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A life in brine

A brine shrimp seen from above.

Astrid and Hanns-Frieder Michler/SPL

Brine shrimps can easily be kept in a jar or aquarium. This article explores some aspects of their lives which are relevant to your GCSE science course.

Brine shrimps are sometimes sold under the name 'sea-monkeys' but they are never found in the sea and are not related to monkeys. So what are they and where do they live? Brine shrimps are small feathery Crustacea (Figure 1) that live in salt water (brine) lakes. This brine may be even saltier than the sea. The shrimps swim about incessantly on their backs. They feed by using their leaf-shaped legs to gather microscopic algae from the water.

Salt lakes are formed in hot countries in places where rivers do not have an outlet to the sea but run into lakes. The lake water evaporates quickly, concentrating the salts that are dissolved in it. One such lake is Lake Utah, USA, near Salt Lake City.

In Bangladesh, brine shrimps are grown by the million in huge salt pond farms. They are used to feed prawns that are farmed for human food: so algae, shrimps, prawns and people make a simple food chain.

LIFE CYCLE

Brine shrimps are tiny when they hatch but grow to around 1 cm in length in just 2 weeks. They have two small eyes on stalks on their heads and one eye in the middle of their foreheads. They have two pairs of antennae, 11 pairs of leafy legs (phyllopodia) and they swim upside down. Brine shrimps filter minute single-celled green algae from the water. The shrimps are transparent so you can see the algae inside their guts.

After 2 or more weeks the shrimps are adults and pair up. Males are white or greeny-blue, with long clasping antennae which they use to hold on to their partners. Females are white to orange in colour, with smaller antennae, and they carry a big egg sac on their abdomens. The male and female swim together for several hours, even a few days, before they mate.

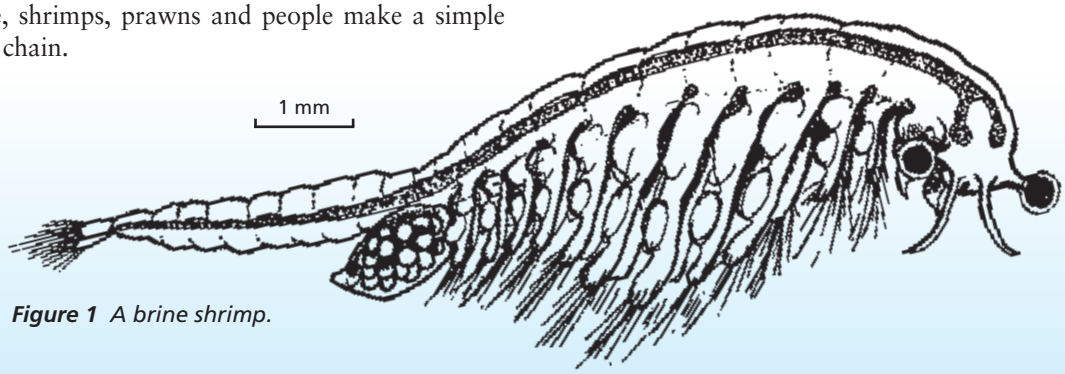


Figure 1 *A brine shrimp.*

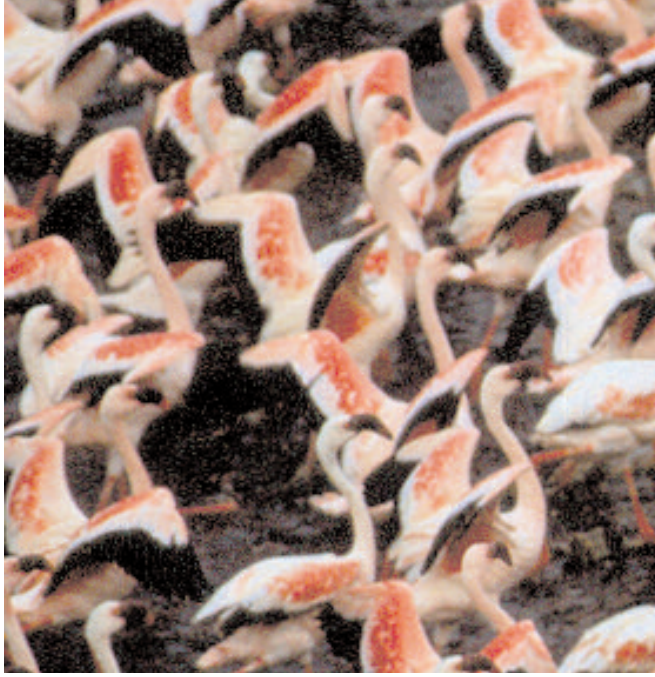
GCSE key words

- Osmosis
- Active transport
- Producer
- Consumer
- Food chains and webs

Look up 'sea monkeys' in an internet search engine and prepare to be amazed!

Brine shrimps are rich in protein, fats and carotenoid pigments. The carotenoids are photosynthetic pigments in the algae. The pink colours in the feathers of the flamingo come directly up the food chain from this algal source. This is an example of bioaccumulation.

Dr Jeremy Burgess/SPL



Male and female brine shrimps swimming together.

Michael Dockery

Above: *Electron micrograph of hatching brine shrimp egg-cysts. Their thick walls, clearly visible, allow them to survive dry conditions.*

You can observe this 'mate guarding' easily yourself (see Box 2). Mating itself happens very quickly.

Male brine shrimps seem to be attracted to larger females. This may be because larger females are able to produce more eggs and therefore more offspring. Females get a powerful boost from swimming with a bigger, faster male. This helps them to gather more food — and perhaps to escape being eaten.

Females may produce about 20 young each week. They can be in two possible forms — either a swimming nauplius (*naw-plee-us*) larva or a dormant egg-cyst.

