Artemia, the magic Brine Shrimp

The story of Artemia, the brine shrimp, does not start in the 20th century, when researchers discovered and improved the value of this tiny crustacean organism as a very suitable food for fish larvae. Nor does it start in the mid-18th century with a first scientific description by Schlösser. And not even with the first known written record by an Iranian geographer in 982 describing an "aquatic dog" from Lake Urmia.

The history of Artemia and other Anostracods (fairy shrimps) truly started around 500 million years before this, in the late Cambrium and early Ordovician period when their ancestors split off from their marine Branchiopod relatives to colonize freshwater biotopes. During the following 250 million years they evolved and colonized the planet, always seeking out ecological niches which were free of significant predators.

Since the Triassic period, when the first dinosaurs appeared on Earth, most species have remained virtually unchanged. The Artemia family is characterised by having selected hypersaline habitats as their ecological niche - lakes and bodies of water, so saline (up to 300 g/l) that few other higher organisms could survive. In order to thrive in these hostile environments, brine shrimp evolution resulted in a few significant adaptations.

Artemia turns red in environments with low oxygen level.

The first problems to overcome were the high osmotic pressure and low oxygen content of the water due to its high salinity. Brine shrimp developed a strong osmoregulatory capacity allowing them to remove excess salt from their body. And unlike most other crustaceans, who rely on the copper-based hemocyanin as oxygen-carrying blood protein, brine shrimp are using an iron-based hemoglobin protein which can function in conditions of decreased oxygen pressure. This becomes especially visible when Artemia, living in high density populations at low oxygen levels, turn almost blood red in color, a phenomenon which can also be seen with another planktonic crustacean, the water fleas (Daphnia spp.).

Also for its food, Artemia cannot afford to be picky. They evolved to become non-selective filter feeders ingesting everything between 20-40 µm, making optimal use of the limited organic particles and microscopic organisms that can be found in their hostile saline environment. In their best known habitat, the Great Salt Lake in Utah, their main diet consists of halophilic bacteria and archaea, and micro algae from the genus Dunaliella.

Great Salt Lake (Utah, USA) is the largest habitat for Artemia salina.

Did you know...

that flamingos get their pink color from eating Artemia? The organisms in the diet of Artemia are an excellent source of carotenoid pigments. The pigments don't provide a specific red color to the Artemia but are able to color up the animal feeding on Artemia, like the famous flamingos and also our beloved aquarium fish.

Easy hatching

Even their reproductive strategy is optimized for these harsh living conditions. When water parameters and food availability are relatively favorable, the females give birth to free-swimming larvae (Instar I nauplii) developed from embryos. This allows for an explosive population increase in a limited time window, with nauplii becoming sexually mature in around three weeks and adult females able to release up to 200 live nauplii every few days. When this window of favorable conditions begins to close due to lower temperatures or oxygen concentration, increasing salinity and lack of availability of food, the embryos are no longer released as free-swimming larvae, but surrounded by a hard, brown shell consisting of chitin, lipoproteins and hematin (the brown pigment).

One gram of Great Salt Lake Artemia cysts contains about 285000 eggs.

These very resistant dormant 'eggs' are called cysts and can survive extreme conditions like freezing and dehydration. When circumstances improve, like in spring in the Great Salt Lake, the cysts hatch into live nauplii to start the cycle over again. It is especially this last characteristic that made Artemia an essential part of the rise of aquaculture worldwide. It is very hard to overestimate the value of a product that can be easily stored and transported and yet, in less than 24 hours can be turned into an essential live food for fish and shrimp larvae.

The main ingredients for this are seawater strength saline water and the above-mentioned dry cysts. Fine-tuning of hatching water temperature, pH, salt composition, aeration and illumination all provide added efficiency, but the brine solution and the cysts are basically the starter package.

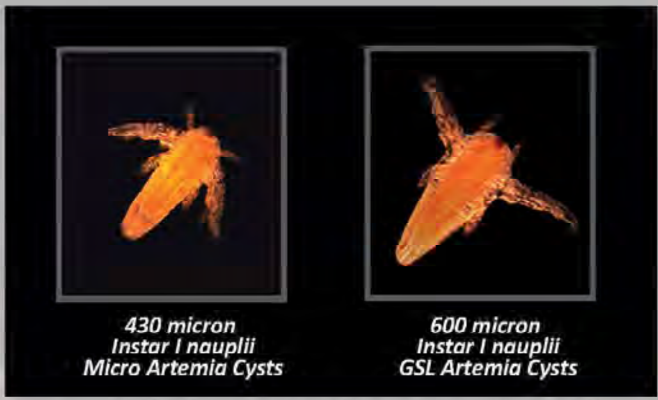
Artemia hatching cones are used to separate the hatched Artemia nauplii (at bottom, see arrow) from the empty shells.

The different stages from Artemia cyst to Instar II nauplius.

