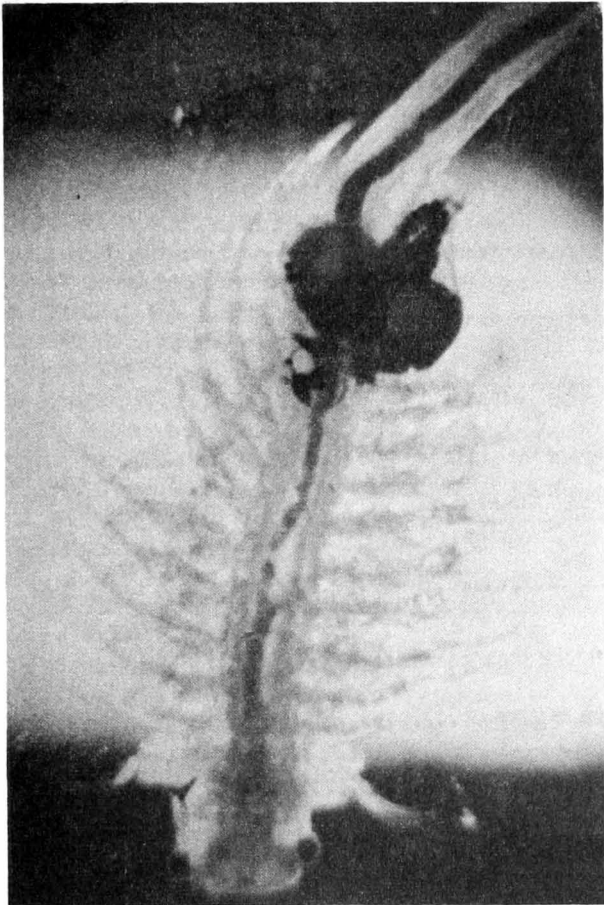


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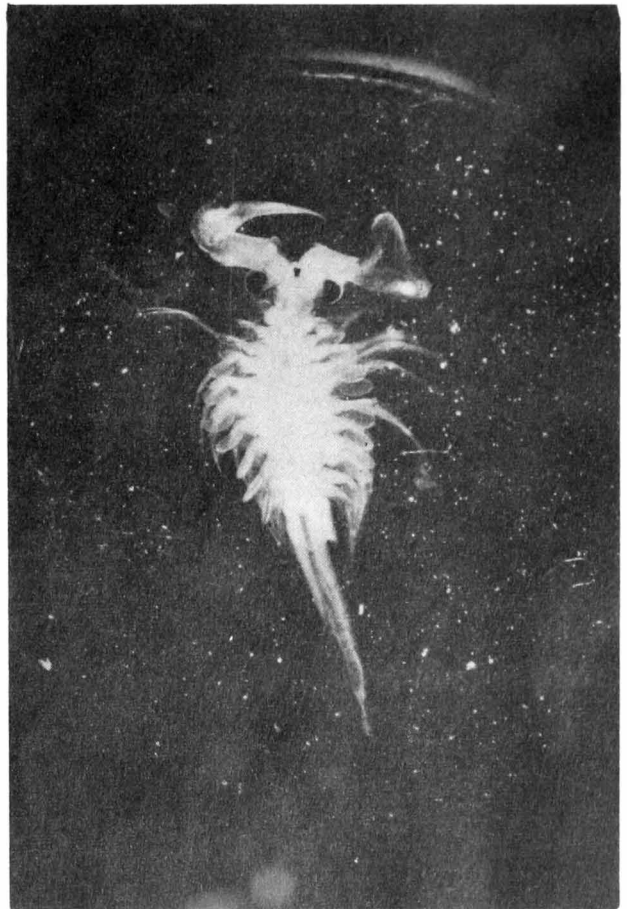
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# Brine Shrimp

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Adult female *Artemia salina* with cluster of eggs.  
Courtesy of Utah Department of Fish and Game.



Adult male *Artemia salina*. Courtesy of Steinhart Aquarium.

By

Lola T. Dees

UNITED STATES DEPARTMENT OF THE INTERIOR  
FISH AND WILDLIFE SERVICE  
BUREAU OF COMMERCIAL FISHERIES  
WASHINGTON 25, D.C.

