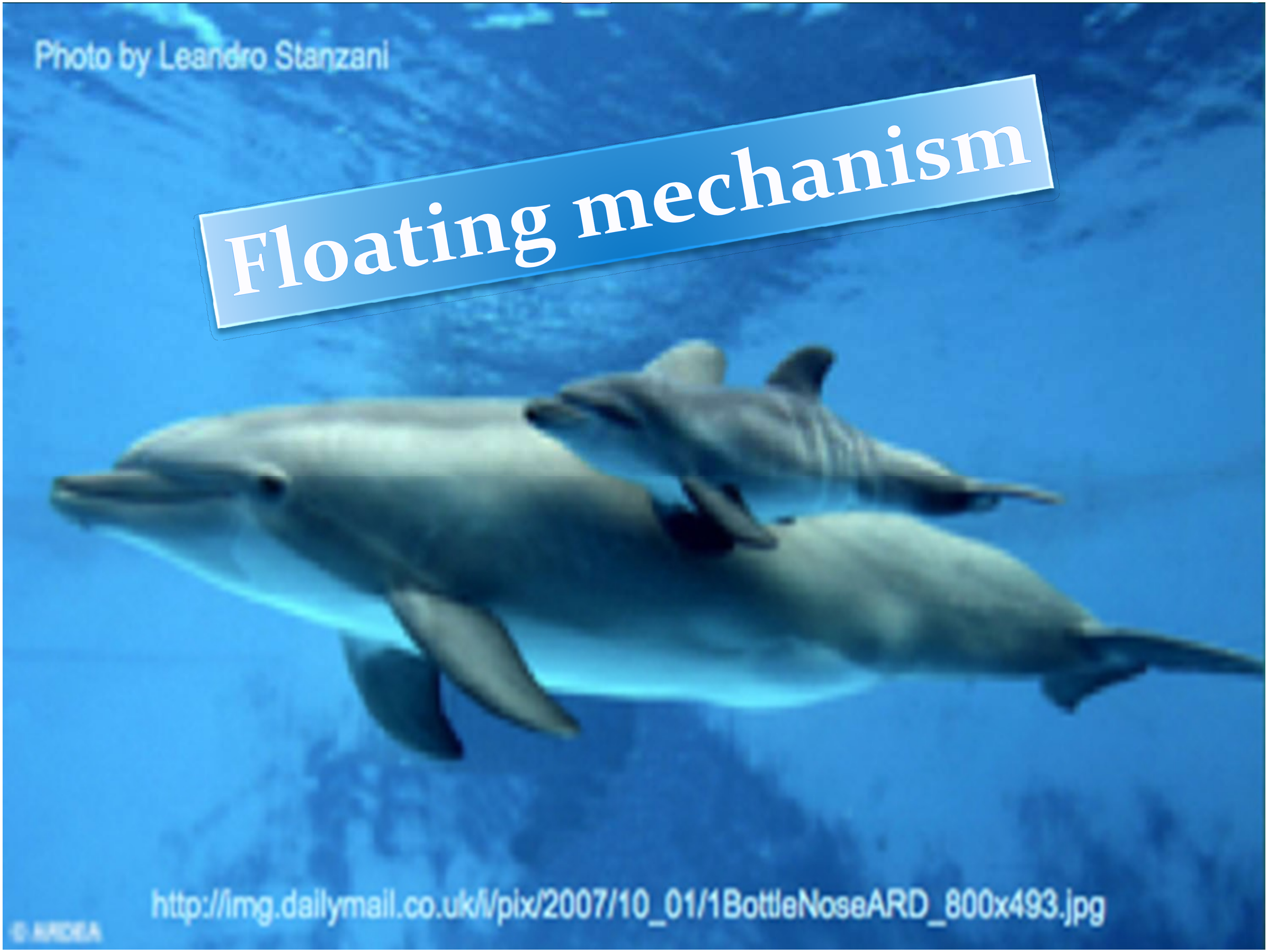
Photo by Leandro Stanzani
Floating mechanism
http://img.dailymail.co.uk/i/pix/2007/10_01/1BottleNoseARD_800x493.jpg
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Why is this? Because of Archimedes' Principle

“The buoyant force on an object immersed in a fluid is equal to the weight of the fluid displaced by that object" the force pushing down on each one (mass*gravity) was different, resulting in the 3 different outcomes

For the metal cube, the force of it's weight is greater than the buoyant force, so there will be a net force down, and the cube will accelerate down (sink).

For the cork cube, the force of it's weight is smaller than the buoyant force, so it will accelerate up (float).

This last scenario is called neutral buoyancy, and it's what marine mammals have, so it doesn't take energy for them to stay still in the water, and it's not particularly hard for them to go up or down when they want to either.

