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THE EVOLUTION OF THE CLEAR WATER HATCHERY SYSTEM FOR Macrobrachium rosenbergii IN THE FRENCH WEST INDIES FROM 1979 TO 1984

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ABSTRACT

The clearwater larval rearing method for Macrobrachium rosenbergii was perfected in the french research center of Tahiti in 1977 and carried on to improve the technique especially on recirculating systemm.

This aquaculture is launched in Martinique by the regional council in 1976. A first "green water" hatchery is built and provides juveniles to the first ponds. In 1978, CNEXO (now IFREMER) is asked to cooperate for scientific and technical assistance in two fonctions : first, to built, set and run a small test hatchery using Tahiti AQUACOP - type "clearwater" system ; second, to help the development of ponds and the spreading of grow-out biotechnology.
This second hatchery is built in 1979 and supplies juveniles in 1980.

The development of ponds (26 ha in 1984) required the increasing of the hatcheries capacity which is now done with clearwater system in both buildings. The former "greenwater" hatchery shelters the breeders and the 6 first stages of larvae. The new enlarged hatchery, after change of tanks (5 x 1 m3 to 3 x 7 m3) shelters the second phase of the larval rearing (stage 6 to PL) until the entire metamorphosis and harvest of PL. This disposition allows overlaping cycles and consequently more cycles per year (7 millions PL production in 1984).

In Guadeloupe, the first ponds started in 1978. Two cooperatives and 11 ha of ponds in 1982 have determined the contruction of a regional hatchery. For saving time, a small light one had been quickly set in six months and produced post larvae since july 1983.

This paper studies the evolution of the classical recent standarts of the clearwater "AQUACOP" rearing method through the necessary adjustments in the carribean conditions.

RESUME

La méthode d'élevage larvaire de Macrobrachium rosenbergii a été mise au point au Centre Océanologique de Tahiti en 1977. Elle n'a cessé d'être perfectionnée depuis notamment avec l'introduction du circuit fermé. Cette aquaculture est lancée par le Conseil Régional de la Martinique en 1976. Une première écloserie "eau verte" est construite et produit des juvéniles pour les premiers bassins.

En 1978, le CNEXO est sollicité pour développer une coopération scientifique et technique notamment dans deux domaines : d'abord, construire, équiper et faire fonctionner une petite écloserie test utilisant la méthode "eau claire" type AQUACOP (TAHITI) ; ensuite aider au développement des bassins et à la diffusion des techniques d'élevage.

Cette seconde écloserie est construite en 1979 et sort des juvéniles en 1980. Le développement des bassins (26 ha en 1984) nécessite bientôt l'augmentation de la capacité des écloseries ce qui est maintenant réalisé avec la généralisation de "l'eau claire" dans les deux bâtiments -l'ancienne écloserie "eau verte" abrite les géniteurs et les 6 premiers stades larvaires- la nouvelle écloserie "eau claire", après changement des bacs (5 x 1 m3 à 3 x 7 m3) abrite la seconde phase de l'élevage larvaire (stade 6 à PL) jusqu'à la métamorphose complète et la pêche des post-larves. Ce dispositif permet le chevauchement des cycles et donc un plus grand nombre par an (production de 7 millions de PL en 1984).

En Guadeloupe, les premiers bassins apparaissent en 1978. Deux coopératives et 11 ha de bassins en 1982 entraînent la décision de construire une écloserie régionale. Pour gagner du temps, une petite écloserie légère est installée en six mois et produit des juvéniles depuis juillet 1983.

Ce papier étudie l'évolution des récentes normes de la méthode d'élevage larvaire classique en "eau claire" d'AQUACOP dans les conditions des Antilles Françaises.

INTRODUCTION

Many species of Macrobrachium exist in the world but most of them are overfished for their quality and their price since a long time.

The giant freshwater prawn Macrobrachium Rosenbergii has shown so evident advantages for aquaculture that its spreading all over the tropical belt had been highly predictable since 1975.

