Aquaculture, 7 (1976) 59—74.

COST COMPARISONS OF REARING LARVAE OF FRESHWATER SHRIMP, *MACROBRACHIUM ACANTHURUS* AND *M. ROSENBERGII*, TO JUVENILES

R.W. HAGOOD and S.A. WILLIS

Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, Fla. (U.S.A.)

Florida Department of Natural Resources Contribution No.253

(Received December 20th, 1974; revised April 10th, 1975)

ABSTRACT

Hagood, R.W. and Willis, S.A., 1976. Cost comparisons of rearing larvae of freshwater shrimp, *Macrobrachium acanthurus* and *M. rosenbergii*, to juveniles. *Aquaculture*, 7: 59—74.

Costs were determined for rearing larval *Macrobrachium rosenbergii* (De Man) and *M. acanthurus* (Wiegmann). Rearing was conducted in two phases. First-phase rearing (first 10 days) was conducted in conical fiberglass tanks with recirculated, filtered, brackish water; second-phase rearing (final 30 days) was done in aerated 1 000-l concrete tanks. To minimize water quality problems and debris accumulation in second-phase rearing, larvae were transferred every 4 to 5 days to a new tank of clean water. Larval food consisted of newly hatched *Artemia* and either freshly ground fish or freeze-fried fish.

Mean survival in five *M. rosenbergii* rearing trials was 43% in 40 days at a final density of 12 juveniles per liter. Mean survival of four *M. acanthurus* trials was 25% in 44 days at a final density of 3 juveniles per liter. Average total cost of labor, operation (electricity), food and water per thousand juveniles produced was \$3.56 for *M. rosenbergii* and \$13.42 for *M. acanthurus*.

Extrapolation of results to larger (3 000-l) second-phase rearing tanks showed *M. rosenbergii* rearing cost could be reduced to \$1.87/1 000.

INTRODUCTION

Interest in shrimp aquaculture, principally *Macrobrachium* culture, has increased considerably in the last few years. Many federal, state and university laboratories are now working on projects related to shrimp farming. Increasing numbers of corporations and entrepreneurs are also undertaking pilot studies on the profitability of shrimp culture. A major concern in applying research results to practical ventures is evaluation of production costs. Costs of larval rearing and reliability of yield are important parts of this evaluation.

Studies in other parts of the world have given some larval rearing cost figures. Liao and Huang (1970), working in Taiwan, reared six different species of penaeid shrimp at an estimated cost of \$2.02 per thousand with 25—30% survival to metamorphosis. The same authors quote Shigueno (1969), who reared *Penaeus japonicus* at a cost of \$1.01 per thousand.

Mock and Neal (in press) compared a system of penaeid shrimp culture developed in Galveston, Texas, with one developed in Japan and found operation costs per thousand postlarvae to be \$0.89 and \$2.37, respectively. They also noted the Japanese system required a greater initial investment, had lower production per volume, and was less dependable than the Galveston system. In their report on prawn culture in England, Forster and Wickens (1973) estimated \$2.35 per thousand as a realistic cost for rearing either penaeid or *Macrobrachium* larvae. Fujimura and Okamoto (1970), rearing *M. rosenbergii* in Hawaii and using a method modified from Ling (1962), indicated \$1.93 per thousand was a good estimate of rearing cost, with 21% survival to metamorphosis.

This paper presents the actual cost of rearing larvae of *Macrobrachium rosenbergii* (De Man) and *M. acanthurus* (Wiegmann) using methods developed by Dugan et al. (1975), and gives estimates of optimal rearing cost on a commercial scale based on these results. Comparisons are made between the costs and success of rearing these two species and rearing results of other investigators.

MATERIALS AND METHODS

Five groups of *Macrobrachium rosenbergii* and five groups of *M. acanthurus* were reared from hatching to juvenile stages to evaluate costs of larval rearing. Each group consisted of all larvae from the complete hatch of either one or two female shrimp.

Brood stock

Macrobrachium acanthurus brood stock used in these trials originally was captured in canals along the southeast coast of Florida. Some hatches, however, were from first generation, laboratory-reared females crossed with wild males. *Macrobrachium rosenbergii* hatches were from sixth-, seventh-, and eighth-generation laboratory-reared shrimp. Our original stock of sixth-generation shrimp was obtained from Mr T. Fujimura at the Hawaii Department of Fish and Game.

