Life and The Salty Oceans

Text by Michael Symes
Photos: Peter Symes

It would seem to be self-evident to use the adjective 'salty' in connection with the World's oceans. Everybody knows that the oceans are salty. It is perhaps the first thing that comes to mind when we think of the oceans.

Everyone who has taken in a mouthful of ocean water while swimming knows that the ocean is really salty. About 70% of the Earth is covered with water, and we find 97% of that water in the oceans. However, it is not generally known just how important the salinity of the oceans is for life on this planet. Not only has it importance for the heat transmission, for example, from the seas to the land and vice versa, and thus affecting global climate, but it is of the greatest importance on the types of life that have evolved in these waters. Because of this salinity special, strategies have had to be evolved not only by the animals that live there but also by the plant life. But how saline are the oceans?

Tunicates, or Squirts

Salinity of the oceans

The salinity of the oceans depends on the solvent ability of water. It is the most universal solvent known, being able to dissolve both acids and bases. All water has some dissolved material in it. The difference between fresh water and ocean water is that ocean water contains many more dissolved salts. Ocean water is about 3.5% salt. And more than 90 percent of that salt would be sodium chloride, or ordinary table salt.

Kitchen salt

Composition of dissolved salts

At least 72 chemical elements have been identified in sea water, most in extremely small amounts. Probably all the Earth's naturally occurring elements exist in the sea. Elements may combine in various ways and form insoluble precipitates that sink to the ocean floor. The tabulated 7 ionic species make up 99.7% of the oceans' salinity.

Cation	Concentration %
Na^{+}	1.08
Mg^{++}	0.13
Ca^{++}	0.04
K^{+}	0.04

Anion	Concentration %
Cl^{-}	1.91
SO_4^{--}	0.27
HCO_3^{--}	0.01

From the top of the ocean all the way to the depths of the ocean, salinity is between 3.3 to 3.7% with the average salinity being about 3.5%. The salinity for almost the entire ocean at sea surface is around 3.3 – 3.6% with some geographic variations of salinity due to precipitation and evaporation. The salinity of ocean water varies. It is affected by such factors as melting of ice, inflow of river water, evaporation, rain, snowfall, wind, wave motion, and ocean currents that cause horizontal and vertical mixing of the saltwater. Evaporation leaves behind dissolved salts increasing salinity and precipitation freshens the top ocean layers. So, salinity is high in mid-latitudes where evaporation is high and precipitation is low. Salinity is low near the equator because precipitation is so high. Very high latitudes can also see decreases in salinity where sea ice melts and freshens the water.

The saltiest water, at 4.0%, occurs in

the Red Sea and the Persian Gulf, where rates of evaporation are very high. Low salinities occur in polar seas where the salt water is diluted by melting ice and continued precipitation. Partly land-locked seas or coastal inlets that receive substantial run-off from precipitation falling on the land also may have low salinities. The Baltic Sea ranges in salinity from about 0.5 to 1.5%. The salinity of the Black Sea is less than 2.0%.

Life in and around the oceans

The saline environment has quite an effect on life in the oceans. Most creatures that live in the ocean could not live in fresh water. However, when the highly saline waters of the ocean meet fresh water, an estuary is formed. This is a special environment where some creatures have learned to adapt to a mixture of fresh and salt water. When fresh water, ground water and soils are altered by human actions and salinity greatly increases, it can have an extreme detrimental effect on life there. Changes in salinity brought about by human residential, commercial and industrial activity can kill plant life, aquatic life, and animal life in a given area. Humans have the responsibility to make sure their actions are not causing this type of devastation.

Mangrove trees

One important example of plant life that has adapted to salty conditions is the mangrove tree. Mangroves are a unique part of the coastal ecosystem, being found along tropical seacoasts on both sides of the equator. They are thought to have originated in the Far East. There are several types of mangrove with the Galapagos being home to four of them.

They are interesting because they have evolved mechanisms enabling them to cope with high salt conditions. The Black Mangrove, for example, has the highest salt tolerant leaves of all the mangroves, with its leaves being equipped with special salt-extracting glands. Much research has been done in attempting to elucidate how this salt extraction functions but many fundemental questions remain. The gland ultrastructure has been described but questions remain regarding processes inside the cells as well as ion transport from the secretory cells to the cuticle.