As a matter of fact, this species has left its native area (South East Asia) to get many other countries towards the East (Taïwan, Hawaï, Tahiti, Florida and the caribean area) and the west (Sri Lanka, India, Mauritius, Africa, etc. - Bardach et al 1972 -)

The determining factor of the development has been the control of reliable survival in hatchery, for this omnivorous animal can afford natural conditions within such a wide range that its grow-out has never been a real problem.

Various alternative techniques for larval rearing are used in many countries (New and Singholka 1982). The most reliable methods for mass production are :

- the "green water" system which includes natural phytoplancton with relatively low densities (30-50 larvae/liter) in usual rectangular concrete tanks. Its native hatchery is in Hawaï (Fujimura and Okamoto 1970) ;
- the "clearwater" system which uses chlorinated, filtered, heated water with relatively high densities (80-100 larvae/liter) in usual cylindro-conical fiberglass tanks. Its native hatchery is in Tahiti (AQUACOP 1977 a and b). This method had succeeded since 1977 reliable mass production of PL either in open system or in recirculating biological filter (AQUACOP 1983). This way of rearing had been developped because it appeared quickly to the AQUACOP team that the optimisation of all the parameters seemed to be the condition to obtain reliable and, above all, cheap mass production of post-larvae.

The comparison of the systems on the same place in Martinique is one of the original features of the development of this aquaculture in this area with the adjustments of the Tahiti method to the local conditions.

HISTORY

In 1974, the vice-president of the regional council of Martinique, Mr J. BALLY, visited Mauritius and discovered the aquaculture of Macrobrachium rosenbergii. The similarity of climate and topography with the French West Indies led him to try this aquaculture in this country with the help of the british biologist Roy Jenson he met in Mauritius.

In 1976-77, Roy Jenson, who had been trained to these techniques by Fujimura in Hawaï, built the first "green water" hatchery in St Pierre (Martinique) with six 3 m3 concrete tanks and three 9 m3 tanks. He imported the first broodstock from Hawaï and started the production of post-larvae for some private experimental ponds in Martinique and Guadeloupe. He also started (1977-78) the training of a local team managed by SAFEM (local management and assistance company).

Before his leaving, he recommended to ask CNEXO for a technical and scientific assistance. CNEXO accepted and proposed to build a small "clear water" system hatchery on the same place to test the two methods.

This was done in 1979-1980 with the construction and the equipment of a small Tahiti type hatchery with five 1 m3 cylindro-conical fiberglass tanks. A biologist of CNEXO - FRANCE AQUACULTURE - Group achieved alone the first production of PL in july 80 with the planned results (over 260 000 PL in 41 days). The training of the neigbouring technicians began at the second cycle and was carried out until the total control of the method by the local team without any help.

During the next two years (1981-1982), the two hatcheries ran and produced in parallel to compare the features of the two techniques and to face an increasing demand of PL for new ponds in the two islands. Gradually, phytoplancton disappeared from the green water hatchery which allowed to test with succes the first phase of rearing in concrete tanks and second phase in fiber glass tanks more easy to handle.

The development of ponds in Martinique and Guadeloupe between 1982 and 1983 (19 to 36 ha on the whole) compelled the cooperative (SICA) to prepare the extension of the second hatchery. After three trials with bigger capacity (3, 5, 7 m3), three 7 m3 fiberglass tanks finally took place in the hatchery with few modifications. The system of two overlapping rearing phases in two different structures had been generalized with success.

In Guadeloupe, at the end of 1982, the producers of prawn asked CNEXO for a local hatchery to avoid the dependence on air plane importation. A small hatchery with a light hothouse and five 1,1 m3 fiberglass tanks was built with in six months and produced the first PL under clearwater recirculating system in july 83. The biological filter was an AQUACOP design, experimented in Tahiti. At the beginning, the productions of PL were not as good as in a specific design hatchery building and many adaptations appeared to be necessary. But the confidence for reliable regular PL supply was created and bananas and sugar cane farmers started to plan new ponds in many places (16 ha in december 83).