The hatching process consists of several important stages. Initially, the dried cysts start to rehydrate, taking up water from the solution which causes them to inflate. After around 20 hours, the outer membrane, or chorion, is ruptured and the embryo emerges, still wrapped in a thin transparent membrane which stays attached to the chorion. Because of its appearance, this step is called the umbrella stage. Just a few hours later, the embryo is developed enough to finally hatch as an Instar I nauplius, a bright yellow or orange larvae of around 400-500 µm, which resembles a droplet with two swimming arms. At this stage, the nauplius is not capable of feeding. It will only be able to take up food particles after another eight hours when it molts into an Instar II nauplius, slightly more elongated than the Instar I. Another 14 molts later, going through different Instar stages in a time span of about three weeks, the Artemia reaches maturity at a size of roughly 1cm.

Non-selective filter feeder

The increasing economic importance, initially in the aquarium business and later on in the aquaculture industry, triggered a scientific research frenzy that soon resulted in the discovery of hundreds of different strains and geographical variations, spread over every continent with the exception of Antarctica.



An example of different strains of Artemia, resulting in different sizes at the same stage.

Both genetics and variable living and feeding conditions result in a variety of parameters that are all-important when using Artemia as food for larval fish and shrimp. Clear changes have been found in size, biochemical composition (omega fatty acid profiles), reproductive strategy (sexual, asexual), cyst size, cyst hatch rate (speed of hatching), hatching percentage (nauplii/100 cysts) and hatching efficiency (nauplii/g dry cysts).

Although the use of Artemia was a major driver behind the rise in global aquaculture production, it also became clear that for all the benefits Artemia was offering, it was nutritionally not the perfect feeding organism. Especially for marine larval organisms, the biochemical composition, especially the content and ratios of omega-3 fatty acids, was not optimal for the proper early development of several important fish and shrimp species. This deficiency, among others, lead to problems like bad pigmentation, deformities and an often lethal sensitivity to all kinds of stress factors.

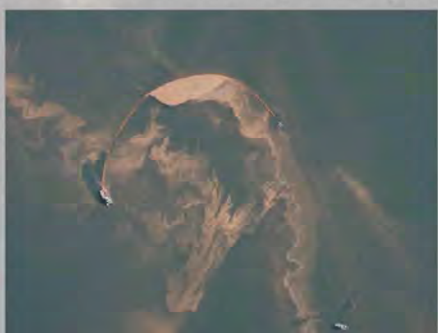
Artemia nauplii instar II enriched with HUFA oil droplets (droplets visible inside black circle).

To solve this problem, another typical characteristic of Artemia turned out to be crucial: its non-selective filter feeding habit. This allowed researchers to fill up the nauplii with the necessary essential nutrients that the Artemia lacked itself. Apart from using micro algae and yeast preparations, the use of small emulsified water-soluble oil droplets proved very efficient in enriching the nauplii with essential omega oils and vitamins.

This scientific breakthrough allowed for an even greater use of Artemia in the aquaculture industry, up to the point that the global harvest, which remains dependent on natural factors, couldn't keep up with the increased demand, despite the fact that harvesting practices had improved over the years.

A versatile product

While the initial harvesting method was simply to collect the cysts that were washed upon the lake shores, more intensive techniques soon involved the use of small boats and even planes to collect the floating cysts wherever wind and current concentrated them, forming a thick layer on the water surface. From there, they are brought ashore to go through several rounds of washing and drying.



The harvesting process on the Great Salt Lake (Utah, United States).

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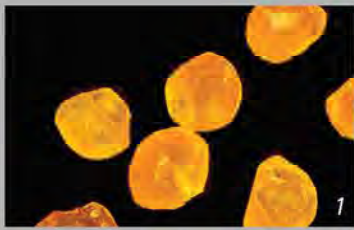
The steep price increase as a result of the high demand sparked renewed interest in the development of Artemia replacement products. Despite the clear improvements that were made, a complete replacement remains an elusive dream in the cultivation of many aquaculture and aquarium species. Certain enzymatic and other factors in fresh Artemia nauplii still seem very hard to mimic through artificial diets, which also lack the feeding-triggering movement of live feed.

The shortage also led to further diversification in the number of the harvest locations, including artificial inoculations of additional hypersaline water bodies, and in the number of new applications. Non-compliant cyst batches were technically upgraded to improve efficiency, or decapsulated (Shell Free Artemia) to be used as a feed.



Novelties like the Sep-Art Artemia, allowing to magnetically remove unhatched cysts from the live nauplii, and the availability of frozen, preserved and even freshly hatched and cooled nauplii further increase the ease of use and efficiency of Artemia in the aquaculture industry and aquatics.

Dehydrated, decapsulated Artemia cysts (1) and the same cysts after hydration (2).

Artemia is definitely here to stay and it has a bigger impact on day-to-day life than it might seem. A lot of seafood, like many farmed fish and shrimp species, would not be on our plates if it weren't for Artemia. Many of the popular marine and freshwater ornamental fish, which are farmed nowadays thanks to Artemia, probably received Micro Artemia Cysts in their early stages, and adult Artemia is a well-known food for larger fish, whether it's fresh frozen in blisters or processed in dry fish foods.

A selection from Ocean Nutrition's Artemia products.

As a major player in the ornamental aquatic pet industry for many years, Ocean Nutrition is continuously following up on the latest biological and technological innovations around Artemia, in order to continue to provide top quality, sustainable Artemia products for the aquaculture industry and aquatics.

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