Imagine an animal that is as dense as a rock trying to swim up for air, or one that has low density, like a balloon, trying to dive down to find food; it would take a lot more energy to counteract that net buoyancy-weight force (up or down) than it would if that net buoyancy-weight force was 0. So by having neutral buoyancy, marine mammals save energy.

How do they achieve neutral buoyancy?

They have more fat in their bodies (fat is less dense than water), it also helps that saltwater is a little more dense than pure water, so the buoyant force is a little stronger.

The forces at work in buoyancy. Note that, because the upward force of buoyancy is equal to the downward force of gravity, the object is floating.

In science, buoyancy is an upward force exerted by a fluid that opposes the weight of an immersed object. In a column of fluid, pressure increases with depth as a result of the weight of the overlying fluid., Thus a column of fluid, or an object submerged in the fluid, experiences greater pressure at the bottom of the column than at the top. This difference in pressure results in a net force that tends to accelerate an object upwards.

and (as explained by Archimedes' principle) is also equivalent to the weight of the fluid that would otherwise occupy the column, i.e. the displaced fluid. For this reason, an object whose density is greater than that of the fluid in which it is submerged tends to sink. If the object is either less dense than the liquid or is shaped appropriately (as in a boat), the force can keep the object afloat.

This can occur only in a reference frame which either has a gravitational field or is accelerating due to a force other than gravity defining a "downward" direction (that is, a non-inertial reference frame). In a situation of fluid statics, the net upward buoyancy force is equal to the magnitude of the weight of fluid displaced by the body.

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Stability

A floating object is stable if it tends to restore itself to an equilibrium position after a small displacement. For example, floating objects will generally have vertical stability, as if the object is pushed down slightly, this will create a greater buoyancy force, which, unbalanced by the weight force, will push the object back up.

Rotational stability is of great importance to floating vessels. Given a small angular displacement, the vessel may return to its original position (stable), move away from its original position (unstable), or remain where it is (neutral).

The magnitude of that force is proportional to the difference in the pressure between the top and the bottom of the column

SUBMARINES

Submarines rise and dive by filling large tanks with seawater. To dive, the tanks are opened to allow air to exhaust out the top of the tanks, while the water flows in from the bottom. Once the weight has been balanced so the overall density of the submarine is equal to the water around it, it has neutral buoyancy and will remain at that depth. Most military submarines operate with a slightly negative buoyancy and maintain depth by using the "lift" of the stabilizers with forward motion.

Divers

Underwater divers are a common example of the problem of unstable buoyancy due to compressibility. The diver typically wears an exposure suit which relies on gas filled spaces for insulation, and may also wear a buoyancy compensator, which is a variable volume buoyancy bag which is inflated to increase buoyancy and deflated to decrease buoyancy.

The desired condition is usually neutral buoyancy when the diver is swimming in mid-water, and this condition is unstable, so the diver is constantly making fine adjustments by control of lung volume, and has to adjust the contents of the buoyancy compensator if the depth varies.

When a fish is totally immersed in displaces an amount of water it water equal to its body volume. If the weight of the displaced water is greater than the weight of the fish, the fish said to be positively buoyant and will tend to float. If the weight of the water is less than that of the fish, the fish is said to be negatively buoyant and will tend to sink .

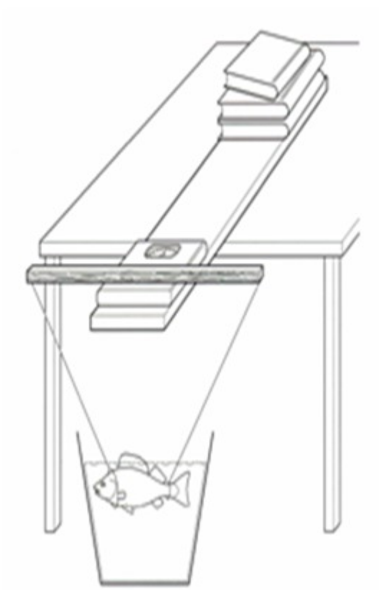
So if a fish or any aquatic animal were made of materials that were of the same density {density= mass / volume } as the water in which it lived, it would not weight anything in water, and would be neutrally buoyant. Seawater has a density of around 1.03 g cm and freshwater one of around 1.00 g cm { at 1 atmosphere and 15 degree C } but most animal tissues are of greater density.

Muscles are full of contractile proteins with densities around 1.33 g cm , and skeletal tissues such as bone may be so loaded with calcium salts that their density is over 2.00 g cm There are, of course, some less dense substances in most animals, such as fats of different kinds, and many marine animals {including bony fish } have body that are more dilute than seawater { and are hence less dense }.

Many snowbird fish { tuna, bonito, mackerel} have an average density greater than that of seawater. This means that the upward acting buoyancy force is not great enough to completely cancel the down ward acting force of weigh so that without an additional upward force, they would sink.

