

Swimming with Sharks



Would you let your kids keep a pet shark? You would if you were part of the Bajau tribe, where children learn to swim before they can walk and spear fish at age 8.

The Bajau are sea nomads in Indonesia, the Philippines, and Malaysia, who live on boats and follow fish populations.

Traditionally, they come ashore only to trade their catch and escape storms.

To make their living diving for fish, the Bajau have adapted to do things the rest of us can't. In fact, they've developed some of the same capabilities as seals and whales.

When they dive, their bodies direct blood away from their extremities and toward their brain and organs.

Most importantly, they've developed 50 percent larger spleens, which act like an oxygen reserve, storing and then releasing more red blood cells into their systems when they dive.

All Bajau, even those who *don't* dive, have an enlarged spleen, indicating it's genetic.

With these adaptations, most Bajau can spend 5 hours a day underwater. They dive easily to 60 ft and stay there for minutes at a time!

They can go to depths over 200 ft with nothing more than wooden goggles and weight belts to pull them to the bottom. Then surface and do it again.

Western scientists are studying the Bajau to see how they can thrive with less oxygen—a condition called *hypoxia*, which can cause free divers to lose consciousness and drown.

Perhaps the secrets of the Bajau will save lives elsewhere.

Bajau divers can spend a long period of time underwater, with relatively short resting times between dives.

Credit: Dr. Melissa Ilardo, University of Utah, with permission



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Background: Swimming with Sharks

Synopsis: Can humans evolve to survive in a foreign environment like the ocean? The answer is yes! Over many generations, some seagoing humans have evolved differently to allow them to stay underwater much longer than ordinary humans.

- *Hypoxia* is a condition in which the body is starved of oxygen at the tissue level; it may result in serious injury or death.
 - Acute hypoxia, which occurs with severe oxygen deprivation, affects those who occasionally participate in activities like breathhold-diving. However, sea nomads of Southeast Asia such as the Moken, Moklen, Urak Lawoi, Orang Suku Laut, and Bajau don't exhibit symptoms of the condition.
- Recently, researchers have engaged with and studied the Bajau (BA-jo) people to find out how they can stay submerged in water for much longer than the rest of us without suffering from hypoxia.
 - The Bajau are fishermen descended from ethnic Malaysians who migrate from place to place along coastlines from the Philippines southward to Indonesia.
 - Traditionally, they live on long houseboats known as *lepas* but come ashore during storms and to trade their fishing catch with islanders. When not living on boats, they still don't really live on the land—they build stilt houses in shallow coastal waters.
 - Since they live on the water, children learn to swim very early, and start fishing and spear hunting by the time they are 8 years old.
 - By the time they are adults, many Bajau are expert free divers. They wear wooden goggles, but no wetsuits or flippers, and sometimes use weights to counteract buoyancy. They spend up to 5 hours a day underwater, catching 2–18 lbs of fish using spears, nets, lines, and their bare hands.
 - They can stay submerged 60 ft below the surface for up to 3 minutes at a time.
 - They can dive to depths of up to 230 ft with no adverse effects—some even perforate their own eardrums so they can dive deeper without pain!
 - Because they recover quickly from deep dives, they can dive more frequently.
- When your face is immersed in cold water, you instantaneously hold your breath—known as the *human dive* response. But the special genetics of the Bajau physiologically enhance this response so that these divers can exceed typical human limitations while underwater.
 - The heart rate lowering to conserve oxygen is called *bradycardia*.
 - Peripheral vasoconstriction decreases the size of blood vessels in the extremities, redirecting blood to vital organs like the brain, heart, and lungs—a phenomenon that appears to be genetically enhanced in the Bajau.
 - The spleen acts as an emergency supply of oxygen by contracting to force oxygenated red blood cells into the circulatory system.
 - One Bajau genetic mutation increases levels of T4, a thyroid hormone that increases metabolic rate to combat low oxygen levels. This hormone also appears to regulate spleen size in some other mammals, like Weddell seals.
 - Compared to the Saluan farming tribe that lives on the islands, ultrasound scans show us that the Bajau have spleens that are 50 percent larger, regardless of whether they are divers or not—the larger spleen size is an inherited characteristic of the tribe, not just a physiological change in the bodies of the divers.
 - A 50 percent larger spleen makes more oxygen available to Bajau fishermen during each dive. With the spleen as an extra storage tank for red blood cells, divers can access extra oxygenated blood when needed, while avoiding having unhealthy high blood cell counts all the time.

References: Swimming With Sharks

Physiological and Genetic Adaptations to Diving in Sea Nomads | Cell
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Are Humans Still Evolving? Freediving People Have Evolved to Stay Underwater Longer | The Conversation
Enlarged Spleen Key to Diving Endurance of "Sea Nomads" | UC Berkeley News

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- The Bajau genome has been altered over many generations to enable them to comfortably undertake both deep dives and long dives; they probably hold the record for the most extreme low oxygen experiences on the globe.
 - Historical records and linguistic analysis show that the Bajau have been living this way for at least 1,000 years.
 - They may be the last of their kind, as their traditional ways can't compete with commercial diving firms.
 - Were the divers who could dive deeper and longer better providers, impacting the gene pool through natural selection?
- Research on the physiological differences in indigenous populations that have evolved over many generations provides a new way of understanding hypoxia, and may ultimately help save lives in hospital intensive care units, where seriously ill patients often suffer from hypoxia.

A Bajau settlement in the Philippines.

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