Rearing method

For the rearing trials, gravid shrimp were selected from the brood stock holding tanks and placed in special larval hatching tanks (Dugan et al., 1975). Upon hatching, larvae were removed and placed in a 12-l plastic bucket for counting. Larvae in each hatch were enumerated by counting larvae in eight 104-ml aliquot samples.

We utilized the larval rearing technique described in detail by Dugan et al. (1975). Basically, the method involves two phases of larval rearing. First-phase rearing of larval stages I—V (8—12 days) was accomplished in 150—200-l conical, fiberglass tanks with recirculated, filtered, brackish water of 12—18‰ salinity (*S*). Second-phase rearing of larval stages VI-juvenile (days 9—13 until metamorphosis) was carried out in 1 000-l aerated concrete tanks. Water quality was maintained in first-phase rearing by separate subgravel biological filters. Water quality and debris accumulation were controlled in second-phase rearing by transferring larvae every 4 to 5 days to a new tank of clean water. Larval food consisted of newly-hatched *Artemia* nauplii and either freshly-ground fish or freeze-dried ground fish. The ratio of *Artemia* to fish was gradually changed with time from all *Artemia* to all fish during each trial.

Larval *M. acanthurus* were reared in 16—18‰ *S*, while *M. rosenbergii* larvae were reared in 12—14‰ *S*. Water temperature ranged between 26.2 and 31.5°C during rearing trials.

The first four *M. rosenbergii* rearing trials (trial numbers *Mr* 1—4) were conducted in fall and early winter (September—November) 1973. The fifth *M. rosenbergii* trial (*Mr* 5) and all five *M. acanthurus* trials (*Ma* 1—5) were completed during spring and early summer (April—June) 1974.

Water analyses

During rearing trials, salinity, temperature, pH, and sodium nitrite-nitrogen were measured daily (Dugan et al., 1975). A Rila nitrile colorimetric test kit was used for nitrite, yielding values somewhat greater than actual concentrations (due to nitrate interference). All nitrite values are based on these readings unless otherwise noted.

On two occasions, measurements were made of NH_3-N, NO_2-N, NO_3-N, and PO_4-P with Hach water quality test kits over four successive days to determine in more detail the degree of water quality deterioration between second-phase larval transfers.

Cost analysis

A detailed record of all costs was made during the ten larval rearing trials. Expenditures, presented as cost per thousand juveniles reared, have been grouped into four major categories: food, operation (electricity), water and labor. Electrical operating cost was calculated by recording the time each piece of equipment was used and multiplying by its wattage requirement; total cost was based on a rate of US $0.03 per kilowatt-hour. This category contains all electrically operated equipment, including an air blower, temperature control units, water pumps, lights and equipment used in food preparation. Labor cost was calculated at the rate of $4.00 per hour.

Amortization of capital outlay, building lease expense, maintenance, and other fixed costs were not considered because of the great variability of these items with respect to personnel, location, and hatchery design.

TABLE I

Hatching data

Trial number	Parent generation	Female size			Number in hatch
		Total length (cm)	Orbit length (cm)	Weight	
M. rosenbergii					
Mr 1	8th	15.0	—	40.19	8 200
Mr 2	7th	13.5	—	27.93	10 300
Mr 3	8th	—	—	—	12 000
Mr 4	6th	18.0	—	100.0	114 000
Mr 5	8th	14.1	11.3	43.04	32 600[1]
	8th	16.0	12.8	60.02	
M. acanthurus					
Ma 1	1st x wild ♂	11.3	9.1	24.17	16 000
Ma 2	1st x wild ♂ (2)	11.7	9.3	22.76	13 300[1]
		11.4	9.2	25.95	
Ma 3	wild (2)	10.8	9.2	17.00	21 700[1]
		11.0	9.2	16.02	
Ma 4	wild	8.5	7.0	9.75	10 200
Ma 5	1st x wild ♂ (2)	10.0	—	—	11 500[1]
		9.7	—	—	

[1]Combined hatch, two female shrimp.

RESULTS

Hatching data, including numbers of larvae and female shrimp size for each rearing trial, are given in Table I. Ranges of water quality measurements, photoperiod, and larval survival are given in Table II for first-phase rearing and in Table III for second-phase rearing.