One method of balancing these up ward and down ward forces is through the use of hydrodynamic lift..

How to weigh a fish in water with bathroom scale



We might suppose that because shark skeletons are cartilaginous, and cartilage is less dense than bone, sharks without buoyancy mechanisms that lower their density would be less dense and weight less in water than similarly sized bony fish without buoyancy mechanisms.

Lipids as a Source of Static Lift

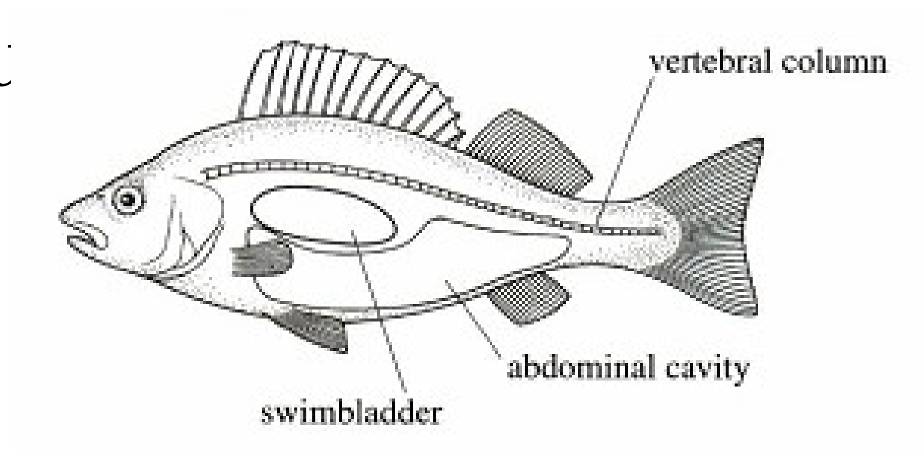
Lipids have virtually the same compressibility as water, so the provided by lipids in a fish remains almost the same when the ambient pressure alters as the fish changes depth. This gives lipids a great advantage over gas in providing static lift, because the lift given by gas varies with ambient pressure unless it is stored in strong rigid container.

Gas as a source of static lift

Animals that use gas for buoyancy face a quite different set of problems, and some of the most remarkable adaptation in the whole animals kingdom have resulted from the need to overcome them.

Buoyancy from elastic gas-filled swim bladders

Most { but not all} teleost have elastic gas-filled swim bladders that are approximately oval and located above the abdominal cavity beneath the vertebral colu



Structure of the swim bladder

In development, the teleost swim bladder forms as a pouch from the roof of the foregut, and in some more primitive bony fish such as herring, eel and salmons, the connection between the oesophagus and the swim bladder remains as an open pneumatic duct in the adult.

Operation of the Swim Bladder

How is gas lost from the swim bladder as the fish ascends?

This problem is the easiest to solve. Because the blood in the systemic circulation will have a pressure of Oxygen of around 20 kilo Pascal, all that is required to lose gas from the swim bladder is to arrange a connection between the swim bladder and circulation, and to ensure that this connection can be shut off when no more gas is to be lost.

How is gas prevented from diffusing out of the swim bladder?

This second problem is solved in a most ingenious way. Next time you buy a fish {not a mackerel or a flatfish such as plaice } for supper, open the visceral cavity and expose the internal organs, the swim bladder is usually conspicuous because it is silvery even if it is not full of gas.

How is gas secreted into the swim bladder as the fish descends?

This problem proved to be much more of a puzzle to physiologists than the two we have already considered. It had long been obvious that the retia were involved, and that there must be some change in the blood as it flows through the gas gland into the wall of the swim bladder.

Swim Bladders and Habitats

Quite a large number of teleost fish have reduced swim bladders or none at all, and are always negatively buoyant. This situation seems very curious, considering the advantages of neutral buoyancy conferred by gas- filled swim bladder. Because the problem of gas secretion and retention become more severe the deeper a fish lives, we might not unreasonably guess that fish with gas-filled swim bladders would be rare in the deep sea.

The function of swim bladders in marine fish, has shown that swim bladders are found in fish living near the bottom of oceans, even at great depth. However, generally they are reduced or absent in fish that live near the surface, { though some fish near the surface have them } and they are absent from many fish living at moderate depth.

Why do these fish forego the advantages of neutral buoyancy?

Unlike flying fish, they move up and down in the upper layers of the sea, and part of the answer lies in what happens as they change depth.

What are the advantages and disadvantages of different buoyancy mechanisms?

It shown why fish adopt different kinds of buoyancy aids by calculating the metabolic costs of achieving buoyancy by swim bladders, by low density fats and by fins. He began with the reasonable assumption that the mechanism favoured by evolution would be the one most economical of energy. For fish that swim at high speed, dynamic lift from hydrofoil-like fins may involve the smallest metabolic cost.