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SUCCESSFUL INOCULATION OF *ARTEMIA* AND PRODUCTION OF CYSTS IN THE COASTAL SALTPANS OF BANGLADESH II

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ABSTRACT: Bangladesh has no naturally occurring *Artemia*, and all the growing shrimp hatcheries of the country depend entirely on import of cysts from foreign countries. Following successful inoculation of *Artemia* and production of cysts for the first time in this country in a coastal saltpan (at Chanua, Banskhali) by the senior author (in 1989-90), a similar second attempt was made under this programme in a saltpan (1000 m^2) of Demoshia, Chakaria, Cox's Bazar, Bangladesh between January and April 1992. A total of 1639.9 g (dry weight) of cysts (i.e. 5.46 kg DW/ha/month) have been produced using the Red Jungle Brand, whereas the previous attempt obtained 517 g of cysts (i.e. 2.07 kg DW/ha/month) using the Great Salt Lake Brand.

KEY WORDS: *Artemia* culture - cyst production - saltpans - Bangladesh coast

INTRODUCTION

Artemia, commonly known as brine shrimp is about 12 mm in length. All over the world *Artemia* cysts are used as one of the most important food items both in finfish and crustacean hatcheries for mass production of fry. This small planktonic crustacean occurs naturally in some extreme regions of the ecological niches in saltlake and brine ponds with salinity ranging between 60 and 300‰; and does not occur in every existing body of saltwater. It is unable to migrate from one saline biotype to another via the sea because it does not have any anatomical defence mechanism or structure against predation by carnivorous aquatic organisms. Because of its unnatural occurrence *Artemia* cysts are to be imported in large quantities from abroad and its nauplii are used as a live food for the larvae and juveniles of many cultured species such as freshwater prawns (*Macrobrachium* sp.), shrimps (Penaeids), lobsters (*Homarus* sp.), crabs and different finfishes (Bardach *et al.* 1972; Sorgeloos, 1976; Rosemark, 1978).

Nauplii of *Artemia* are easily and quickly obtained by hatching them in seawater. They survive and remain active in water of different salinities. Even when put in freshwater, mortality occurs only after 2-3 hours of exposure.

In extremely high salinity conditions of earthen saltpans constructed all over the world in the tropical and subtropical belt for solar salt extraction, only few plant and animal species can live, the most popular organism being the *Artemia* (Persoone and Sorgeloos, 1980).

Artemia eggs are very high in nutrient value, they contain 52% protein and 27% fat. Nauplii and Instar 1, contain 40% protein and the adult has a protein content of 60% of the dry weight which makes them an excellent food (Tunsutapanich, 1979; Sorgeloos and Kulasekarapandian, 1984).

In Brazil a great potential for commercial scale integrated production of salt+*Artemia*+shrimp production in saltpans has been demonstrated (Sorgeloos, 1983).

Now it is proved that inoculation of *Artemia* cyst in man-managed solar saltpan can play a vital role in mass production of *Artemia* and salt. Recently in South America and Australia *Artemia* has been transplanted by man for improvement of the quality of salt produced from the saltpans (Sorgeloos and Kulasekarapandian, 1984).

From quite a long time back, in the coastal belt of Banskhali, Chakaria, Cox's Bazar, Kutubdia, Matharbari and Moheshkhali islands are used extensively for production of salt from the salt pans. So, there is a great potential for culture of *Artemia* as a by-product of salt extraction from the coastal saltpans of Bangladesh.

Thailand, India and the Philippines which have no natural population of *Artemia* have recently started production of cysts from the saltpans by successful inoculations (Vos and Tunsutapanich, 1979).

Karim (1974) and Mahmood & Begum (1978), initiated laboratory scale research work on *Artemia* in Bangladesh and for the first time field trials gave some preliminary positive results on culture of *Artemia* in Bangladesh (Mahmood, 1989). The first successful production of *Artemia* biomass and cysts were reported from a coastal saltpan of Bangladesh (Banskhali) by the senior author (Mahmood, 1990) through inoculation of nauplii hatched out from cysts (Great Salt Lake Brand, U.S.A.). A similar second attempt has been made through this study to produce cysts and *Artemia* biomass using the Red Jungle Brand, U.S.A.