Macrobrachium rosenbergii rearing trials

Rearing trial *Mr* 1 larvae were progeny of a large female shrimp (40 g), yet very few larvae (8 200) were produced. Shrimp of this size usually produce 25 000—35 000 larvae (Ling, 1967). Water quality remained good except during the last 7 days of this trial when nitrites rose to over 7 ppm. The first juvenile was seen on day 24, and 95% of the larvae metamorphosed by day 33; survival was 54%.

Larvae (10 300) used in rearing trial *Mr* 2 were the progeny of one female. They hatched on two consecutive nights, 80% hatching the first night. Water conditions were very good during most of this trial except on days 27—29, when temperature dropped to 26.5°C. The first juvenile was seen on day 25, and 95% of the larvae metamorphosed by day 33; survival was 42%.

Rearing trial *Mr* 3 larvae (12 000), from one female, also hatched on two

TABLE II

First-phase rearing data, including length of first-phase rearing period, survival at the end of that period, and ranges of associated rearing conditions

Trial	Period (days)	Survival (%)	Temperature (°C)	Salinity (‰)	pH	NO_2 (ppm)	Photoperiod (h)
M. rosenbergii							
Mr 1	10	90	28.5—29	12	8.1	0—0.5	14
Mr 2	12	85	28.5—29	12	8.1	0—0.5	14
Mr 3	12	85	28.5—29.5	12	8.1	0	14
Mr 4	9	93	28.5	11—12	8.1—8.2	0—1.0	14
Mr 5	10	⩾ 95	27.4—28.8	13.5—14	7.7—8.2	0—0.5	14
M. acanthurus							
Ma 1	10	71	28.6—29.5	16—17	8.2	0—1.0	14
Ma 2	11	74	28.0—29.3	16—16.5	8.2—8.3	0—0.5	14
Ma 3	10	⩾ 95	28.0—30.0	16—18	8.1—8.2	0—0.5	14
Ma 4	10	74	28.0—28.9	16—17	8.2—8.3	0—1.0	14
Ma 5	10	92	28.0—29.2	16—16.5	8.2	0—1.0	14

TABLE III

Second-phase rearing data, including length of the second-phase rearing period, survival at the end of that period, and range of associated rearing conditions

Trial	Period (days)	Survival (%)	Temperature (°C)	Salinity (‰)	pH	NO_2 (ppm)	Photoperiod (h)
M. rosenbergii							
Mr 1	33	54.0	26.5—30.0	10.5—12.0	8.1—8.2	0—8	12.5
Mr 2	33	42.0	26.5—29.6	11.5—14.0	8.0—8.2	0—0.5	12.5
Mr 3	34	43.5	26.2—29.5	10.5—14.0	8.0—8.4	0—15	12.5
Mr 4	46	27.0	26.5—31.5	12.0—14.0	7.6—8.2	0—15	12.5
Mr 5	52	50.6	27.4—31.0	12.0—14.0	7.7—8.2	0—18	13.4
M. acanthurus							
Ma 1	50	1.5	27.0—30.5	15.5—17.0	8.1—8.2	0—18	13.4
Ma 2	41	8.6	27.5—30.5	15.0—16.5	7.9—8.2	0—10	13.4
Ma 3	50	7.9	27.6—30.3	15.0—16.5	8.0—8.3	0—15	13.4
Ma 4	44	45.6	28.0—31.0	14.0—17.0	7.7—8.4	0—10	13.4
Ma 5	39	37.9	27.5—30.4	14.0—17.0	7.9—8.2	0—10	13.4

consecutive nights with 40% hatching the first night. When larvae were transferred from first-phase to second-phase rearing on day 12, many dead larvae (approximately 15%) were observed on the bottom of the tank. Cause of this mortality is unknown; water quality prior to transfer had been excellent. Second-phase water quality varied considerably; nitrite rose on two occasions (days 20—21 and days 30—36). Temperature and pH also varied more than in previous trials. To more accurately characterize changes in water quality between second-phase larval transfers, measurements were made of NH_3-N, NO_2-N, NO_3-N and PO_4-P on days 22—25 (Table IV). The first juvenile was observed on day 25, and 95% of the larvae had metamorphosed by day 34; survival was 43.5%.