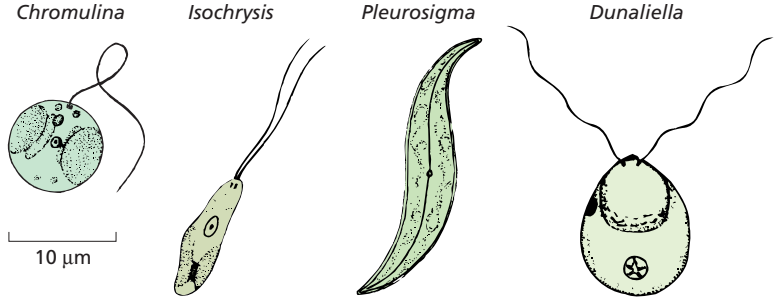


Figure 2 *Algae eaten by brine shrimps.*

YOUNG SHRIMPS

A nauplius has two small antennae from birth and feeds immediately on algae in the water. Initially it has only one eye, in the middle of its head. The

BOX 1 SHRIMPS IN A PICKLE

We use brine and salt to preserve things, but brine shrimps can live in water seven times as salty as sea water! Like ours, the blood inside their bodies is less salty than sea water. As their surface is partially permeable, water will diffuse out of them by osmosis. So how do they manage not to shrivel up completely?

Brine shrimps seem to drink water to replace what is lost by osmosis, but this will make them even more salty inside. Their secret is to pump out sodium ions from the gill surfaces of their leafy legs using energy provided by respiration. This is a form of **active transport** and takes a lot of energy, so in very salty water brine shrimps grow more slowly. They have to use their food energy to fight the challenge of osmosis.

Art Wolfe/SPL

Above: *A flamingo can eat more than a litre of solid crustacean food in a day, filtering the animals from the water at the rate of several hundred animals per minute.*

BOX 2 SETTING UP A BRINE SHRIMP CULTURE

Although you can buy brine-shrimp kits in pet shops, museums and other outlets, these cultures may not keep going for very long. It is often better to start from scratch.

Use an aquarium tank or a large, clear plastic bottle such as a clean lemonade bottle. Keep this in a bright sunny place, like a south-facing window sill. Obtain a culture of the algae and microbes*, add some sand and gravel and put it all into the tank. Make up a solution of sea salt (obtainable from pet shops and supermarkets) using 35 grams of salt per litre of tap water. (It is best to let the tap water stand in a bucket or bowl overnight before you put it in the tank. This will reduce the chlorine content.) Brine-shrimp egg-cysts come with the culture* or may be bought as egg-cysts or adults from pet shops.

When caring for the brine shrimps remember that they need warmth, light and some mineral nutrients in the water (e.g. a few drops of Baby Bio or similar plant food). Stirring the water and cleaning the sides of the tank every week will help them grow well and allow you to see what is going on.

*Your teacher can purchase a brine shrimp culture from David Barnard, Homerton Brine Shrimp Project, Department of Biological Sciences, Homerton College, Cambridge CB2 2PH, tel: 01223 507175.

BOX 3 SHRIMPS IN SPACE

Brine shrimps were used to measure the dangers of radiation in space by placing some on *Apollo 16* as it went round the moon. Cosmic rays (a kind of damaging radiation) go right through living things and can destroy cells. We are in part shielded from them by the Earth's atmosphere. It was found that brine shrimp egg-cysts that had been hit by a cosmic ray were three times less likely to hatch and four times less likely to make it to adulthood. As a result of this study great care goes into making the suits for men and women who go into space.

young nauplii (*naw-plee-ei*) are attracted to the light, which is where the algae grow best. Nauplii moult as they grow bigger. Each time they shed their exoskeleton they swell more and then grow a bigger outer covering. This may happen up to 15 times in the animal's life. Soon the young are swimming everywhere on their backs and feeding with their leafy legs. They may live for months.

Salt lakes sometimes dry up completely and the adult brine shrimps then die. However, they first produce egg-cysts which can survive the drought. These may hatch as soon as it becomes wet again, but if there are few nutrients in the water they may stay dormant. Egg-cysts hatch best in warm, well-lit, slightly salty water with a neutral pH.

Fish cannot produce drought-resistant eggs, so the shallow salt lakes which periodically dry out often have no fish to prey upon the brine shrimps. Without predators, the shrimps multiply rapidly and in summer there may be thousands of brine shrimps to a bucketful of water.

FOOD CHAINS AND WEBS

The salt lake environment is so extreme that few species are able to live there. This makes the food web quite simple. The unicellular green algae (Figure 2) are the **primary producers**, using energy from sunlight to convert water and carbon dioxide to carbohydrates in the process of photosynthesis.

In good conditions algae may double in number every day. One cell can grow and divide to make 100 cells by the following week. We normally think of cows, sheep and rabbits as herbivores, but in a salt lake the brine shrimps are the herbivores or **primary consumers**, filtering out the tiny algae from the green muddy water.

In the absence of fish, the brine shrimps are a significant food source for **secondary consumers**. Flamingoes and avocets are two carnivorous birds that feed on shrimps in shallow salt-lake waters. Flamingoes feed using a pump action and filter system. They have a large muscular tongue that draws water into the mouth through fine peg-like filters in the beak. The brine shrimps are caught and swallowed and the filtered water passes out of the beak again.

Although they are themselves predators, both types of bird are preyed upon in turn by **tertiary consumer** bird raptors. Fish eagles eat many flamingoes and Egyptian vultures commonly take flamingo chicks from the nest.

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● **Draw a food web linking together the organisms mentioned to include the possible flow of energy and materials from the tropical algae.**

Osmosis is the movement of water molecules across a partially permeable membrane from an area of high concentration of water to one of low concentration.

If you set up a brine shrimp culture you can try the investigations on page 16.