Vos and Rosa (1980) stated that more than 50 different strains exist world over with differences in specific characteristics such as hatching rate, nauplius size, viability, optimal temperature and salinity range requirements etc. Until now it has been possible to examine production performances of only one strain in our coastal saltpan (Mahmood, 1990), and thus lot of work remain to be done in this line to sort out the strains suitable for culture in our coastal climatic conditions.

MATERIALS AND METHODS

The study area was located in Demoshia (Chakaria) opposite to Matharbari and Moheshkhali Islands in the coasts of Cox's Bazar, Bangladesh (Fig.1). A traditional saltpan located in the study area was renovated to meet the requirements for integrated production of *Artemia* cysts and salt (Fig.2).

Field preparation was started in December 1991 on a small plot of land (1000 m^2). An existing saltpond was modified for integrated production of *Artemia* biomass, cysts and salt.

Water depth of the pond was maintained to around 30 cm to prevent attainment of too high temperature. It was done by slight excavation of the bottom soil and by raising height of the dykes. Vos (1979) mentioned that water temperature of *Artemia* culture pond should not exceed 35-36^{o}C.

Water intake structures were prepared to allow water intake at regular intervals. Compaction of the soil on the dyke was made to prevent leakage and seepage through the dykes and pond bottom.

Two *Artemia* production ponds (APP) (45 m^2 each) and a series of evaporation compartments were constructed (Fig.2).