Larvae used in trial *Mr* 4 were progeny of a large, sixth-generation female (100 g). This female produced a large number of young (114 000) and was again gravid 18 days later. Larvae were reared for the first 4 days in one 200-l larval system tank. On day 5, the larvae were split into two groups to facilitate feeding and to reduce crowding. On day 9, larvae were transferred to two 1 000-l concrete tanks, and on day 14, the larvae were divided into three approximately equal groups. From previous rearing trials, it was considered that 30—35 larvae per liter was the maximum density that could be reared successfully in second-phase rearing tanks.

Water quality for second-phase rearing in trial *Mr* 4 was poor. Temperature and nitrite fluctuations were greater than in previous trials. The first juvenile was observed on day 29, and 95% of the larvae metamorphosed by day 46; survival was 27%.

Rearing trial *Mr* 5 larvae (32 600) were from two females. After 10 days of first-phase rearing, larval survival was extremely good (95%). During second-phase rearing, approximately 5—8% (2 000) of the larvae were lost accidentally. Water quality was good; only twice did nitrite level increase excessively (days 15—16 and 50—51). The first juvenile was observed on day 32, and 95% of the larvae metamorphosed by day 52; survival was 50.6%. The extended rearing period in this trial may have been caused by an insufficient quantity of

TABLE IV

Water quality analyses over four consecutive days following second-phase larval transfer (rearing trials *Ma* 4 and *Mr* 3)

Day	NH_3-N (ppm)		NO_2-N (ppm)		NO_3-N (ppm)		PO_4-P (ppm)		NO_2 Rila kit (ppm)	
	Ma 4	*Mr* 3	*Ma* 4	*Mr* 3	*Ma* 4	*Mr* 3	*Ma* 4	*Mr* 3	*Ma* 4	*Mr* 3
1	0.45	0.03	0.03	0.001	2.0	1.83	1.9	0.59	0	0
2	0.40	0.30	0.06	0.001	1.0	1.75	1.9	0.64	0.5	0.2
3	1.00	0.66	0.14	0.003	1.5	0.80	2.0	0.67	4.0	0.5
4	1.20	1.07	0.28	0.005	2.0	0.30	2.0	0.64	7.0	2.0

food being given to later stage larvae. Investigation showed this group received approximately one-fourth the average amount of ground fish usually provided.

Macrobrachium acanthurus rearing trials

Trial *Ma* 1 larvae (16 000) were progeny of a laboratory-reared female crossed with a wild male. Second-phase water quality was not good; nitrite concentrations rose on five occasions. During second-phase rearing, larvae were observed clinging to the deflector screen, apparently resting. Many dead larvae (50%) were observed on the tank bottom during the last 8 days of rearing, possibly a result of the continued high nitrite level. The first juvenile was seen on day 36, and 95% of the larvae metamorphosed by day 50; survival was only 1.5%. Because of such poor survival, this trial was not included in cost analysis computations.

Rearing trial *Ma* 2 larvae (13 300) were progeny of two laboratory-reared females crossed with wild males. Water quality during second-phase rearing was much better than in the previous *M. acanthurus* trial; nitrite peaks did not exceed 10 ppm. An unexplained mortality (15—20%) occurred on days 15—17. The first juvenile was observed on day 25, and 95% of the larvae metamorphosed by day 41; survival was 8.6%.

Rearing trial *Ma* 3 larvae (21 700) were from two wild stock females. Survival after 10 days of first-phase rearing was extremely good (95%). Water quality during second-phase rearing was excellent until day 30. Between days 30 and 50, nitrite levels rose and fell with each transfer and exceeded 10 ppm on three occasions, partly because the seawater source contained two ppm nitrite. Approximately 700 larvae were lost when they became trapped behind the larval deflector screen. The first juvenile was seen on day 35, and 95% of the larvae metamorphosed by day 50; survival was 7.9%.

Larvae (10 200) used in rearing trial *Ma* 4 were progeny of a wild female. Water quality during second-phase rearing was good; nitrite level concentration rose on only one occasion (day 44). Fluctuation of pH was greater than in other trials. Water quality analyses for NH_3-N, NO_2-N, NO_3-N, and PO_4-P were made on days 16—19 to evaluate changes in rearing water between larval transfers (Table IV). The first juvenile was observed on day 31, and 95% of the larvae metamorphosed by day 44; survival was 45.6%.

