Performance of white shrimp, *Penaeus indicus*, in highly saline pond waters

Omer M. Yousif, Krishna Kumar and Abdul Fatah Ali A[1]

The first shrimp culture trial in the United Arab Emirates (UAE) was initiated in the mid-1980s by the Marine Resources Research Center (MRRC) at Umm Al Qaiwain, Ministry of Agriculture & Fisheries (MAF). This trial involved the rearing of wild *Penaeus semisulcatus* larvae averaging 0.01 g in 500 l plastic tanks where they attained an average body weight of 15.8 g within a period of seven months (Ministry of Agriculture and Fisheries 1984). In the early 1990s, the potential of two additional species, *P. monodon* and *P. indicus*, was also evaluated. Trials with *P. monodon* indicated its unsuitability for culture in UAE because of its poor tolerance to low temperature (17°C) during the winter. The first trial with *P. indicus* involved the culture of 2.36 g juveniles, imported from Saudi Arabia, in a 1600 m^2 concrete pond stocked at the rate of 14.7 individuals/m^2 and reared for 11 months. The average body weight and feed conversion ratio attained were 22.74 g and 4.96. A second attempt was made with larvae produced at MRRC hatchery but all the shrimp died in the pond within two months. A third trial was carried out with larvae averaging 0.16 g that were stocked in the previously mentioned pond at the rate of 36/m^2 that were fed commercial shrimp feed twice a day. The mean body weight achieved after a culture period of five months was 19.29 g (Ishikawa 1995).

The first trial in UAE to grow shrimp in earthen ponds in Abu Dhabi Emirate was conducted on Abu AL Abyad island, 100 km west of Abu Dhabi. The island, which covers an area of 490 km^2, is characterized by its harsh environmental conditions. The island is mostly a desert tract of limestone mainly formed from marine sediments and most of the surface is covered by low-lying sabkha (inland or coastal saline flats) and beach sand flats. It is also known for its low rainfall (annual mean ranging from 5-160 mm) high air temperature (reaching up to 48°C during the summer), high relative humidity and high annual evaporation rate (about 3.3 m in the coastal area and 4.0 m inland). The island is rich in natural and artificially dredged channels fringed with mangrove, *Avicennia marina*. All channels are directly connected to the sea. The water in these channels is hypersaline, reaching up to 58 ppt during the summer.

This first trial involved the culture of locally hatchery-bred 49 day-old postlarvae (PL_{49}) of the Indian white shrimp, *P. indicus*, in a 1 ha tidal pond situated along one of the artificially dredged channels for 113 days. Final average body weight was 20.17 g, with a survival rate of 72 percent and feed conversion ratio of 2.0. The shrimp were found to mature under pond conditions and, hence, provided a continuous supply of broodstock (Al Ahbabi *et al*. 2000, Yousif *et al*. 2000). The findings have encouraged further trials on the culture of this species on the island. Results of the second pilot hatchery and pond production trials conducted during the 2001 season are reported here.

Fig. 1. Harvesting of shrimp nauplii in 30-l harvesting buckets from the 400-l hatching black fiberglass tanks.

Fig. 2. 0.25 ha grow-out liner ponds for P. indicus *in Abu Al Abyad island.*

Postlarvae Production

The hatchery techniques conformed to the Galveston method (McVey and Fox 1983). Every six months, a batch of 200 adult *P. indicus* (1: 1 ratio of males to females) averaging 25-30 g was placed in each of the two indoor 15 ton circular fiberglass maturation tanks where they were gradually acclimated to a salinity of 35 ppt. The natural salinity of 50-55 ppt was reduced over a period of 10 days by adding freshwater to reduce the salinity

Table 1. Mean minimum-maximum water temperature, salinity, dissolved oxygen, pH and ammonia recorded during the growout period (mid-May through early December).