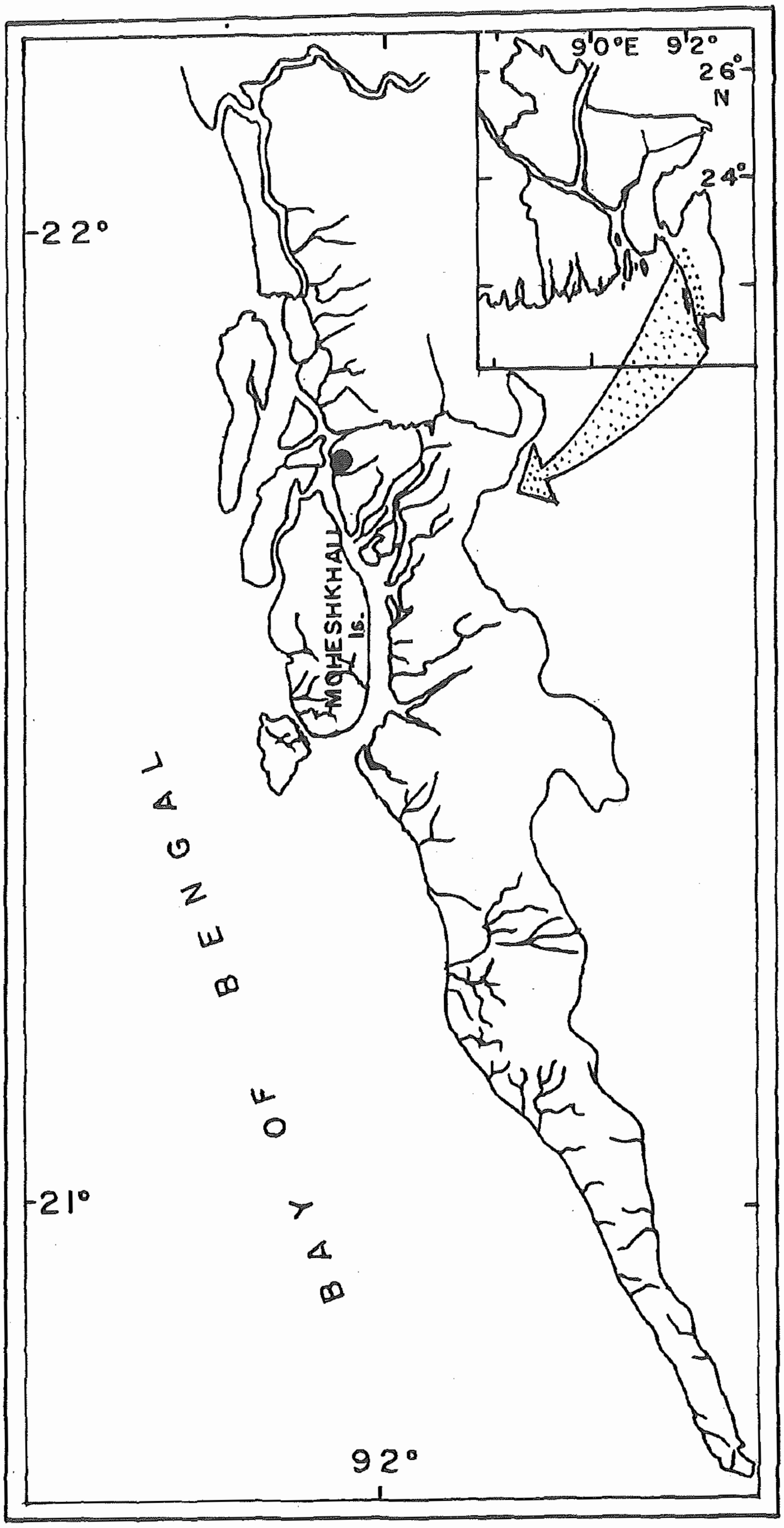

Fig.1. Map showing geographical location (black dot) of the experimental *Artemia* production ponds in a coastal saltpan of Demoshia, Chakaria, Cox's Bazar.

At the dyke sides of the *Artemia* production pond (APP) cyst barriers were fabricated with bamboo frame and lined with black polyethylene sheet for collection of cysts at ease.

'Lab-lab' is undesirable in *Artemia* ponds. Unlike shrimp it is not a good food for *Artemia* and when it starts floating it can seriously hamper cyst harvest (Vos and Rosa, 1980). Pond bottom was dried, raked up and all traces of decayed 'lab-lab' were removed.

Sea water of 25 ppt was pumped in the reservoir on January 9, 1992 which passed through a screen of 1 mm mesh to prevent entrance of shell or finfish larvae. This water was drawn from a mangrove estuary near the experimental saltpan. Water of mangrove area has a much higher food content for *Artemia* in its suspended organic detritus particles (Vos and Rosa, 1980).

After six days of water intake, salinity was increased about 57 ppt by gradual evaporation. Then pond water was fertilized with both inorganic and organic fertilizer as follows: inorganic fertilizer : 180 g of urea was applied in each pond (APP); organic fertilizer; simultaneously 3.6 kg of dry chicken manure was also applied in each pond.

Weekly replenishments were made at the rate of 45 g of urea and 900 g of dry chicken manure in each pond. Fertilization was done when the pond water level attained its maximum after intake of fresh brine in order to ensure bloom of phytoplankton.

Artemia cysts (Red Jungle Brand, U.S.A.) weighing 30 g were taken in a plastic container and 3 litres of seawater (about 35‰) were added with provision of continuous aeration. After an incubation period of 30 hrs, the nauplii hatched out. Newly hatched nauplii were taken in a polyethylene bag, concentrated sea water from APP was introduced slowly and gradually to help adapt nauplii to the temperature-salinity regime of the APP. Then nauplii were distributed throughout the whole pond uniformly. The nauplii were inoculated to APP at 7 pm on the 22nd of January, 1992.

Hydrometeorological parameters (water temperature, dissolved oxygen, salinity and pH) of the APP were recorded at five days intervals following standard methods (APHA, 1976) at the culture site.

Water depth was maintained around 30 cm and water temperature below 35°C. Salinity gradually increased to as high as 153‰. From time to time, concentrated brine from the *Artemia* production pond (APP) was drained to the crystallization pond to produce salt.

Cysts were collected regularly from along the side of the cyst barriers where they aggregated following wind drift. A fine meshed scoop was used for this purpose. Soon after collection cysts were put on a sieve and washed with several changes of freshwater to remove soluble matters. The cysts were then transferred to a container filled with water of 250-300‰. Aeration was provided continuously from a tube. The cysts kept on floating at the surface while other solid matter such as earth, sediments and other particles sank to the bottom of the container. Cysts were then removed from the container and allowed to be dried in the air to about 10% moisture content level avoiding direct sunlight. The dried cysts were transferred to screw capped containers and kept in a cool dry place such as a freezer.