Rearing trial *Ma* 5 larvae (11 500) were progeny of two small, laboratory-reared females crossed with wild males. Water quality during second-phase rearing was good; nitrites did not exceed 10 ppm. Between days 29 and 30, approximately 700 larvae were lost unexplainably when they became stranded on the deflector screen, which was properly in place. The first juvenile was seen on day 26, with 95% of the larvae completing metamorphosis by day 39; survival was 37.9%.

Rearing costs

The average total rearing cost per thousand juveniles was \$3.56 for *M. rosenbergii* and \$13.42 for *M. acanthurus* (Table V).

TABLE V

Larval rearing cost data

Trial	Number in group	Rearing time (days)	Juvenile yield	Total survival (%)	Labor cost ($/1 000)	Operation cost ($/1 000)	Water cost ($/1 000)	Food cost ($/1 000)	*Artemia* (g/1 000)	Fish (g/1 000)	Total cost ($/1 000)
M. rosenbergii											
Mr 1	8 200	33	4 499	54.0	2.39	1.10	0.07	0.57	23.8	180.0	4.16
Mr 2	10 300	33	4 274	42.0	2.15	1.21	0.07	0.59	22.5	115.8	4.00
Mr 3	12 000	34	5 219	43.5	2.09	1.01	0.04	0.67	30.8	85.6	3.81
Mr 4	114 000	46	30 499	27.0	1.71	0.56	0.05	0.40	17.6	79.2	2.73
Mr 5	32 600	52	16 542	50.6	1.93	0.31	0.03	0.84	39.3	24.1	3.10
Average (%)		39.6	12 206	43.4	2.05 (57%)	0.84 (23%)	0.05 (1%)	0.61 (17%)	26.8	96.9	3.56
M. acanthurus											
Ma 1	16 000	50	243	1.5	—	—	—	—	—	—	—
Ma 2	13 300	41	1 155	8.6	14.57	3.19	0.38	4.18	200.0	85.6	22.32
Ma 3	21 700	50	1 705	7.9	11.58	2.87	0.39	2.59	119.1	98.8	17.43
Ma 4	10 200	44	4 677	45.6	3.59	0.80	0.09	0.98	45.9	30.8	5.46
Ma 5	11 500	39	4 355	37.9	5.40	0.82	0.12	2.13	102.4	37.5	8.47
Average[1] (%)		43.5	2 973	25.0	8.78 (66%)	1.92 (14%)	0.24 (2%)	2.47 (18%)	116.8	63.2	13.42

[1] Average of four trials. *Ma* 1 not included.

Food cost

One-gallon cans of dry *Artemia* eggs (1 250 g) cost $25.00 per can or $0.02 per g. An average of 27 g of eggs were used to rear one thousand *M. rosenbergii* juveniles and 117 g to rear one thousand *M. acanthurus* juveniles.

Ground fish prepared from whole Atlantic croaker (*Micropogon undulatus*) cost $0.44 per kg. Washing ground whole fish through a 0.6-mm mesh screen yielded 70% of the fish as usable food; the adjusted purchase price of usable ground fish was $0.63 per kg. Some ground fish was freeze-dried, yielding 21% of the fish as usable food; the adjusted purchase price was $2.06 per kg. Ninety-seven grams of fish were used per thousand *M. rosenbergii* juveniles, and 63 g were used per thousand *M. acanthurus* reared (Table V). Average food cost per thousand juveniles was $0.61 for *M. rosenbergii* and $2.47 for *M. acanthurus*.

Operating cost

A list of electrical equipment and costs for first-phase and second-phase rearing is given in Table VI. First-phase rearing in the larval system cost $0.219 per day for each group of larvae (each tank). Cost of second-phase rearing per trial consisted of $0.016 per day for aeration and lights, $0.108 per day for fall and winter heating, and from $0.081 to zero cost per day for spring and summer heating.

Operating cost for food preparation was $0.0026 per kg of ground fish and $2.53 per kg of freeze-dried fish. Average operating cost per thousand juveniles was $0.84 for *M. rosenbergii* and $1.92 for *M. acanthurus*.

Labor cost

Labor costs were determined by recording the amount of time needed to complete certain tasks. A list of the tasks and time required per rearing trial is shown below (40-day period).