In 1984, the hatchery of Martinique succeeded in the production of higher quantity of PL with increasing densities in the 7 m3 tanks (35 to 75 larvae/liter). Though over 1,5 million PL had been exported towards Guadeloupe and Guyane, the SICA cooperative was bound to reduce the production because of slower development of ponds (26 ha at the end of 1984). The system of a first phase up to 14 th day in concrete tanks, and the second phase in fiberglass tanks for metamorphosis and PL harvesting appeared to be reliable and easy-to-hand even for big amount of larvae.

In Guadeloupe, the provisional hatchery supplied small-scale but regular productions of PL. The development of ponds (22 ha at the end of 1984) decided the main cooperative to plan the construction of mass-production hatchery. The SICA cooperative of Guadeloupe asked then the CNEXO - FRANCE AQUACULTURE - Group for the whole design of this new hatchery (studies, engineering, work control, etc.) and for the training of a local team.

RESULTS AND DISCUSSION

Table 1 presents the main data of PL production of the two hatcheries of Martinique :

Table 1. Annual productions of post-larvae of the hatcheries of Martinique since 1979

Year	79	80	81	82	83	84
Green water hatchery (a)	1,209	1,149	1,636	827	840	-
Clear water hatchery (a)	contruc-tion	531 (b)	1,093	1,360	148	-
Combined hatcheries (a)	-	-	-	-	2,988	6,966
Annual total	1,209	1,680	2,729	2,187	3,776	6,966
Observa-tion	hurricane "David"	hurricane "Allen"		clearwater in both hatcheries (c)	test 5, 7 m3 tanks	willingly limited production

(a) = x 1000 post-larvae
(b) = in 6 last monthes (2 cycles)
(c) = and first trial of 3 m3 conical fiberglass tank

With 34 m3 of concrete larval tanks the first "green water" production hatchery revealed to be able to supply between 1 to 1,6 million PL/year. With 5 m3 of fiberglass tanks and the same number of people, the second "clearwater" test-hatchery was able to supply between 1 and 1,3 million PL/year.

It appeared quickly obvious that first, the small clearwater hatchery had to be enlarged with fit new tanks ; second, two hatcheries working in parallel with two entire teams cost too much for a moderate overall production.

The original solution which had been tested with success since 1982, was the complementary use of the two buildings in clearwater : starting of larva rearing in concrete tanks (until day 12-14) and transfer in fiberglass tank for metamorphosis and PL harvesting.

This technique allows a much higher production with less than two teams (6 persons instead of 2 x 4 p), and a nearly permanent supply of PL which is a great advantage for the various restocking strategies of farmers.

Of course, bigger fiberglass tanks were needed. The last and best solution was a 7 m3 homothetic development of the 1 m3 cylindro-conical shape allowing an homogeneous density of larvae and feed, and a suitable bottom area for benthic PL. The low densities of the first productions appeared step by step unnecessary. The problem is now to develop pond surfaces up to 40-45 ha which should be enough to balance the hatchery budget.

Table 2 presents the results of the tempory light hatchery of Guadeloupe (5 x 1,1 m3)

Table 2 . Productions of the Guadeloupe hatchery.

Year	1983	1984
Production of PL per cycle	Construction	304.000
		255.000
	130.000	245.000
	160.000	165.000
	203.000	230.000
Annual total	493.000	1 189.000
mean/cycle	163.000	238.000

This hatchery has three specific features, which explains medium results :

1 - For saving time and money, a hothouse had been chosen instead of an adequate building.

2 - The hatchery is 600 m from the sea without possibility of pumping which requires a biological filter and the carriage of salt water.

3 - All the equipments had been imported from Europe and some of them revealed not to be exactly suitable.

Therefore, significant progress in final survival rate had been realized through many small technical adjustments. The major interest of this hatchery remains the fastness of the operation : 7 months between the decision and the first PL .

Table 3 introduces a comparison between the main parameters of the "clearwater" larval rearing method in differentes places, times and equipments.