OBSERVATIONS AND RESULTS

PHYSICO-CHEMICAL PARAMETERS:

Air temperature was recorded from the experimental area, mean of which has been

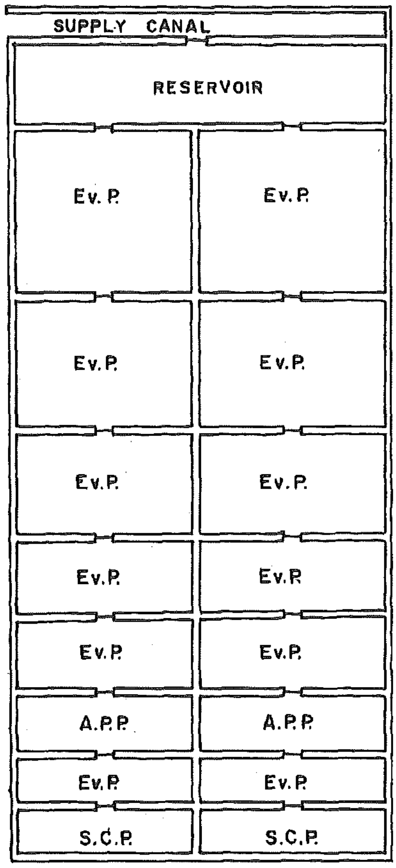

Fig.2. Layout of the *Artemia* cyst production and evaporation ponds (over 1000 m^2) in the coastal salt producing area of Demoshia, Chakaria, Cox's Bazar. (Ev.P. = Evaporation pond. APP = *Artemia* production pond. SCP = Salt crystallization pond).

shown in Fig.3a. During the study period, the lowest mean atmospheric temperature was 22.5°C, recorded on 29th February, 1992 and highest (33°C) on 5th, 10th and 15th of April, 92 (Table I).

The mean values of water temperature have been plotted in Fig.3a. The lowest mean water temperature (19°C) was recorded on the 13th, 15th and 29th February, 1992 and the highest (34.2°C) on the 15th of April, 1992 (Table I).

In *Artemia* production ponds minimum salinity was found to be 50‰ at the beginning of the experiment during the month of January and the maximum (153‰) in April (Fig.3b, Table I).

The range of dissolved oxygen (mean value) varied between 4.0 and 6.0 ml/l. The maximum and minimum values were found to be 6.0 and 4.0 ml/l in the month of January and April respectivley (Table I).

During the experiment water depth varied between 24 and 30 cm with a mean value of 28.06 cm. Minimum depth was encountered on the 15th of January and the maxima on 31st January, 8th February and 10th April, 1992 (Table I). The hydrogen ion concentration of the APP (Table I) during the study period was observed to be in the range of 7.7 to 7.9.

Table I. Environmental parameters of the *Artemia* cyst production ponds during pre-monsoon dry season of 1992.

Date	Air Temp. (°C)	Water Depth (cm)	Water Temp. (°C)	Salinity (‰)	DO (ml/l)	pH	Seawater Salinity (‰)	Remarks
15/1/92	24.0	24	22.0	50	6.0	7.9	25	
20/1/92	25.0	27	23.0	70	5.7	-	-	
25/1/92	24.5	29	22.0	79	5.6	-	-	
31/1/92	25.0	30	23.0	85	5.2	7.8	-	
04/2/92	26.0	28	24.0	94	5.1	-	-	
08/2/92	24.0	30	22.0	93	5.7	-	-	H.R.*
13/2/92	23.0	27	19.0	97	5.3	-	-	
15/2/92	23.0	29	19.0	94	6.0	7.8	-	H.R.*
20/2/92	23.0	28	21.0	98	5.4	-	-	
29/2/92	22.5	27	19.0	101	5.1	-	-	
05/3/92	26.0	27	25.0	110	4.8	-	-	
10/3/92	29.0	27	29.0	116	4.5	-	-	
15/3/92	29.5	28	30.0	120	4.4	7.9	-	
20/3/92	30.0	27	30.5	123	4.3	-	-	
25/3/92	30.5	27	31.0	129	4.4	-	-	
31/3/92	32.2	27	33.0	135	4.3	7.8	-	
05/4/92	33.0	28	34.0	141	4.0	-	-	
10/4/92	33.0	30	34.0	148	4.0	-	-	
15/4/92	33.0	29	34.2	153	4.0	-	-	

* Heavy rainfall

Table II. *Artemia* density and cyst harvest record during pre-monsoon dry season of 1992

Date	Population density (individuals/l)	Cyst harvest	
		Cyst weight (g)	Dry weight (g)
15/1/92	nauplii released	-	-
20/1/92	40.0	-	-
25/1/92	80.0	-	-
31/1/92	120.0	-	-
04/1/92	135.0	140.0	79.0
13/2/92	160.2	210.0	104.5
29/2/92	230.0	242.2	127.4
05/2/92	233.0	243.0	132.0
10/3/92	240.1	297.0	147.0
15/3/92	250.0	300.4	152.0
20/3/92	257.0	320.0	163.0
25/3/92	289.3	347.0	173.0
31/3/92	307.0	356.0	183.0
10/4/92	320.0	373.0	187.0
15/4/92	323.0	378.0	192.0
Total:		3,206.6	1,639.9

