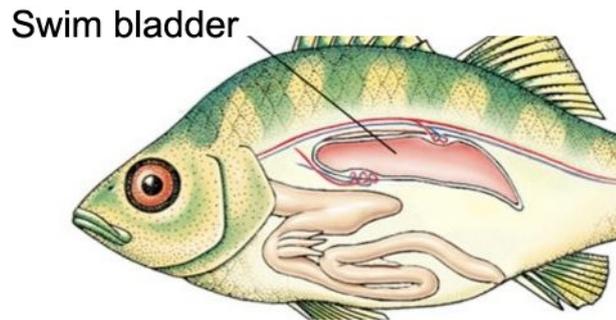


SWIM BLADDERS, BUOYANCY, RESPIRATION AND THE RISE OF TERRESTRIAL ANIMALS ... Rob Shepherd

Beachcombing early this summer I came across an object that I had not seen before. Initially I thought it may be a 'shark egg' (for some unknown reason I often place unidentified beach objects into that category!). On closer inspection, it consisted of a tough, semi-transparent, pressurised fibrous casing devoid of any internal contents. It was clearly no 'shark egg'. I consulted Possum Pete Crowcroft who advised me it was a swim bladder most likely from a puffer fish. Feedback from *iNaturalist* confirmed Pete's opinion.



Left: Swim bladder found on the Surf Coast. Right: Location of the Swim bladder in bony fish

Swim bladders are found in all bony fish but not in cartilaginous fish such as sharks and rays. The main function of the swim bladder is to assist with the fish's buoyancy by pumping air in and out of the bladder. It's like a buoyancy vest on a scuba diver: adjusting the amount of air in the swim bladder enables bony fish to descend, maintain neutral buoyancy or ascend without expending much energy. In contrast, cartilaginous fish expend significant energy; without a swim bladder they must continuously swim to adjust or maintain a specific depth—the alternative is to adapt to a life on the ocean floor (fish are denser than fresh or salt water and therefore naturally sink). Swim bladders have allowed fish to adapt to many different fresh water and marine environments including swimming and feeding near the water surface close to plankton*.

Many (but not all) fish control their swim bladder pressure via a connection to the gut. They gulp air into their gut when at the surface and release air through their mouth as they ascend. In these species the gas within the bladder is essentially air. Other species have evolved bladders that are in close contact with blood vessels. These fish are able to inflate and deflate the gas within their swim bladder via gas exchange across their blood vessels. The swim bladder of these fish contains a gas rich in oxygen.

Darwin considered that the lung in air-breathing vertebrates was derived from the swim bladder. His hunch turned out to be correct. Some fish contain swim bladders filled with blood vessels and are able to use the bladder as a secondary form of respiration in addition to their gills, while in lungfish the swim bladder evolved into an air-breathing lung similar to that in terrestrial animals. Although it remains unclear precisely which bony fish ancestor gave rise to the first amphibians, the development of the swim bladder into a primitive lung was a key to the great expansion of terrestrial life that includes amphibians, reptiles, birds and mammals. Neil Shubin notes that recent genetic research has demonstrated that 'the genes used to build swim bladders in fish are the same ones used to make lungs in both fish and people'.

Finally, Wikipedia notes that the pressurised gas swim bladder produces a strong reflection of sound, which is used in sonar equipment to find fish—technology catching up with evolution?

*A number of modern bony fish have given up their swim bladders including many species that live sedentary lives on the sea floor such as blennies and flatheads.

References: Shubin, N. *Some Assembly Required*, Oneworld, 2020.

<https://www.earthlife.net/fish/bladder.html>