Parameter	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ʃ)								
Minimum	26.0	28.0	30.0	28.5	29.4	27.7	22.0	22.0
Maximum	33.0	34.5	34.5	33.5	33.0	33.0	28.0	26.0
Salinity (ppt)	58	58	56	55	52	50	55	55
Dissolved oxygen (mg/l)								
Dawn	3.4	3.3	3.6	3.6	2.8	3.3	3.9	3.6
Dusk	6.9	7.2	6.7	7.3	7.6	7.9	8.4	8.0
pH	8.1	7.9	7.9	7.9	8.0	8.2	8.1	8.0
NH^4-N (mg/l)	0.01	0.03	0.05	0.04	0.04	0.04	0.05	0.02

by 2 ppt/day. After one week of acclimation in the maturation tanks under 35 ppt and at water temperature of 27°C, unilateral eyestalk ablation with hot forceps was applied to the females to induce maturation. The brood animals were fed *ad libitum* with fresh mussels, squid, clams and crabs. Water was exchanged daily at a rate of 50 percent. The photoperiod was maintained at 14:10 (light:dark). The gravid females (stage 4) were sorted daily using underwater light, to candle the ovaries, and kept in 400 l black fiberglass spawning-hatching tanks at a maximum stocking density of four females/tank (Figure 1). Immediately after spawning, the females were removed and returned to their respective maturation tanks. On the following day, the hatched nauplii were collected in a 100 μ collection buckets, stocked in a 10 ton fiberglass larval rearing tanks and grown to the 10 day-old postlarval stage (PL_{10}) in 35 ppt salinity water. Fifty percent of the larval rearing tank water was exchanged daily until the Z_1 stage after which the exchange rate was gradually increased to 400 percent by stage Pl_5. The hatchery feeding protocol included the microalgae *Chaetoceros gracilis* during nauplii and zoea stages (N_5-Z_3) and *Tetraselmis* sp. along with newly hatched instar I *Artemia* during mysis the M_1-PL_5 stages. Also, artificial plankton was given at all larval rearing stages. Water temperature in the larval rearing tanks was maintained at 27-28°C. When the animals were in the PL_{5-10} stages, the salinity in the larval rearing tanks was gradually raised over seven days until it reached the natural level of 50-55 ppt. The postlarvae were then transferred to the 40 ton outdoor concrete nursery tanks where they were grown to the juvenile stage.

Growout

In mid-May 2001, juvenile shrimp averaging 0.08 g were stocked in two 0.25 ha lined ponds at a rate of 30 individuals/m^2 (Figure 2). Seawater was supplied by pumping from a nearby dredged channel. As a result of the high evaporation rate in the coastal area of the island, a daily water exchange rate of 5-10 percent was maintained throughout the culture period. However, a mechanical failure of the water pumps during May and June caused the water exchange rate to be maintained at less than five percent, resulting in a salinity high of 58 ppt (Table 1).

Discharge water was passed through a gravel filter before it was released to the sea. Two paddle wheel aerators were installed in each pond and operated at night. Commercial pelleted feed[2] containing 38-40 percent crude protein was fed to the shrimp. The initial feeding rate was 15 percent of body weight daily and was gradually reduced to two percent body weight by the time the shrimp were harvested. The daily feeding allowance was hand broadcast three times a day during the first three months and then adjusted to four times daily for the remainder of the growing period. Due to a temporary shrimp feed shortage during August, a 2 mm commercial fish feed (52 percent crude protein, 10 percent lipid) was offered for 30 days. At two week intervals, samples of a minimum of 250 individuals were trapped from each pond, weighed and measured. Water temperature, salinity and dissolved oxygen were monitored daily, while pH and ammonia were determined every two weeks. The minimum/maximum water temperature ranged during the growout period (mid-May through early December 2001) as shown in Table 1. With the exception of salinity and water temperature, water quality variables were considered to be within the desirable range for the shrimp.

In early December 2001, both ponds were completely harvested, using special traps. The shrimp attained an average weight of 20.0 g within seven months of culture in the ponds (Table 2; Figures 3 and 4). The average daily weight gain, specific growth rate, feed conversion ratio and survival percentage are presented in Table 2.