Incidently, apart from their ability to survive saline conditions they are also interesting in being unique in having true plant vivipary. Mangrove species reproduce by producing flowers and rely on pollination by bees and insects. After pollination, the seed remains on the parent tree where it germinates and grows roots before disloging.

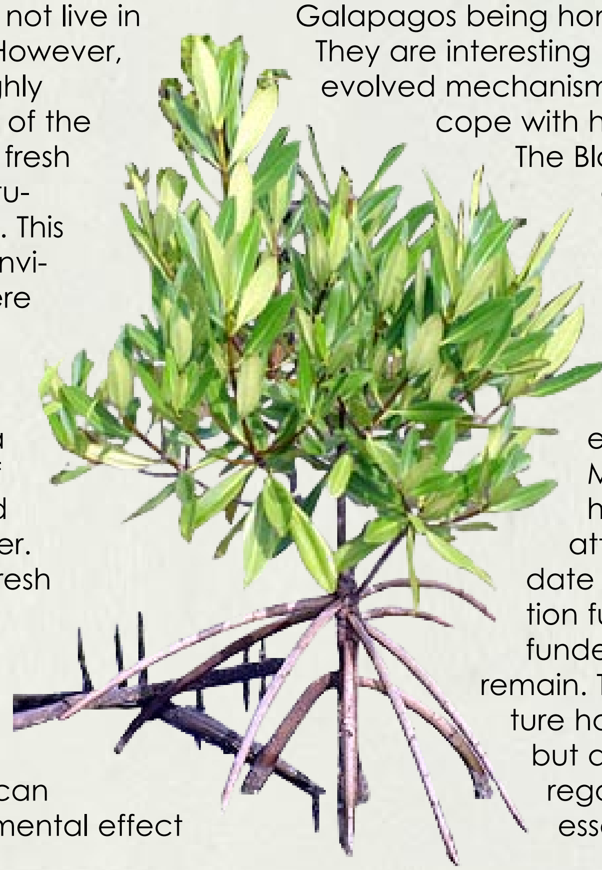
Marine animal life

Due to the salt content, life in the oceans is quite different from that found in freshwater. However, sea water and river water differ in more ways than in just their salt content. For example, rivers carry to the sea more calcium than chloride, but the oceans nevertheless contain about 46 times more chloride than calcium. Also, silica is a significant constituent of river water but not of sea water. Furthermore, calcium and bicarbonate account for nearly 50% of the dissolved solids in river water yet constitute less than 2 percent of the dissolved solids in ocean water. These variations seem contrary to what one would expect.

Life's affecting salt composition

Part of the explanation is the role played by marine life, both animals and plants, in ocean water's composition. Sea water is not simply a solution of salts and dissolved gases unaffected by living organisms in the sea. Mollusks, for example oysters, clams, and mussels, extract calcium from the sea to build their shells and skeletons.

Crab on a red mangrove root off Semporna, Borneo Plants and animals alike. They all have to cope with the changing salinity and, in some places, a constant cycle of flooding and drying out.



Background: Mysids, small crustaceans, usually less than 10 millimeter long, that swarm over the seabed and are often mistaken for juvenile fish. These are from the brackish Great Belt, Denmark
Center: Young red mangrove, Florida

The Salty Oceans

Foraminifers, very small one-celled sea animals, and crustaceans, such as crabs, shrimp, lobsters, and barnacles, likewise take out large amounts of calcium salts to build their bodies. Coral reefs, common in warm tropical seas, consist mostly of calcium carbonate as limestone, formed over millions of years from the skeletons of billions of small corals and other sea animals. Plankton, tiny floating animal and plant life, also exerts control on the composition of sea water. Diatoms, members of the plankton community, require silica to form their shells and they draw heavily on the ocean's silica for this purpose.

Some marine organisms concentrate or secrete chemical elements that are present in such minute amounts in sea water as to be almost undetectable: Lobsters concentrate copper and cobalt; snails secrete lead; the sea cucumber extracts vanadium; and sponges and certain seaweeds remove iodine from the sea.