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# BRINE SHRIMP

By Lola T. Dees  
Branch of Reports  
Division of Resource Development

## INTRODUCTION

The problem of providing live food for their fish beset aquarists until about 1947. It was then discovered in the United States that brine shrimp eggs will remain viable (alive) for at least 10 years when stored in a dry and fairly cool place and will hatch in salty water. This discovery led to the eggs being collected in quantity in their natural environment and marketed on a commercial basis throughout the world as a source of constant live food for aquarium fishes. The eggs cannot be used as fish food because fish cannot digest the tough shells. However, the newly hatched shrimp, which fish relish, do not have a firm shell and can be readily torn to bits by most small fishes. Live shrimp are caught in San Francisco Bay salt ponds and frozen for shipment to pet shops all over North America (Jenné, 1960).

Brine shrimp are crustaceans of the genus *Artemia*, subclass Branchiopoda, and order Anostraca. They occur throughout the world, living and reproducing only in water of high salinity in natural salt lakes and also in ponds where sea water is evaporated to obtain salt. Although they may have descended from ancient fresh-water forms, they cannot live long in fresh water.

## SPECIES

The taxonomic status of *Artemia* has long been controversial, especially in Europe where *Artemia* varies more than it does in the United States (Pennak, 1953). The present consensus is that there is a single world-wide species, *Artemia salina*, which has many varieties. In the United States brine shrimp are best known from the Great Salt Lake, Utah, where the salinity of the water in 1950 was about 25 percent<sup>1</sup>, and in San

Francisco Bay, California, primarily in the salt-evaporating ponds. Sometimes these brine shrimp congregate to form ribbon-like patterns on the surface of the Great Salt Lake nearly half a mile wide and extending for miles out into the lake (fig. 1). They are often so abundant that the water looks red.



Figure 1.--Windrow of adult brine shrimp in Great Salt Lake. Courtesy of Utah State Department of Fish and Game.

Great Salt Lake is the remains of a fresh-water lake, called Lake Bonneville, which drained into the Pacific Ocean by way of the Columbia and the Snake Rivers. Because of decreased rainfall and a drop in level, its outflow stopped. Evaporation by the sun then became greater than the inflow of fresh water from the Jordan River and the Bear River, and the salt concentration increased. In recent times the lake area has varied according to fluctuations in the lake level, ranging from 2,200 square miles in 1873 to 1,500 square miles in 1940.

The ancestors of the Great Salt Lake brine shrimp may have lived in Lake Bonneville

<sup>1</sup> Sea water has about 3 percent salt.

when it was fresh water and gradually adapted to the increasing saltiness of the lake.

## LIFE HISTORY

### Description

Adult brine shrimp are about one-third of an inch long. The males are smaller, but stronger and more active than the females. They have 11 pairs of swimming legs and 2 stalked compound eyes. Disclike gills occur about midway on the legs. The brine shrimp's variation in color from pale yellow-green to blood red is caused by the concentration and the chemical nature of the salts in solution in ponds and lakes where they live.

The adult brine shrimp in Great Salt Lake and in San Francisco Bay die when the water temperature falls below 6° C. (about 43° F.).

### Food

Brine shrimp eat the free-floating algae and other microscopic organisms that occur in brine ponds and salt lakes.

### Reproduction

Brine shrimp reach sexual maturity within 18 to 21 days after hatching and reproduce in two ways. If no males are present, the females have embryos that develop from an unfertilized egg (Relyea, 1937). This phenomenon is called parthenogenesis. When mature females and males are present, the male fertilizes the eggs within the reproductive tract of the female (Dempster, 1953). The eggs remain within the body of the female until a tough shell has formed around each one. Then the eggs, which resemble fine brown sand, are deposited in the water where they will hatch if conditions are favorable. If the female deposits her eggs in sea water which has a specific gravity of 1.09 or higher, they will float on the surface and will not hatch but may be blown by the wind or be carried by water currents to the beaches, where they remain until the rains wash them back into the water. The rains tend to dilute the surface water; and when the eggs come in contact with it, they usually hatch, provided the specific gravity of this water is less than 1.09 and the temperature is higher than 9° C.

In many instances the eggs hatch within the ovisac of the female, and the embryos

develop into nauplii (larvae) before they are born (Dempster, 1953). Movements of the muscles surrounding the ovisac keep the young in motion. Just before birth occurs, some nauplii are suddenly released from the others and moved toward a funnel-shaped aperture in the ovisac. After a few convulsive movements of the funnel muscles, the aperture opens and the nauplii are forcefully ejected into the water.

