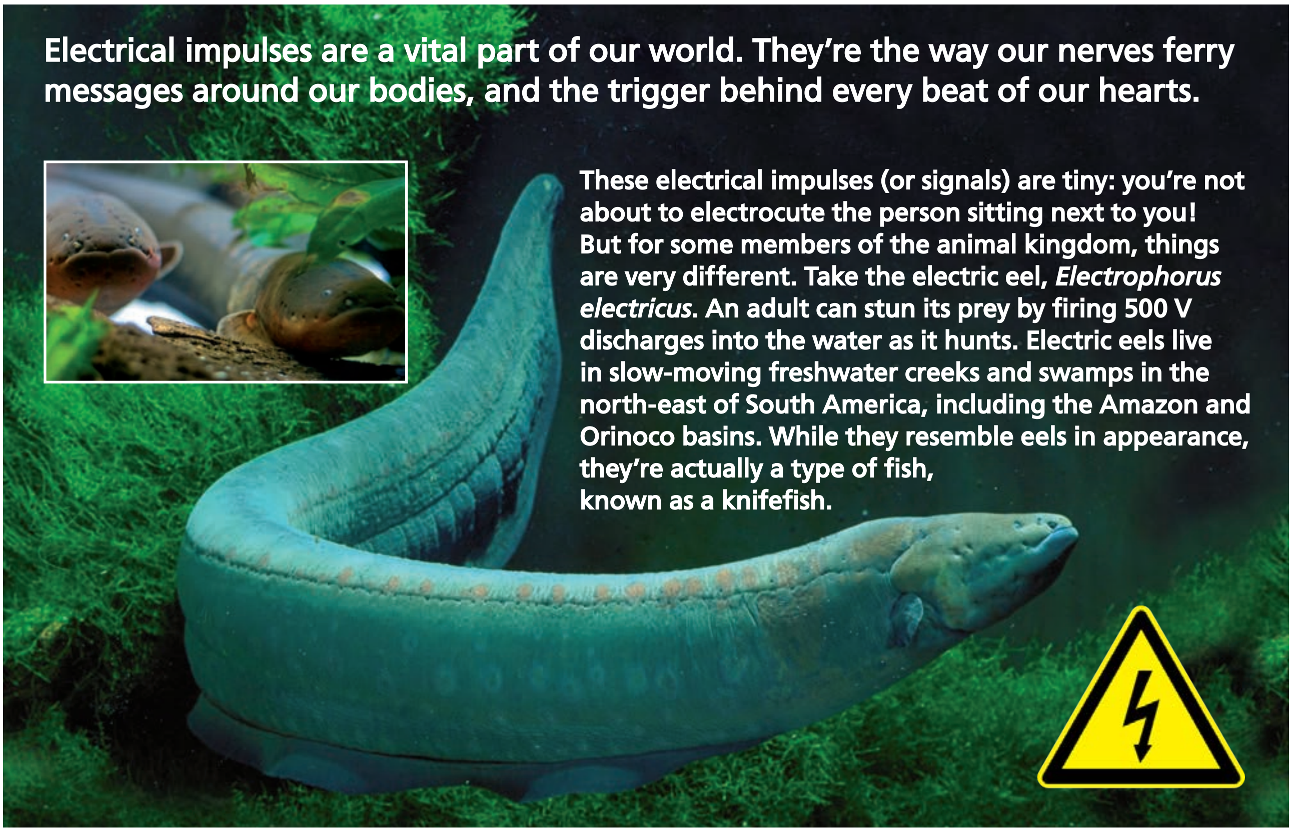
fact sheet

Electric eels

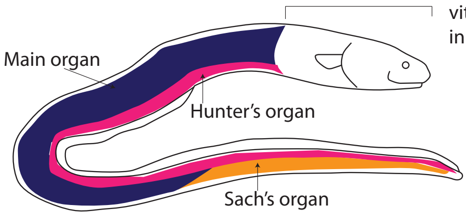


Electrical impulses are a vital part of our world. They're the way our nerves ferry messages around our bodies, and the trigger behind every beat of our hearts.

These electrical impulses (or signals) are tiny: you're not about to electrocute the person sitting next to you! But for some members of the animal kingdom, things are very different. Take the electric eel, *Electrophorus electricus*. An adult can stun its prey by firing 500 V discharges into the water as it hunts. Electric eels live in slow-moving freshwater creeks and swamps in the north-east of South America, including the Amazon and Orinoco basins. While they resemble eels in appearance, they're actually a type of fish, known as a knifefish.

How it works

The secret to their shocking talent lies in three abdominal pairs of electric organs that make up most of their long body: the Sach's organ, the Hunter's organ and the Main organ.

