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INTENSIVE LARVAL CULTURE OF *Macrobrachium rosenbergii*: A COST STUDY

AQUACOP[1]
Centre Océanologique du Pacifique
CNEXO-COP
B.P. 7004
Taravao, Tahiti (French Polynesia)

ABSTRACT

Pilot scale larval culture of *Macrobrachium rosenbergii* began in Tahiti at the end of 1976. Since then, four batches of postlarvae (2.3 millions) have been produced. Operating expenses cost was $13-35/thousands postlarvae.

Based on the results obtained from the pilot program, we can project the cost of a commercial scale hatchery producing 10 million postlarvae/year at $12/1,000. This includes construction and equipment costs. Due to the high cost of living in Tahiti, this figure would undoubtedly be lower in many other regions.

INTRODUCTION

From 1973 to 1976, the CNEXO-COP Aquaculture Team (Aquacop), in collaboration with the Fisheries Territorial Service, developed an original technology to produce post-larval *Macrobrachium rosenbergii* (Anuenue strain) in Tahiti (Aquacop, 1977a,b). At the end of 1976, the first production at pilot scale gave reliable results (Aquacop, 1977b) and, after bacterial disease in the next two trials, three successful production runs were conducted. Since effective treatments have been developed against bacterial attacks, the production system now appears technically feasible. The present paper analyzes the cost of producing *M. rosenbergii* postlarvae using our technology to determine the economic

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[1]Aquaculture team of the COP. Algae and mollusc cultures: J. L. Martin, O. Millous, Y. Normant, D. Gillet, O. Le Moine. Nutrition: A. Febvre, P. Vilmorin, J. J. Lainé, L. Mu, J. M. Guesne. Water quality control and treatment: J. Calvas, B. Couteaux, J. Bonfils, J. Y. Robert. Pathology: J. F. Le Bitoux, S. Robert. Crustacean and fish cultures: P. J. Hatt, M. Jarillo, J. P. Landret, J. Goguenheim, F. Fallourd, O. Avalle, J. Moriceau, D. Lacroix, S. Brouillet, R. Galzin, H. Pont, D. Amaru, V. Vanaa, A. Bennett, D. Sanford. Technology: J. F. Virmaux. Aquaculture program coordinator in tropical area: A. Michel.

feasibility of the technology for production size aquaculture.

THE PRODUCTION TECHNOLOGY

Since hatchery technology is described in detail elsewhere (Aquacop, 1977a,b), only a brief summary is given here.

For brood stock, approximately 1,000 female and 500 male prawn, all generally larger than 30 g in weight, are maintained in a 1,000 m^2 earthen pond. As long as water temperature remains above 23°C, these animals can produce more than one million larvae/week as needed. One hundred gravid females with dark grey (nearly ready to hatch) eggs are seined from the brood stock pond, placed in 2 m^3 circular tanks and within two days release more than one million larvae.

After hatching, the larvae are reared in cylindrical tanks with conical bottoms and central aeration. The hatchery includes experimental tanks of 0.8 m^3 and production units of 2 m^3. Larvae are stocked in the tanks at initial density of 100 larvae/liter and production is routinely greater than 50 postlarvae/liter in 45 days.

Salinity of the culture water is increased from 4 ppt at hatching to 12 ppt for rearing and temperature is maintained at 29-31°C. The water in each rearing tank is completely exchanged once a day at 1600 hours, and prior to use it is chlorinated and filtered.

The larvae are given two types of food: inert particles (ground skipjack tuna or squid, fish eggs, scrambled hen eggs, frozen adult *Artemia*, compound diet) and newly hatched *Artemia* nauplii. The inert foods are given from 0800 to 1400 in four to six meals and the *Artemia* nauplii after the daily water exchange. The amount of food given is adjusted according to consumption.

Postlarvae are harvested from each tank at the end of the 4th, 5th and 6th week. They are transferred to 2 m^3 tanks where the salinity is dropped to zero within 24 to 48 hours. After acclimation to fresh water the prawns are sent to grow-out ponds; their average weight is 8-15 mg at this time.

To avoid bacterial contamination and resulting mass mortalities, the hatchery is washed out and allowed to dry for a few days between production runs. Antibiotics (chloramphenicol, penicilline-streptomycine, terramycine, 1-20 g/m^3) are used if bacterial diseases appear during larval culture.

