Artemia *Research and its Applications. 1987. Vol. 3. Ecology, Culturing, Use in aquaculture*
P. Sorgeloos, D. A. Bengtson, W. Decleir, and E. Jaspers (Eds). Universa Press, Wetteren, Belgium. 556 p.

Rearing *Artemia* in a salt pan near Sambhar Lake (India)

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Abstract

Attempts were made to reintroduce *Artemia* into the Sambhar Salt Lake, the largest inland salt lake of India. The lake, once a natural biotope of brine shrimp, is now totally devoid of *Artemia* because heavy floods during the recent past resulted in considerable ecological changes.

Rearing trials with laboratory-hatched *Artemia* nauplii from Didwana Lake (India) were made in a 2 ha salt pan filled with brine from Sambhar Lake. Prior to and after inoculation, the water of the pan was analyzed for the main abiotic and biotic parameters. The inoculated *Artemia* did not survive in Sambhar Lake, but did survive when cultured in the laboratory in aerated Sambhar Lake water. Low levels of dissolved oxygen probably prohibit *Artemia* from living in Sambhar Lake.

Introduction

The ecological history of Indian inland saline lakes reveals that they have been subjected to extreme environmental conditions varying from immense floods to long dry periods. Sambhar Salt Lake which once harboured a rich *Artemia* population (Baid, 1958) is now totally devoid of it (Alam, 1980 ; Bhargava, 1984). This has been a consequence of repeated floods in the region during the last decade, resulting in the introduction of a variety of freshwater biota including predatory fishes through a riverine system. The salinity of the lake has been reported to drop from 160 ‰ to 4.3 ‰ during flood conditions. Adverse climatological conditions, apart from considerations of *Artemia* dispersion, are considered as limiting for the presence of *Artemia* in salt-water bodies which seem to be suitable for brine shrimp (Persoone and Sorgeloos, 1980).

Since the salinity of Sambhar Salt Lake has regained a moderately high level and no predators occur, an endeavour has been made to reintroduce the brine shrimp in this lake environment. To begin with, rearing trials with the *Artemia* from Didwana Salt Lake (India) have been carried out in a salt pan near Sambhar Salt Lake. The present communication deals with the results of two inoculation experiments conducted in a salt pan under different weather conditions, and also of the rearing of *Artemia* of Didwana Salt Lake origin in the brine of Sambhar Salt Lake under controlled laboratory conditions.

Materials and methods

Didwana Salt Lake (27° 3′ N and 74° 5′ E) is, presently, the only inland natural biotope of *Artemia* in India. Cysts collected from this lake during March-April 1984 were used for the experiments.

Sambhar Salt Lake (26° 58′ N and 75° 55′ E) is the largest inland alkaline saline lake in India, located in the semi-arid region of the State of Rajasthan. The lake is shallow, with a maximum depth of 3.75 m but is widely spread covering an area of about 190 km^2. In the close vicinity of the lake are large numbers of salt pans which are used for extraction of edible salt from the lake. One of the salt pans (2 ha area ; 0.25 m depth) was chosen for the inoculation experiments.

Cysts were hatched in the field laboratory at the lake site. Freshly-hatched nauplii in instar I stage were separated and immediately released in the pan during the cooler hours of the day at various points in the direction of the wind so as to ensure their quick dispersal. The stocking density was 12 nauplii/l. Prior to and after the inoculation the water was analyzed for the main abiotic and biotic parameters : minimum and maximum temperature, pH, dissolved oxygen, salinity, phytoplankton, and zooplankton. The experiments were carried out during October 1984 and March 1985.

Results and discussion

At the initiation of the October 1984 experiment, the salinity of the pan was 63.22 ‰, the dissolved oxygen level 8 mg/l, and pH 9. A zooplankton population (105 individuals/l) comprising *Cyclops* sp. and *Brachionus* sp., and unialgal phytoplankton population of *Spirulina* sp. (425×10^3 cells/l) formed the main biota of the pan.