Task	Hours
Transferring gravid shrimp from brood tank to hatching tank. Transferring larvae from collecting tank to first-phase reating tank.	0.20
Feeding larvae (fish and *Artemia*) three times daily.	1.30
Preparation of ground fish.	0.12
Artemia culture.	3.39
Second-phase larval transfers, including transferring larvae, cleaning and refilling old tank.	1.25
Total	6.26

approximately 20% with 3 000-l tanks because of increased aeration and heating. Total operating cost of the 35-day projection is slightly less, as rearing time would be shorter. Total labor cost is higher because of additional time required to transfer larvae from larger tanks. Labor cost per 1 000 juveniles produced is much less than the average for 1 000-l tanks.

Several factors must be considered for successful *Macrobrachium* culture. The first is species selection; *M. rosenbergii* is the hardier of the shrimp tested and seems the more adaptable to artificial culture. Most commercial ventures are already using *M. rosenbergii*. If rearing methods similar to ours are used, we recommend use of 3 000-l second-phase rearing tanks operated at optimum capacity for the system. Larval survival up to 75—80% can be expected if water quality and accumulation of debris are controlled.

A commercial hatchery raising *M. rosenbergii* for sale or for pond stocking should be able to produce juveniles at a cost of $2.00 or less per 1 000 (at present economic conditions). The reliability and cost of larval rearing seems predictable and encouraging to shrimp aquaculture. Further refinements in larval rearing undoubtedly will be made; however, the major emphasis in future research should be in solving the problems related to *Macrobrachium* pond culture. When shrimp pond culture becomes as reliable and predictable as hatchery culture is becoming, shrimp aquaculture should become a practical reality.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of the entire mariculture staff of the Marine Research Laboratory, especially F.H. Hoff, J.A. Mountain, T.A. Frakes, W.K. Havens, and K.R. Halscott. Thanks are also due D.K. Camp and J.A. Quick Jr, for their critical review of the manuscript. This project was made possible through the funding of the U.S. Department of Commerce NOAA, National Marine Fisheries Service, Act PL88-309, Project Number 2-206-R.

REFERENCES

Dugan, C.C., Hagood, R.W. and Frakes, T.A., 1975. Development of spawning and mass larval rearing techniques of brackish-freshwater shrimps of the genus *Macrobrachium* (Decapoda Palaemonidae). Fla. Mar. Res. Publ. No.12, 28 pp.

Forster, J.R.M. and Wickins, J.F., 1973. Prawn culture in the United Kingdom its status and potential. Fish. Exp. Stn Conway Lab. Leafl. No.27, 31 pp.

Fujimura, T. and Okamoto, H., 1970. Notes on progress made in developing a mass culturing technique for *Macrobrachium rosenbergii* in Hawaii. FAO Indo-Pac. Fish Counc., 14th Sess., 18 pp., mimeographed.

Liao, I.C. and Huang, T.L., 1970. Experiments on propagation and culture of prawns in Taiwan. FAO Indo-Pac. Fish Counc., 14th Sess., 37 pp., mimeographed.

Ling, S.W., 1962. Studies on the rearing of larvae and juveniles and culturing of adults of *M. rosenbergii* (de Man). FAO Indo-Pac. Fish Counc. Curr. Aff., 11 pp., mimeographed.

Ling, S.W., 1967. The general biology and development of *Macrobrachium rosenbergii* (de Man). FAO Exp. Pap.30, 18 pp.

Mock, C.R. and Neal, R.A., in press. Penaeid shrimp hatchery systems. Gulf Coast Fish Cen. Natl. Mar. Fish. Ser., 24 pp.

Shigueno, K., 1969. Problems on prawn culture *Penaeus japonicus* Bate. Jap. Fish. Resour. Conser. Assoc. Fish. Propagation Ser., No.19, 96 pp. (in Japanese).

R.W. HAGOOD
S.A. WILLIS

Cost comparisons of rearing larvae of freshwater shrimp, *Macrobrachium acanthurus* and *M. Rosenbergii*, to juveniles

Aquaculture, 1976, 7, 59-74.

R.W. HAGOOD
S.A. WILLIS

Cost comparisons of rearing larvae of freshwater shrimp, Macrobrachium acanthurus and M. Rosenbergii, to juveniles

Aquaculture, 1976, 7, 59-74.

R.W. HAGOOD
S.A. WILLIS

Cost comparisons of rearing larvae of freshwater shrimp, *Macrobrachium acanthurus* and *M. Rosenbergii*, to juveniles

Aquaculture, 1976, *7*, 59-74.