The hatchery labor force consists of a technical manager and two to four assistants (young biologists, technicians, workers). Two workers can manage eight to ten tanks per day and the amount of labor required is virtually the same for both 0.8 and 2 m^3 tanks. However, for continuous daily management of eight production tanks, a squad of four would be recommended because of the normal five-day work week and occasional absenteeism. About one third of the labor is for feeding, one third for observations and countings, and one third for water changing.

PRODUCTION RESULTS AND COSTS

Duration: it was determined that it could be greatly reduced by increasing the size of brood stock, so all the spawnings are obtained within a few days, and by raising the temperature of the water in the tanks. From one batch at 25°C, 95% of the metamorphosis was obtained on the 70th day after spawning, while from another batch at 30°C, on the 32nd day. Survival: it has increased from an average 45% for the last experiment assay to an average of 72% for the last pilot-scale assay (Table 1). Survival during the first three weeks, before occurrence of the first postlarvae, is generally above 90% but the survival during metamorphosis varies widely (35-100%). All efforts were made in the last assays to improve it. Operating expenses: they are computed for each production on the mid-1978 basis to facilitate comparisons (Table 2). Social insurances, holiday bonuses and management costs are all included in computing labor costs. The main difference in food cost between assay 4 and the others is due to the fact that less food was lost through screening and washing. Energy costs are computed by multiplying the power of every electrical fitting by the number of hours each one worked and adding on 10% for electrical losses in the circuit. The investment: for a hatchery, capable of producing 10 million postlarvae a year, the investment cost is estimated at $2.3/1,000 postlarvae (Table 3). All the figures are from pro-forma invoices on a mid-1978 basis. Amortization is computed for 20 years for land and housing, 5 years for mechanical fittings and plastic tanks, 3 years for apparatus such as freezer, mixer-liquefier, microscope, measurements fittings.

DISCUSSION

The cost of labor is the major expenditure in the operation (65 to 80% of the total) and the skill and efficiency of those employed the major reasons for its success. Since the amount of labor is virtually the same for the 0.8 and 2 m^3 tanks, we assume that with the same labor cost more postlarvae could have been produced by using only the larger size tanks. Table 4 gives the expected cost in the production hatchery described above, based upon the figures of Tables 2 and 3--less than $12/1,000 postlarvae.

Two savings can be projected (Table 4). Energy: by using solar energy to heat the water to 31°C, instead of our present costly electrical probes, a saving of 66% on energy cost is effected, but with a $54,000 investment for solar panels and reservoirs. Labor: water treatment through biological filters is under trials in COP, and can probably be used on the production scale within a few years. The daily water changing is suppressed without supplementary cost. With those two savings we can assume that a three-man team (one biologist and two technicians) can run a 12-tank hatchery all year round.

Many prices in French Polynesia are higher than in other places; land scarcity makes it expensive ($73,000 to $97,000/acre); salaries are much higher than in many tropical countries; almost everything must be imported and long distance shipping and high import taxes increase all prices of goods by an average of 66%. It can be assumed that in a country other than French Polynesia, the production cost could be cut in half.

TABLE 1. Technical Conditions and Results for the Last Experimental Scale Batch (Exp.) and Four Pilot-Scale Batches, in the CNEXO-COP Macrobrachium Hatchery

Serial no.	Exp.	1	2	3[a]	4
Total[b] duration (days)	60	71	56	40	40
of spawnings	4	18	10	3	3
Average temperature (°C)	27	28	29.5	30	30
Labor force					
Biologists	1	2	2	2	1
Technicians	1	2	2	2	2
Workers	2	2	2	1	0
Numbers and volumes of rearing tanks (m^3)	8 x 8	5 x 8 3 x 2	7 x 8 4 x 2	4 x 8 4 x 2	4 x 2
Initial density	130(100-160)	120(95-155)	150(95-200)	205(180-240)	150
Density at occurrence of first postlarvae	x	90(75-110)	95(55-185)	90(70-110)	150
Number of postlarvae produced per liter	40(30-60)	50(30-75)	55(30-65)	55(45-80)	75(70-80)
Larval survival (%)	x	80(70-90)	51(13-100)	90(80-100)	100
Metamorphosis survival (%)	x	60(36-66)	60(45-92)	60(43-96)	72(67-76)
Total survival (%)	45(32-56)	44(28-48)	31(7-63)	55(34-88)	72(67-76)
Number of postlarvae produced (in thousands)	390	520	550	600	610

[a]For this production, each tank was split in two at day 15; for this reason the initial density is the double of the density at occurrence of first postlarvae.