The natural environment determines whether a female will bear living young or lay eggs (Jenné, 1960). Some shrimp along the coast are washed into a tidepool and left as the tide retreats. If the pool is above the normal high tide line, several weeks may elapse before the sea again reaches the pool. Meanwhile, the water in the pool evaporates, and the salinity increases. The brine shrimp at this time bear living young. Evaporation may continue, and the salt percentage rise. More shrimp and less water mean less food, and the population starts to decline. Responding to this changed environment, the females stop bearing living young and begin laying eggs. When the tide reaches the place where the tidepool was, the eggs are washed out to sea. Though they had lain on the shore for weeks, they now hatch.

### The young

The eggs, which are not harmed by low temperatures, hatch in nature in great numbers in the spring. Baby shrimp (fig. 2) are born with a single eye and one main set of legs (von Hein, 1950). During growth, they acquire a shell which they shed a number of times. Changes occur in the body at each molt until, in the adult, there are 2 eyes and 11 pairs of legs.

## RELATIVES

The several kinds of fresh-water fairy shrimp (*Branchipus*, *Eubbranchipus*, and others) are closely related to brine shrimp. Water fleas (*Daphnia*) are more distant relatives.

## ENEMIES

The chief enemies of brine shrimp in nature are salt-water fly larvae, birds, and human collectors. So far as known, brine shrimp do not have harmful parasites. An abundance of brine shrimp in some areas may result from a lack of enemies.

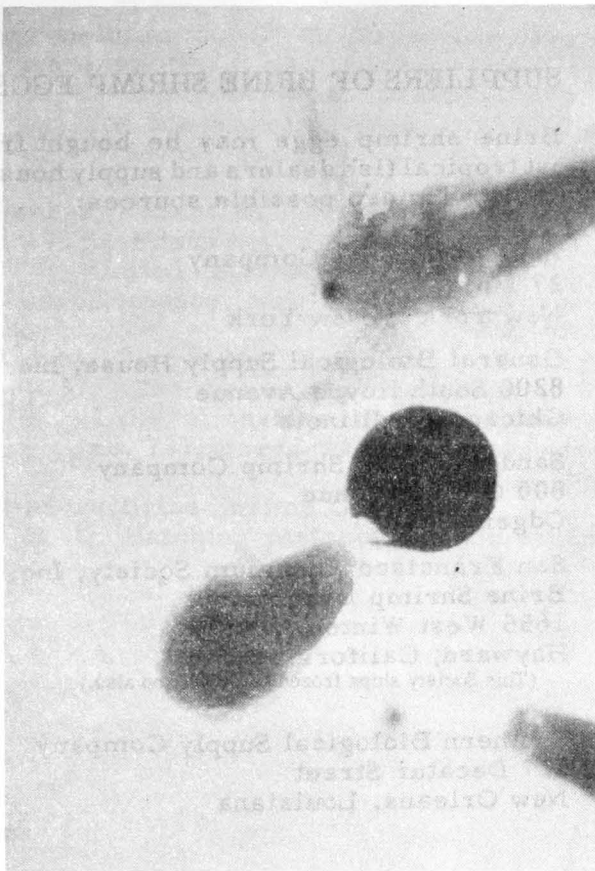


Figure 2.--Hatching brine shrimp and newly hatched brine shrimp. *Courtesy of Utah State Department of Fish and Game.*

## UTILIZATION

Brine shrimp are valuable. They are excellent as zoological teaching material for classroom laboratories, for the development from egg to larva may be observed under a microscope by the students.

Brine shrimp are superior organisms for testing insecticides (Michael et al., 1956). This crustacean demonstrates a high sensitivity against a broad range of compounds.

Baby brine shrimp have become in recent years one of the standard foods for young tropical aquarium fishes, after the fishes have passed the stage when they need microscopic organisms as food (San Francisco Aquarium Society, 1958). Adult brine shrimp also form an excellent food for larger fish.

Fish hatcheries also use brine shrimp for feeding fish. The Utah Fish and Game Department collected brine shrimp in the Great Salt Lake for use as an experimental trout food (Utah State Department of Fish and Game Bulletin, 1956). The Department

found that growth and mortality of newly hatched rainbow trout fed a brine shrimp diet were approximately the same as when the trout were fed a turkey blood and liver diet or a dry feed. Kokanee (land-locked sockeye) salmon fed brine shrimp made excellent growth, while those fed blood and liver or dry feed lost weight. Native trout fed brine shrimp gained more weight than those fed blood and liver or dry feed.

