Brine Shrimp and Ecology of Great Salt Lake

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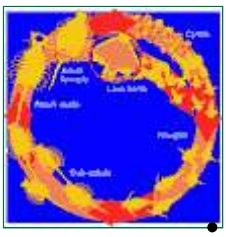
Brine Shrimp Lifecycle

The brine shrimp, *Artemia,*belongs to the phylum Arthropoda (joint-legged invertebrates), class Crustacea (shrimp, crab, lobster). There are several species of *Artemia* worldwide; *Artemia franciscana* is the species living in Great Salt Lake (and also in San Francisco Bay). Brine shrimp live in hypersaline lakes in which the salt content may be 25%, predators and competitors are few, and algal production is high. The life cycle of *Artemia* begins from a dormant cyst that contains an embryo in a suspended state of metabolism (known as diapause). The cysts are very hardy and may remain viable for many years if kept dry. Water-temperature and salinity changes in Great Salt Lake occur in about February and cause the cysts to rehydrate and open to release the first growth stage, known as a nauplius larva. Depending on the water temperature, the larvae remain in this stage for about 12 hours, subsisting on yolk reserves before molting to the second nauplius stage, which feeds on small algal cells and detritus using hair-like structures on the antennae known as setae.

Although the cysts are very small (about 200 micrometers in diameter; 50 could fit on the head of a pin) at times they become so numerous that they form large red-brown streaks on the surface of the lake. Under optimum conditions of food supply and lack of stress from increasing salinity or decreasing dissolved oxygen, fertilized female shrimp may produce eggs that hatch soon after emerging from the ovisac to produce nauplius larvae, which is known as ovoviparous reproduction. If conditions are perfect, the female can live as long as 3 months and produce as many as 300 live nauplii or cysts every 4 days. However, the cold spring-time temperatures and variable food supply in Great Salt Lake usually limit the population to two or three generations per year.

The nauplii molt about 15 times before reaching adult size of about 10 millimeters in length. Adult male shrimp are easily identified by the large pair of "graspers" on the head end of the animal. These are modified antennae and are used to hold unto the female during mating. The population of *Artemia franciscana* in Great Salt Lake includes both males and females and reproduces sexually, but some species of *Artemia* exhibit parthenogenesis, a reproductive mode in which only females are present that give rise to young females in the absence of males. Adult shrimp feed primarily on phytoplankton (algae) suspended in the water but can also "graze" on benthic algae such as blue-greens or diatoms growing on the bottom of Great Salt Lake in shallow areas. They also may reprocess fecal pellets excreted earlier in the year when large numbers of phytoplankton present in their diet were incompletely processed. A recent study showed that the shrimp can graze on diatoms that colonize shrimp exoskeleton parts released from their many molts. As the food supply becomes exhausted, salinity increases, dissolved oxygen decreases, or a combination of these conditions occurs, the female shrimp switch from producing live young to producing cysts through oviparous reproduction. In Great Salt Lake, the adult shrimp typically die from lack of food or low temperature during

December. Although, live brine shrimp have been observed in the lake at a water temperature of 3 degrees Celsius (37 degrees Fahrenheit), it is unlikely they can reproduce at that temperature. The cysts, which in Great Salt Lake are lighter than the lake water, float on the water surface where they may be harvested or may overwinter to form the source of shrimp for the following year.

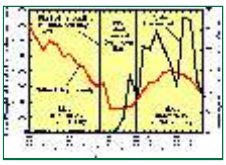


Brine shrimp are also called "Sea Monkeys" and are raised in aquariums for their entertainment value. For information on raising Artemia from cysts commercially available to individuals click on the links below:

- Aqualink
- Sea Monkeys Worship page
- Information on aquaculture and shrimp farming
- Information on research in Artemia

Commercial Shrimp Industry

The brine shrimp industry began on Great Salt Lake during the 1950's when adult shrimp were harvested to be used as fish food in the aquarium trade in the United States. During the 1970's, the market became dominated by harvest of the cysts, which were used in the commercial aquaculture of shrimp, prawns, and some fish primarily outside of the United States. As the demand for *Artemia* cysts grew, so did the reported harvest from Great Salt Lake.



The quantity and quality of the shrimp cysts depends on many environmental factors, but salinity of the water is very important. Although the cysts from Great Salt Lake will hatch at 2 to 3% salinity, in the lake environment there is greater production of cysts at salinities above about 10%. As lake salinites drop near 5 to 6%, the cysts lose buoyancy, sink, and are more difficult to harvest. During the flood years of 1983-87, when record flows of freshwater entered Great Salt Lake, the salinity of the south part of the lake (also called Gilbert Bay) dropped to about 5.5% and the commercial shrimp industry moved to the part of the lake north of the railroad causeway (called Gunnison Bay) where most of the shrimp were located. By about 1989, the salinity in the south part of the lake was near 10% and the industry again relocated to the south part.

The harvest of cysts in 1995-96 and 1996-97 was about 15 million pounds gross weight (about half is suitable for final product). In 1997 declining salinity (to 11%) resulted in a shift in the algal community to large diatoms which were not a good food source for *Artemia*. The 1997-98 harvest was stopped after about 3 weeks and only 6.1 million pounds of cysts were harvested. The cysts are used not only as a food supply for the aquaculture industry but also for bioassay testing of toxins, drugs, and other chemicals.

USGS publications dealing with the ecology of Great Salt Lake

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