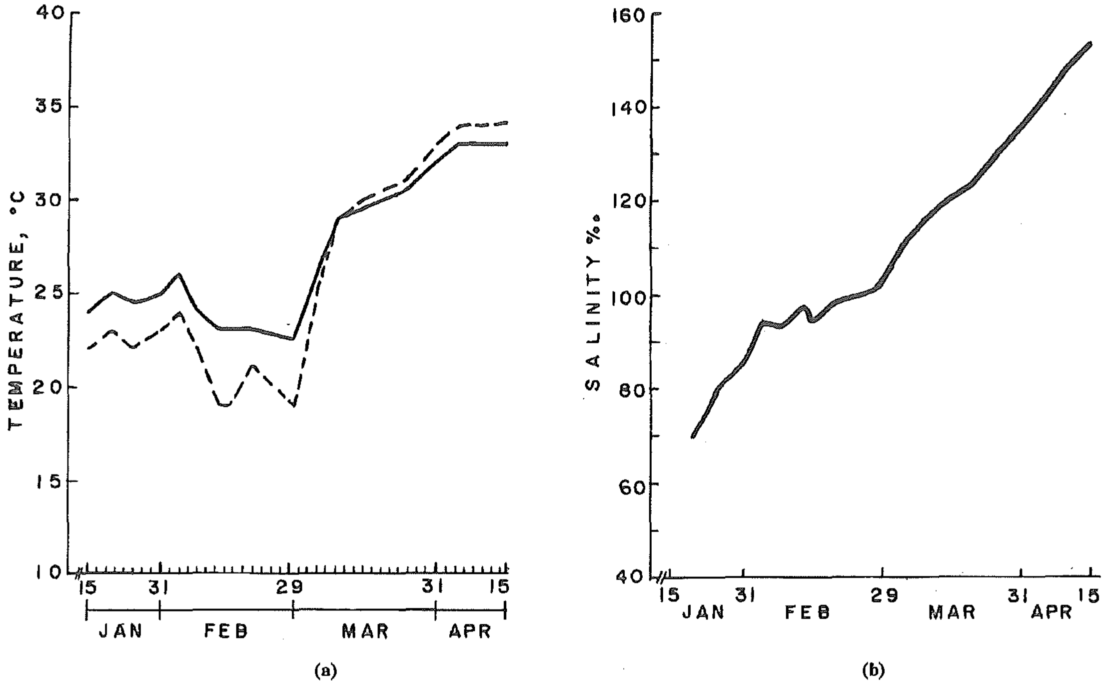

Fig.3. (a) Distribution of atmospheric (solid line) and aquatic temperature (broken line) during January-April, 1992 in the experimental *Artemia* culture area of Demoshia, Chakaria, Coxis Bazar; (b) Gradual increase of salinity in two *Artemia* production ponds (APP) during the experimental period (January-April, 1992).

ARTEMIA BIOMASS AND CYST PRODUCTION:

Artemia were harvested with a dip net. A continued and steady increase in population density of *Artemia* is apparent form the data (Table II). Highest density (323 individuals/l) was recorded on April 15, 1992.

Cysts were found to accumulate on the cyst barrier on the 3rd of January, 1992. Cyst collection was started on 4th January and continued till April 15th. A total of 1639.9 g (dry wt.) of cysts were harvested during the whole course of the experiment (Table II).

DISCUSSION

In the present study *Artemia* dry cyst production was 5.46 kg/ha/month using the Red Jungle Brand (U.S.A) as the inoculator (Table II) whereas the previous attempt (Mahmood, 1990) obtained 2.07 kg/ha/month using the Great Salt Lake Brand, U.S.A. In view of production performances between these two different strains it appears that Red Jungle Brand is probably more useful for culture in our coast.

In the Philippines cyst production of *Artemia* was achieved to 20 kg DW cysts/ha/month (Jumalon *et al*., 1987). Lower rate of production in our two preliminary experimental studies may be due to sudden lowering of the salinity regime in the *Artemia* production pond (APP) as a result of sudden and irregular rainfall during the period of experiments or other environmental conditions, and the geographical strains utilized (Mahmood, 1989, 1990). So, a continuous and intensive study is necessary to tag the useful strains for Bangladesh coast from among more than 50 round the world (Vos and Rosa, 1980).

