

INTRODUCTION OF *ARTEMIA* IN COASTAL SOLAR SALTWORKS: ECONOMIC OPPORTUNITIES AND ECOLOGICAL CHALLENGES. THE CASE OF THE BOHAI BAY, PR CHINA.

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EXTENDED ABSTRACT

Bohai Bay is one of the three bays forming the Bohai Sea, a semi-enclosed area or gulf of the Yellow Sea, in northeastern China. Due to the effluents of the adjacent Beijing-Tianjin area's rivers and runoff, massive amounts of waste water are discharged into the Bay. Being surrounded by heavily populated and industrialized areas, and due to overfishing, intensive coastal aquaculture, accumulation of nutrients and sediments, it is an environment where the natural ecosystem is heavily under stress (Jin, 2004). The Bohai Bay coastal area is the main salt producing region of the country, with more than 200 saltworks operational over a total area of about 600,000 ha, producing a total of about 20 million tons of salt per year.

These saltworks used to be the biotope of various local parthenogenetic *Artemia* strains, the scientific study of which did not start before the early '90s, especially in the Tanggu area. Tackaert and Sorgeloos (1991a, 1993) described the area as highly eutrophicated, where harvesting of *Artemia* cysts and especially biomass, used in local shrimp hatcheries and grow-out facilities, had become a considerable industry employing several hundreds of people; nauplii of the brine shrimp *Artemia* are the most common live food, used in marine larviculture. The local parthenogenetic Tanggu *Artemia* populations were, however, characterized as being poorly adapted to the present environment in the saltworks, where the original habitat has been strongly modified for the sake of solar salt production. Nevertheless, in this period, the yearly production of Tanggu cysts amounted up to approximately 100 tons.

But, as elsewhere in the world, alternative *Artemia* strains with better economic perspectives were sought and introduced, or dispersed themselves after incidental introduction as a result of aquaculture activities. Since the early '90s large quantities of cysts and biomass have been collected from several inland lakes in Inner Mongolia, China, in order to sustain the rapidly expanding shrimp industry in the area (Tackaert and Sorgeloos, 1991b). Xin et al. (1994) confirmed the import of over 100 tons of Great Salt Lake *A. franciscana* cysts annually for use in the local hatcheries. But especially the San Francisco Bay (USA) *A. franciscana* strain is highly appreciated as combining high productivity in saltworks with interesting market characteristics: production of small cysts, simple diapause termination procedures, better colonizing ability at higher salinities, as compared to the Tanggu parthenogenetic strains (Triantaphyllidis et al., 1995). Laboratory competition experiments in well-defined conditions of temperature, salinity and food availability illustrated the dominance of *A. franciscana* over parthenogenetic strains (Browne, 1980; Browne and Halanych, 1989). Current *Artemia* production in the

Bohai Bay area amounts up to 600 tons for cysts and 20,000 tons for biomass. Taking into account the different fitness of these populations, and the local or regional dispersal of populations following introduction, it can be expected that the natural biodiversity of the genus *Artemia* in this area has been affected by this massive introduction of allochthonous cysts for several years. Since the first introduction of *A. franciscana* in the area in 1992, the average cyst diameter of locally produced cysts has decreased from 272 to 240 μm , while there has been an increase in biomass production varying locally between 30 and 100 %, which indicates the growing share of *A. franciscana*.

The cyst bank of the Laboratory of Aquaculture & *Artemia* Reference Center, Ghent University, Belgium, contains about 75 cyst samples from the Bohai Bay area, dating back from the late '80s until today. A selection of samples was used to assess the status of this presumed shift in species composition through HpaII RFLP analysis of a 1500 bp mitochondrial rDNA fragment in the individual cysts; according to Bossier et al. (2004), this analysis is sufficient to identify the presence of *A. franciscana* in a sample. HpaII also allows identification of other species down to the species level. The sex ratio of the populations was determined through laboratory culture tests. With two exceptions, all samples consisted of varying mixtures of parthenogenetic and *A. franciscana* and/or *A. sinica* individuals. These results clearly demonstrate that *A. franciscana* has become a competitor – and probably a threat – for the autochthonous parthenogenetic Bohai Bay populations. The gradual dispersion of this exotic species in new environments, competing with and eventually outcompeting local populations, is a pattern becoming increasingly common in the last two decades in various parts of the world (Amat et al., 2005; Green et al., 2005). Keeping in mind the high dispersal capacities of *A. franciscana* (Camara, 2001) and its competitive advance over parthenogenetic strains, the disappearance of the local Bohai Bay strains in large parts of their original distribution area, if not already a fact, is at least a short-term possibility. As immediate measures to ban or limit the introduction or further dispersal of exotic *Artemia* are not realistic in the socio-economic context of the Bohai Bay, again a plea should be made in favour of the preservation of the original gene pools in cyst banks (Beardmore, 1987).

Keywords: *Artemia franciscana*, Bohai Bay, invasive *Artemia*, parthenogenetic *Artemia*, RFLP analysis

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