Brine shrimp also aid salt production. They precipitate insoluble calcium carbonate and calcium sulphate impurities from the brine in the salt-water evaporation ponds. The shrimp strain these impurities out of the water along with their microscopic food (Baas-Becking, 1931). The calcium carbonate and calcium sulphate particles are not absorbed in the intestine but become incorporated in the fecal pellets, which drop to the bottom of the pools. This precipitation occurs before the salt is crystallized in the final stage of solar production.

Brine shrimp are not commonly used for human food because they are too small. However, they were so numerous at times in the past that Indians inhabiting the Great Salt Lake region dried them for food.

## COLLECTING AND PROCESSING THE EGGS

Brine shrimp eggs in their natural environment are found floating on top of the water or on the shore where the wind deposits them. They are netted from shallow water or scooped up from the shore, along with mud, and placed in buckets.

Processing the eggs without damaging the tender embryos or starting them to hatch is an exacting technique (Jenné, 1960). The mud is washed by a high-pressure spray through a fine screen. This separates out dead shrimp, parts of dead fishes and birds, and other large impurities. Eggs and water then pass through a sluice box which picks up sand. Since wet, fertile brine shrimp eggs sink in fresh water, the overflow removes dead eggs, shells, and dust, leaving practically pure, fertile eggs at the end of the box.

The eggs are then spread out in a thin layer to dry in the sun. When completely dry, they are cleaned once more by falling through a blower which removes more dust and light dead eggs.

A small sample of the eggs is weighed and then allowed to hatch. The larvae are weighed to assure a high-quality yield when

the eggs reach the aquarist. The eggs are then vacuum packed in cans for shipment to pet dealers, scientific laboratories, schools, and commercial fish hatcheries all over the world.

### HATCHING THE EGGS

Hatching the eggs is simple. If sea water is not available, a brine solution can be made by adding 6 level tablespoons of table salt (without iodine), or rock salt, to 3 quarts of fresh water (San Francisco Aquarium Society, 1958). Thoroughly mix the solution and pour it into an open glass or enamelware pan, about 14 x 8 x 2 inches. Insert a wooden or a glass partition so it will block off about one-fourth of the water at one end of the pan. (The wooden partition should be seasoned by prolonged soaking or boiling in water for 30 minutes.) The partition should extend above the surface of the solution and allow  $\frac{1}{4}$ -inch clearance between the bottom of the partition and the bottom of the pan.

Evenly sprinkle into the smaller compartment of the pan one-half level teaspoon of dry eggs and cover with cardboard or black cloth. The eggs will hatch within 24 to 48 hours at a water temperature of 75° to 80° F. The larvae, being strongly attracted by light, will swim underneath the partition into the lighter area of the pan, where they can be collected with a bulb syringe. Squirt out the salt water with the young shrimp in it into a fine mesh net. After being gently rinsed free of salt under a cold water faucet, they may be fed to small aquarium fishes. The young shrimp cannot live more than 12 hours in fresh water.

### REARING THE SHRIMP

To raise brine shrimp larvae to maturity, place a few of them in a quart or larger container of sea water or brine solution and supply them with food (General Biological Supply House, Inc., 1959). Yeast and one-celled floating algae are satisfactory foods. The algae will usually appear soon in a culture of natural sea water and later in a brine solution in which the eggs (with the natural debris attached to them) are placed. Brine shrimp require from 4 to 5 weeks to reach maturity.

Adult shrimp rarely produce eggs under laboratory conditions. The reason is unknown.

### SUPPLIERS OF BRINE SHRIMP EGGS

Brine shrimp eggs may be bought from most tropical fish dealers and supply houses; the following are possible sources:

Aquarium Stock Company  
27 Murray Street  
New York 7, New York

General Biological Supply House, Inc.  
8200 South Hoyne Avenue  
Chicago 20, Illinois

Sanders Brine Shrimp Company  
800 Ogden Avenue  
Odgen, Utah

San Francisco Aquarium Society, Inc.  
Brine Shrimp Department  
1655 West Winton Avenue  
Hayward, California  
(This Society ships frozen brine shrimp also.)

Southern Biological Supply Company  
517 Decatur Street  
New Orleans, Louisiana

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1937. The brine shrimp of Great Salt Lake. *American Naturalist*, vol. 71, no. 737, p. 612-616.

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N. D. Hatching instructions for Sanders

brine shrimp eggs. 2 p. (Available at 800 Ogden Avenue, Ogden, Utah.)

San Francisco Aquarium Society, Inc.

1958. The brine shrimp and how to hatch its eggs. 3d ed. 8 p. (Available at Steinhart Aquarium, Golden Gates Park, San Francisco 18, California.)

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