Table 3. Main parameters of PL production in different clearwater hatcheries from 1981 to 1984

Localization	COP (a)	COP	Martinique	Martinique	Guadeloupe
dates of production	83-84	83-84	81-83	84	83-84
Number of cycles	5	6	10	11	8
Total rearing volume (m3)	14-22	5	5	21	5,5
Unit volume (m3)	2	5	1	7	1,1
Operation mode	Experimentation/production	production	production	experimentation/production	production
Water system	R (b)	R	O (c)	O	R
Duration (days)	40	39	36	38	41
Dry feed / 100.000 PL (kg)	0,4	0,5	1,4	0,7	1,4
Artemia / 100.000 PL (kg)	2,4	2,7	2,2	2,3	3,7
Initial density (L/l)	100	98	124	137 (d)	91
Final survival (%)	72	59	46	57	43
Number of PL/liter	72	58	57	33	39

(a) = Centre Océanologique du Pacifique - Tahiti -
(b) = Recirculating system (with biological filter)
(c) = Open system (water exchange every day)
(d) = High density larval first phase (120 - 160 L/l) until D 12-14

The results of Tahiti COP show good scores for every parameter but it must be underlined that this hatchery is half experimental and half production unit in a general research center. The scientific and technical assistance is the best one could find and there is no constraint of profitability at the end of the year. Under nearly same conditions, the famous cylindro-conical 2 m3 tank still obtains much better average PL productivity than the new big U-shape tank (5 m3). We can notice a better productivity in small volumes (2 or 1 m3 tanks) than in big volumes inside a same hatchery (5 or 7 m3 tanks).

It is difficult to say if it's because of a lack of experience in greater volume or unscaled results. However, in Martinique, the final survival rate increases from 1981 to 1984 mainly thanks to better trained technicians (46 to 57 % final survival).

The productivity of the 7 m3 tank seems to be widely improvable after this year of production because two cycles out of eleven had reached 44 PL/liter (annual mean : 33 PL/liter). It is also interesting to know that only one more technician is needed to jump from 5 x 1 m3 to 3 x 7 m3.

The open system seems to take a little less time than the recirculating one even with un-heated larval first phase (26 to 29° C from D1 to D 12-14 ; 32 °C after fransfer in 7 m3 tanks).

The advantage of economy of pumping an handling in recirlating system is balanced by the advantage of easiness of chemical treatments in case of pathology is open system.

The initial density in 1 m3 tanks is certainly too high (124 larvae/l) which explains a relatively low survival rate (46 %). A lower density would have probably given a better final productivity with economy of feed. The best one seems to be around 100 larvae/liter. This rather high density still allows very good final survival rate if adequate rearing conditions.

The results of Guadeloupe appear not to be so good, mainly because of unsuitable building and some inadequate equipments. It must be said that only one technician and one local worker have made it run with few help from outside. Anyway, 39 PL/liter (43 PL/l in 1984) is a good result for a quick test including adjustment first trials.

Though it is difficult to compare these three hatcheries in different natural conditions and equipments, smaller volumes (1 or 2 m3) still seem to afford higher density and better productivity than big volumes (5 or 7 m3).
A balance must be found between the optimum size of the tank and the production capacity according to the local equipment availability.

CONCLUSION

Concerning the original AQUACOP "standard" method, we can assure that with permanent high quality equipments and scientific assistance, the clearwater hatchery system can supply reliable productions from 58 to 72 PL/l according to the size of the tank, even in recirlating system.

When exporting, if it's realized with suitable fittings and an ordinary trained team, the classical open system with 1 m3 tanks can also afford reliable production (57 PL/liter) with low requirements of artemia and duration.

With a hothouse ans approximate fittings in recirculating system the performances cannot be so good although they remain conclusive for a quick and short term demonstration or help.

The future of big tanks (after some further progress with 5 and 7 m3 tanks) seems to be good for mass production especially with recirlating system to save pumping and handling time.

Actually, as it had been experimented with success in the French West Indies, a part of the design of the hatchery and its equipment (tanks, water circulation system, etc ...) remains dependent on the local conditions and opportunities without forsaking the clearwater standard system.
This demonstrates that this system can be easily adapted when the specification brackets and the rules of processing are respected.

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