It was surprising to note that after inoculation no nauplii survived after 12 h in the pan while populations of other zooplankters also declined to less than half of the number (45 ind./l). Competition for food among zooplankton does not seem to be the cause of this mass mortality of nauplii as at this stage they do not require food. As the pan was free from predators, the question of predation is also ruled out. It was presumed that possibly the low water temperature (around 15 °C) and drop in dissolved oxygen concentration during the night resulted in the mortality of the nauplii and other zooplankters.

In order to verify the above presumption the experiment was repeated during March 1985 when the water temperature was moderate (20-31 °C). The salinity of the pan during this period was 90 ‰ and the pH 9.4. The pan was free from zooplankters, while a phytoplankton population of 700×10^3 cells/l comprising *Spirulina* sp., *Aphanocapsa* sp., and *Nitzschia* sp. was present. The dissolved oxygen was low (2.14 mg/l) even during sunshine. Nauplii inoculated during this period also showed a total mortality within 12 h.

The ionic composition of Didwana Salt Lake, to which the *Artemia* cysts originally belonged, was compared with that of the salt pan in which the population was inoculated (Table I). Although the water of the salt pan was relatively harder, there was not much difference in the milliequivalent percentage (mEq %) of major cations and anions.

In order to ascertain any specific role of ionic composition in the mortality of the *Artemia* population, laboratory culture in brine from the same salt pan was tried. The temperature was maintained at 30±2 °C. The brine was aerated through air pumps. No supplementary food was

TABLE I

Ionic composition (in mEq %)
of the inoculated salt pan (near Sambhar Salt Lake) and Didwana Salt Lake

Ions	Salt pan	Didwana Salt Lake
Cations		
Na^+	97.64	98.61
K^+	0.13	0.21
Ca^{++}	1.08	0.40
Mg^{++}	1.12	0.76
Anions		
CO_3^-	5.80	0.39
HCO_3^-	2.01	0.30
Cl^-	91.03	98.90
SO_4^-	1.14	0.39

provided for the first 2 days of culture ; however, thereafter the manuring was done as described by Dwivedi *et al.* (1980). Interestingly, the brine shrimp population thrived well. In another culture in which no artificial aeration was provided, the nauplii died similarly to those in the experiments in the salt pan. In the aerated culture the brine shrimp attained the adult stage 15 days after inoculation. The length of the adults varied from 10 to 14.5 mm. The adults commenced to breed on the 48th day.

The study reveals that a major bottleneck in *Artemia* culture in salt pans of Indian arid or semi-arid regions is the high rate of evaporation causing a rapid increase in the salinity (6 ‰/day) which in turn results in low levels of dissolved oxygen. This is probably due to : the mass mortality of phytoplankton and an increase in the decomposition rate of the dead algae.

During their study on *Artemia* rearing in earthen salt ponds in the Philippines, Primavera *et al.* (1980) observed a similar phenomenon of total collapse of *Artemia* population when solar salt was added to a pond to increase its salinity. They attributed it to two major factors : resultant high concentration of $CaSO_4$ which may have been toxic to *Artemia* (Vos, 1979), and a salinity increase (44 to 53 ‰) stimulating excessive lablab growth which may have led to unfavourable environmental conditions (low oxygen concentration, a high BOD, high concentration of ammonia and/or sulphide, etc.). Lablab was described as a microbenthic complex of bacteria, diatoms, blue green algae, protozoans, and other microorganisms by Rabanal (1966, cited from Primavera *et al.*, 1980). In their study on brine shrimp in temporary saline ponds of Iraq, Khalaf *et al.* (1977) also pointed out the effect of low oxygen on the disappearance of *Artemia* population.

The rearing of *Artemia* in such salt pans is not recommended.

Acknowledgements

This work was carried out under a Man and Biosphere Project sponsored by the Department of Environment, Government of India. Authors are thankful to the National MAB Committee, India, for the financial support and to the Head, Department of Zoology, University of Jodhpur, Jodhpur, for providing facilities.

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