The growth and productivity of *P. indicus* achieved in the trial compared well with conventional shrimp yields reported from other locations. However, in comparison with the earlier culture trial carried out on Abu Al Abyad island under extensive conditions in a tidal pond (Al Ahbabi *et al*. 2000), the shrimp in the current study showed relatively poorer growth, survival and feed conversion. The lowest growth rate was observed during

Fig. 3. Harvest of P. indicus *from the liner ponds.*

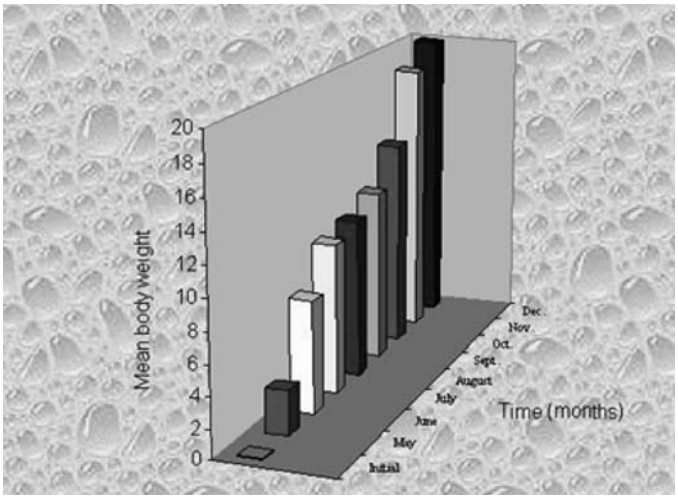

Fig. 4. Growth performance of P. indicus *during grow-out period in liner ponds.*

Table 2. Performance of *Penaeus indicus* during the growout period in 0.25 ha lined ponds.

Parameter	Value
Stocking density (postlarvae/pond)	7,500
Initial average weight (g)	0.08
Final average weight (g)	20.0
Weight gain (g/shrimp)	19.93
Specific growth rate (percent/day)	2.26
Yield (tons/ha)	3.4
Food conversion ratio	2.48
Survival (percent)	59

August and was probably associated with malnutrition resulting from the shrimp feed shortage. The high salinity and water temperature during May and the quality of feed given to shrimp during August were suspected to be the direct causes of the high feed conversion ratio and low survival rate recorded in the trial. Nevertheless, the animals grew at a reasonable rate during a relatively short period of time. The acclimation of the animals prior to stocking in the ponds may have improved their ability to tolerate the harsh culture conditions to some extent.

In conclusion, these findings further demonstrate that *P. indicus*, Red Sea strain, is a strong osmoregulator and, most importantly, they provide additional evidence of its potential for commercial operations under severe salinity and temperature conditions. Future trials should focus on the optimization of pond management techniques.

Notes

[1]Fish & Shrimp Farming Project, Abu Al Abyad, P.O. Box 372, Abu Dhabi, United Arab Emirates. Fax: 00971-2-8839112. E-mail: onrash@emirates.net.ae

[2]Gaspar Prawn Feed, Taiwan

References

Al Ahbabi, M.S., O.M. Yousif and K.K. Kumar. 2000. Shrimp in hypersaline waters of the United Arab Emirates. Fish Farming International 14(4): 34-35.

Ishikawa A. 1995. Activities of shrimp culture in UAE from November 1993 to October 1995. Marine Resources Research Center, Umm Al Qaiwain, Ministry of Agriculture and Fisheries, United Arab Emirates.

Ministry of Agriculture and Fisheries (MAF). 1984. Study on mariculture environment of Umm Al Quwain Lagoon and the experimental rearing of shrimp, rabbitfish and mullet. *Technical Report* No. 8. Department of Fisheries, United Arab Emirates.

McVey, J.P. and J.M. Fox. 1983. Hatchery techniques for penaeid shrimp utilized by Texas A&M-NMFS Galveston laboratory program. Pages 129-154, In: J.P. McVey, editor. CRC Handbook of Mariculture. Vol. 1. Crustacean Culture. CRC Press, Boca Raton, Florida, USA.

Yousif, O.M., A. Qadeer and K. K.Krishna. 2000. Preliminary observations on the culture of white shrimp *Penaeus indicus* in the hypersaline waters of Abu Dhabi Emirate. The second Arab International Conference on Environmental Biotechnology-Coastal habitats. 8-12 April 2000, Abu Dhabi, United Arab Emirates.