In the coastal salinas of Banskhali, Chakaria, Cox's Bazar, Kutubdia, Matharbari and Moheshkhali Island poor families are largely dependent on salt extraction from the solar saltpans. There this integrated technology can be easily adopted by salt farmers to culture *Artemia* as a by-product of salt production. An integrated culture system *Artemia* + salt + poultry + shrimp can be established in the coastal saltpan area of Bangladesh. From poultry, chicken dung could serve as a good source of organic manure in the APP. This practice can easily fulfill the domestic demand of *Artemia*.

A successful hatchery operation is dependent on appropriate nutritionally balanced, non-polluting, economically viable and readily acceptable feed to obtain the optimum growth and survival (Sorgeloos and Kulasekarapandian, 1984). Thus there is no match of *Artemia* as a source of feed in hatcheries.

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REFERENCES

APHA, 1976. *Standard methods for the examination of water and waste water.* 14th Ed. N.Y. Amer. Pub. Health Assoc. 1193 pp.

Bardach, J.E., J.H. Ryther and W.C. McLarney. 1972. Aquaculture, John Willey, N.Y. 868 pp.

Jumalon, N.A., D.G. Entenoir and D. Ogburn. 1987. Commercial production of *Artemia* in the Philippines. In: *Artemia* Research and its Applications, Vol.3. (Sorgeloos *et al.*, eds.). Universal Press. Wettern, Belgium. Pp.239-252.

Karim, M. 1974. Survival of brine shrimp, *Artemia* nauplii under controlled condition of temperature and salinity. *Bangladesh Journal of Zoology* 2:65-69.

Mahmood, N. 1989. Preliminary study on growth of *Artemia* in the coastal saltpans of Bangladesh. Annual Prog. Report. BARC Contract Research Scheme, IMS. C.U., Bangladesh. Pp.1-9.

Mahmood, N. 1990. Preliminary study on culture of *Artemia* in the coastal saltpans of Bangladesh. Final Report, BARC Contract Research Scheme; IMS, C.U., Bangladesh. Pp.1-15.

Mahmood, N. and B. Begum. 1978. On hatching of *Artemia* nauplii under different conditions of temperature and salinity. *Chittagong University Studies* 2: 103-106.

Persoone, G. and Sorgeloos, P. 1980. General aspects of the ecology and biogeography of *Artemia*. In: The Brine Shrimp *Artemia*. Vol.3: Ecology, Culturing, use in Aquaculture. (Persoone *et al.*, eds.) Universal Press, Wettern, Belgium. pp.3-24.

Rosemark, R. 1978. Growth of *Homarus americanus* on *Artemia salina* diets with and without supplementation. *Proceedings of the Meeting of World Mariculture Society* 9:251-257.

Sorgeloos, P. 1976. *Artemia salina* as live food in aquaculture. In: Jaspers. E. (Ed.), *Europian Mariculture Society* Special Publication 2: 37-46.

Sorgeloos, P. 1983. Live animal food for larval rearing in aquaculture; achievements, constraints, perspectives (Bilio *et al.*, Eds.) *Europian Mariculture Society* Special Publication. 300pp.

Sorgeloos, P. and Kulasekarapandian, S. 1984. Production and use of *Artemia* in aquaculture. Central Marine Fisheries Research Institute, Cochin, India. Special Pub. No.15. 74pp.

Tunsutapanich, A. 1979. Cysts production of *Artemia salina* in salt ponds in Thailand. FAO/UNDP: THA/75/008 Project Manual. THA: 75:008:80:WP/9. Pp.1-14.

Vos, J. 1979. Brine Shrimp (*Artemia salina*) inoculation in tropical salt ponds: A Preliminary guide for use in Thailand. FAO/UNDP:THA/75/008 Project Manual. THA/008:79/WP/4. Pp.1-14.

Vos, J. and N.L. de LA Rosa. 1980. Manual on *Artemia* Production in salt ponds in the Philippines, FAO/UNDP/BFAR Project Manual PHI/75/005/WP 6. Pp.1-48.

Vos, J. and A. Tunsutapanich. 1979. Detailed report on cyst Inoculation in Bangpakong, Chachengsao Province, FAO/UNDP Field Document (THA/75/008).