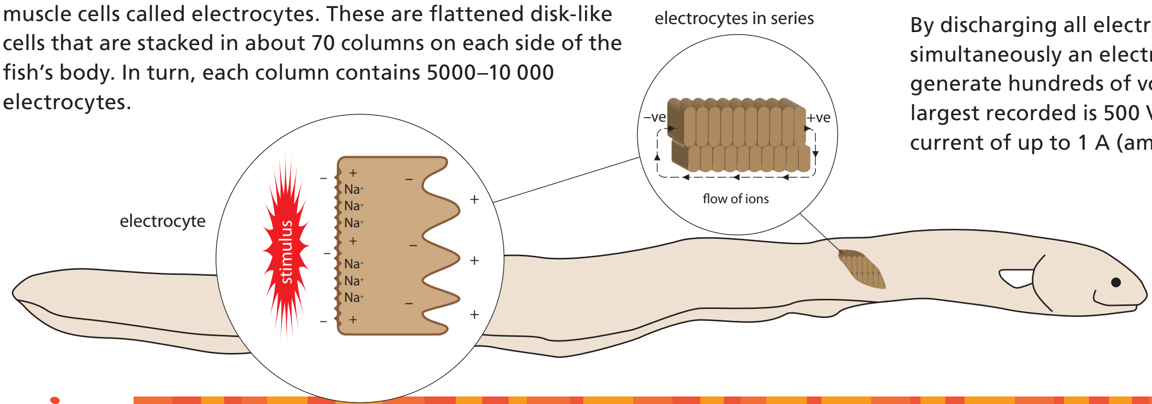


These organs contain hundreds of thousands of modified muscle cells called electrocytes. These are flattened disk-like cells that are stacked in about 70 columns on each side of the fish's body. In turn, each column contains 5000–10 000 electrocytes.

When an electric eel senses prey, or a threat, it sends a signal through its nervous system to the electrocytes. Nerve fibres join each electrocyte on one of its sides, but not the other. The arrival of a signal causes positively-charged sodium ions (Na^+) to flood into the cell.

This flow of ions gives rise to a temporary potential gradient across the cell, and a discharge of electricity.

The voltage produced from each cell is only small, around 150 mV. However, electrocytes are stacked in a series which builds voltage, and in parallel which builds current, like cells in a battery. The head of an electric eel is the positive pole of this 'battery' and the tail is the negative pole.



By discharging all electrocytes simultaneously an electric eel can generate hundreds of volts (the largest recorded is 500 V) with a current of up to 1 A (ampere).

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Varying the output

Using a combination of its three electric organs, electric eels can generate powerful or weak electrical discharges.

Powerful discharges come from the Hunter's and Main organ and are used to defend against predators or stun potential prey. Electric eels can produce hundreds of powerful pulses in quick succession, rendering prey immobile and, importantly, easier to swallow. Like many fish, electric eels lack maxillary (upper) teeth so they rely on pulling prey into their mouths by suction, before swallowing them whole, usually headfirst.

Weak discharges (around 10 V) come from the Sach's organ. These are used for communication and for active electrolocation, where an electric discharge is a way of 'seeing' in the electric eels' dark, murky environment.

Special skin receptor cells, called tuberous receptors, monitor changes in electric eels' self-generated electric field, helping it identify objects and search out food.

The electric eel is even capable of passive electrolocation where skin receptor cells, called ampullary receptors, detect electric fields generated by other animals. Passive electrolocation is a fairly common feature in fish. Sharks detect weak electric fields generated by muscle contraction of their prey, while paddlefish use ampullary receptors to detect their planktonic prey.


Brian Gratwicke

A rare talent

Only a few fish produce powerful discharges like electric eels, but such fish have been known and respected for centuries. Electric catfish are depicted on Egyptian tomb walls that date from around 3000 BC, while the electric ray was used in Roman times as a treatment for headaches and gout (the ray was applied to the patient's head or feet respectively). The electric ray's electrocytes are largely arranged in parallel, meaning it generates a lower voltage (around 50 V) but a higher current.

FACTS

- Adults grow big. They can reach up to 2.5 m long and weigh around 20 kg. Juveniles of 7–10 cm are already capable of generating 100 V.
- Early explorers described electric eel shocks knocking down horses which subsequently drowned. A large shock could cause respiratory paralysis and heart failure in humans.
- Electric eels are nocturnal and poorly sighted. They prey on fish, invertebrates such as shrimps, and occasionally amphibians and small mammals.
- Instead of relying solely on their gills like most fish, electric eels must come to the surface every few minutes to breathe air. This adaptation allows them to survive in oxygen-poor waters.
- It's illegal to possess, rear, sell or buy electric eels in Queensland, Australia. Their 'noxious' status comes from fears that escapees could become established and cause havoc in Australian waters.

Current research

Scientists in America are using electrocytes as a model for artificial cells that could, in the future, power medical implants and other tiny devices.

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