[b]Including the spawning period, the rearing period, the cleaning period. For density and survival figures, the average is given with the maximum and minimum in parentheses.

CONCLUSION

The technology set up by the CNEXO-COP aquaculture team (Aquacop), in cooperation with the French Polynesia Fisheries Service, is now on a pilot scale. The projected production cost ($11.7/1,000 postlarvae) seems low enough to go on to commercial scale. The next step will be to build and run the commercial hatchery, which will supply the farms planned for development in the near future, for the local market.

LITERATURE CITED

Aquacop. 1977a. *Macrobrachium rosenbergii* (de Man) culture in Polynesia: progress in developing a mass intensive larval rearing in clear water. Proceedings World Mariculture Society 8:311-326.

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TABLE 2. Functioning Costs in US$ for the Last Experimental Scale Batch (Exp.) and Four Pilot-Scale Batches in the CNEXO-COP Macrobrachium Hatchery. C = cost for each assay; in brackets on the subtotal lines are given the percentages of this headline on the total cost.

Items	Unit cost	Exp.	1	2	3	4
		C	C	C	C	C
Labor	(per month)					
biologist	2,400	9,600	9,600	9,600	7,200	3,600
technician	900	3,600	3,600	3,600	2,700	2,700
worker	600		2,400	2,400	900	
Total labor (% total)		[80] 13,200	[86] 15,600	[84] 15,600	[81] 10,800	[77] 6,300
Food	(per kg)					
skipjack flesh	.96	96	0	0	0	0
skipjack eggs	.96	0	0	25	45	48
squid	1.86	0	465	409	614	0
alginate diet	1.86	0	0	0	0	260
Artemia cysts	90	1,350	1,440	1,530	1,170	450
frozen adult *Artemia*	38	1,634	304	0	0	0
Total food (% total)		[19] 3,080	[13] 2,209	[10] 1,964	[14] 1,829	[9] 758
Antibiotics (per kg)	96	58	24	77	58	0
Energy (electricity)	(per KWH)					
pumping	.084	12	18	18	18	12
aeration	.084	84	84	84	84	84
heating	.084	0	0	840	420	924
light	.084	84	126	109	126	117
Total energy (% total)		[1] 180	[1] 228	[5] 1,051	[5] 648	[14] 1,137
Functioning cost total		16,518	18,061	18,615	13,335	8,195
Postlarvae: no. in 1000's		390	520	550	600	610
cost/1000		42.4	34.7	33.8	22.2	13.4

TABLE 3. Estimated Investment Cost (in US$) for a Production Hatchery in Tahiti (10 million postlarvae/year)

Items	Initial cost	Amortization (annuities)
Land cost (3,000 m^2)	50,400	2,520
Brood stock ponds (2 x 1,000 m^2)	32,400	1,620
Hatchery building (30 x 10 m)	51,600	2,580
Water pumps and pipes	15,600	3,120
Air suppressor and pipes	3,600	720
Hatching tanks (4 x 2 m^3)	3,600	720
Raising tanks (12 x 2 m^3)	15,600	3,120
Reservoirs (6 x 10 m^3)	10,800	2,160
Sand filter - Circulation pump	3,600	720
Food storage and preparation	6,000	2,000
Laboratory apparatus	8,400	2,800
Miscellaneous	4,800	960
Total	206,400	23,040

TABLE 4. Projected Total Yearly Costs (in US$) in a Hatchery Producing 10 Million postlarvae in Tahiti (7 runs/year, 1.4 million post-larvae/run, 12 x 2 m^3 raising tanks)

			Cost/1,000 PL
With the existing technology:			
Labor	1 biologist	25,200	
	2 technicians	19,000	
	3 workers	19,000	
	Total	63,200	6.32
Food		6,300	.63
Antibiotics		300	.03
Energy		23,800	2.38
Investment cost (cf. Table 3)		23,000	2.30
Total cost		116,000	11.66
Savings through technical improvements:			
Energy saving through solar heating		-16,800	
Investment for solar heating cost for one production		+ 5,400	
Labor force reduction		-31,600	
Projected total yearly cost		73,600	7.4