Lobsters concentrate copper and cobalt; snails secrete lead; the sea cucumber extracts vanadium; and sponges and certain seaweeds remove iodine from the sea.

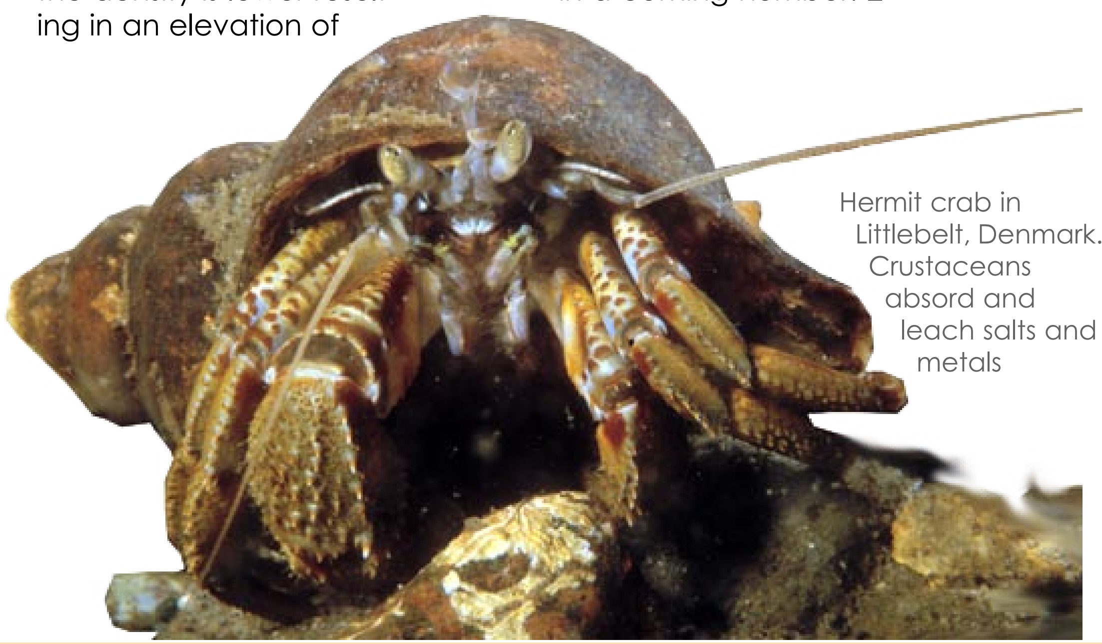
Thus, sea life has a strong influence on the composition of sea water. However, some elements in sea water are not affected to any apparent extent by plant or animal life. For example, no known biological process removes the element sodium from the sea.

Thus, sea life has a strong influence on the composition of sea water.

Global Conveyor Belt

Together, salinity and temperature determine seawater density and buoyancy, driving the extent of ocean stratification, mixing, and water mass formation. Greater salinity, like lower temperatures, results in an increase in ocean density with a corresponding depression of the sea surface height. In warmer, fresher waters, the density is lower resulting in an elevation of the sea surface. These height differences are related to the circulation of the ocean. The changes in density bring warm water poleward on the surface to replace the sinking water driving the global thermohaline (heat and salt) circulation within the ocean called the Global Conveyor Belt.

The is the principal mechanism by which the oceans store and transport heat. The ocean stores more heat in the uppermost 3 meters than that of the entire atmosphere and acts as a global heat engine. Salinity is thus a key ingredient in the global thermohaline circulation. We will be discussing the importance for the environment of the Global Conveyor Belt in a coming number. ■



Hermit crab in Littlebelt, Denmark. Crustaceans absord and leach salts and metals

Drink saltwater to save your life - *perhaps*

In Coleridge's famous poem, in which a becalmed crew is dying of thirst in the middle of the ocean, the narrator says:

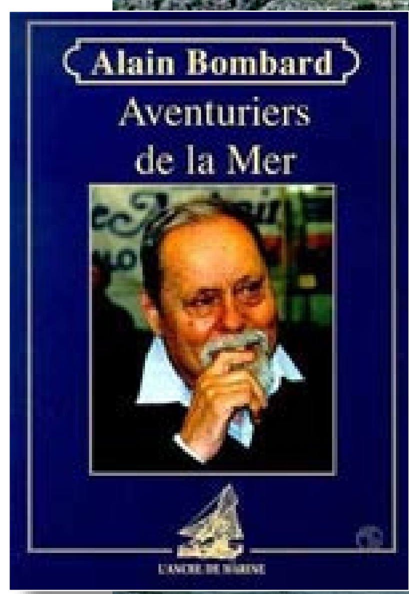
"Water, water, everywhere,
And all the boards did shrink.
Water, water, everywhere,
Nor any drop to drink"

It is certainly ironic that in the middle of all that water they had nothing to drink, for it is well known that if you drink seawater you will die. But, well known or not, can this really be true, or is it just a myth?

Doctor Alain Bombard, who died in France in July this year, claimed to have proved that you can drink seawater and survive. He, in fact, carried out a trial in 1952 in which he survived 53 days on the ocean in a life raft without any fresh water or food. His theory was that the human system can absorb sea water provided it's drunk in small quantities and taken continuously. Plankton is rich in vitamin C and, filtered from the sea with a special net, it contains all the nutrients required. Bombard drank rainwater and up to a pint-and-a-half of sea water a day on his trip.

He was inspired by Thor Heyerdhal's 1947 Kon Tiki expedition, who crossed the oceans on a raft, living on a diet of fish. This event influenced his life so much that he decided to prove the possibility of survival in a blow-up raft with the very limited amount of resources. Bombard drank only small quantities of salt-water and consumed the plankton which it contained.

His most famous book about his Atlantic raft crossing is titled "The Bombard Story. "



Tom Hanks starring in the Hollywood blockbuster "*Castaway*" in which his character also had to depend on his creativity to survive. Promotional photo from 20th Century Fox

In Theory

After theoretical studies at the hospital of Boulogne sur mer, to determine what quantity of fresh water you can get from a fish, from the rain, how much salt water you can drink, etc, he decided to test his theory on a Zodiac inflatable boat and in 1952 to cross the Atlantic Ocean from the Canary Island to the West Indies. He went without any water, just a few basic tools like a net to catch plankton, harpoons to fish, a few books, medical material to study his health, and a sextant.

Emergency provisions were loaded onto the 15-foot-long, 6-foot-wide rubber boat, but a notary sealed them so it would be obvious if Bombard used them. The seal was reported to be still affixed at journey's end. Bombard left the Canary Islands on October 19, and reached the West Indies December 23. He encountered storms, and weeks of dead-calm seas. When he encountered a tanker, he found that he was 600 miles off course. The mix of raw fish and plankton, which he first thought tasted a bit like lobster purée, grew tiresome. He told Life magazine that it added up to "a starving, thirsty hell."

64 days

After 53 days of travel, he encountered a ship. The crew offered him a meal and proposed to bring him to some islands but Bombard decided to continue alone and he reached Barbados on December 23, 1952. When reaching Barbados he was in such poor condition that he was immediately hospitalized. The total trip was 4400km and took 64 days.

Bombard went to an oceanographic institute in Monte Carlo to develop ways for people lost in small boats to survive on even less. He concluded that drinking limited quantities of seawater and fluids pressed from raw fish, and eating fish and plankton would do the job. Thanks to his achievement and interest in sailors, working conditions and standard safety procedures on board ships have all been greatly improved. He also received many letters from sailors who managed to survive life and death situations using his tips.

Is it really possible?

So, can you survive by drinking seawater? It would appear that you can if you use it as a supplement to other sources such as the juice from pressed fish. However, it might be advisable first to read "Alone at Sea" by Hannes Lindermann. He tried Bombard's tricks on two short voyages drinking saltwater - and almost died. His feet and legs swelled dangerously. In "Alone at Sea", 1958, he not only cast doubt on seawater's potability, but also charged that Bombard had cheated by sneaking provisions aboard. Find both books at Amazon.com. and judge for yourselves.

It all depends, it seems. The 33% salt concentration in the water of the Dead Sea would however certainly kill you fast if you drank it

YANN ST. YVES