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FIRST RESULTS OF A 10 ha MACROBRACHIUM FARM IN TAHITI

AQUACOP *

ORERO BP 20 PAPEETE TAHITI FRENCH POLYNESIA

CNEXO-COP BP 7004 TARAVAO TAHITI FRENCH POLYNESIA

ABSTRACT

The Office de la Recherche et Ressources Océaniques (O.R.E.R.O.) in Tahiti and the Centre Océanologique du Pacifique (COP) have developed together for 10 years the whole set of techniques to culture Macrobrachium rosenbergii : hatchery systems, feed formulations and locally produced pellets, nursery and grow-out ponds.

This paper presents the first results of a 10 ha Macrobrachium rosenbergii commercial private farm operating in Tahiti since 1981 with water renewal by gravity flow.

The post-larvae are seeded in nursery ponds at 100/m2 , transferred in growing ponds 2 - 4 months later and then grown at 20/m2 until 20 - 25 g mean weight with partial harvests from the 5th month and draining of pond the 8th to 10th month. Average production is between 2 and 3 tons/ha/year and feed conversion ratio 2,5 to 3.

INTRODUCTION

- In 1973 the "Service de la Pêche" of French Polynesia (now ORERO) and the Centre Océanologique du Pacifique (COP) located in Vairao , Tahiti, have decided to promote the development of Macrobrachium rosenbergii culture for the local market with the following goals :

- produce the post-larvae in a hatchery,

- develop feed formulations using local by-products and set up a feed mill,

- build and operate pilot ponds,

- promote the construction of production farms,

- training of people in the different activities.

The completely controlled culture system developed for mass production of post-larvae uses clear water in 2 m3 cylindar conical bottom tanks with a daily water change and more recently a recirculating system.Productions are 50 to 100 PL/liter in 35 to 40 days using newly hatched artemia and inert particles. The consumptions of artemia (50% hatching) and inert particles to produce 1 million post-larvae are respectively 12 kg and 15 kg. The technology, methodology and production costs have been previously described : Aquacop (1977 a, b, c; 1979c; 1980 ; 1982). A pilot production hatchery is now routinely producing (1979 : 2,8 million PL ; 1980 : 3 million ; 1981 : 4,3 million ; 1982 : 5,2 million) operated by a team of ORERO.

Researches on feed formulations have ended by the set up in 1982 of a feed mill using an extrusion process and incorporating coconut meal (Aquacop, 1976 ; 1979). A special food is manufactured for the larval stages : inert dry particles of different sizes (Aquacop, 1982) which allow to decrease the need in artemia significantly.

From 1973 to 1981 numerous growth experiments have been carried out in earth ponds of different sizes from 700 to 5000 m2. Different densities, feeds and stocking strategies have been compared : (Aquacop internal publications, unpublished data). In these years a total of 19,2 tons have been produced and sold locally.

All these results have lead to set up in 1980 a production farm privatly funded. This paper deals with the problems and constraints encountered for the design; the construction and the operation of this 10 ha farm the first two years, presents its first production results and points out the fields where efforts must be developed.

ENVIRONMENTAL AND MARKET
CONDITIONS IN FRENCH POLYNESIA

French Polynesia is situated in the middle of the South Pacific. It consists of atolls and mountainous volcanic islands : the small part of flat land around high islands is used for habitations and agricultural development and is too expensive for aquaculture. Most of the freshwater is coming from torrentuous rivers whose flow varies greatly according to the rains and completely stops during some period due to a high permeability of the soil.

In these conditions, the only available sites are sloped lands in valleysalong the permanent rivers. The soil there is a mixture of rocky parts and clayey earth called "MAMU", unfavourable for agriculture but suitable for earth dykes construction. An advantage of the slope is the possibility of renewing the water of the ponds by gravity flow from a higher point of the river. Such sites are quite rare and scattered with superficy ranging from 1 ha to 15 ha at the best. Moreover the repartition of the ownership between many people often makes unusable potentially good sites.

So there is no possibility for large farms producing . for export purposes. Only the supply of the internal local market can be   aimed   : this market is estimated to 100 tons a year for a population of 120 ,000 people and a tourist flux of the same magnitude each year. From the harvests data it appears that a total superficy of 40 ha will be sufficient. This product is traditionally known by the natives .Three local species occur in the rivers, but catches are declining as the fishery effort increases due to a high selling price (15 - 20 $/kg heads-on for a 5 to 20 g size).

The freshwater temperature is always between 20°C and 26°C in the rivers allowing continuous production.

FEASABILITY STUDY OF

THE FARM

Numerous experimental rearings were made from 1973 to 1981, at COP and in a 2 ha pilot farm, testing different schemes of production : discontinuous production with one phase, discontinuous production with 2 phases (nursery and growing) and continuous production.

For the discontinuous production, the results in the nursery phase were good until 200 post-larvae per m2 : from P.L. to 1g between 60 and 90 % survival ; duration 2 to 4 months. In the growing phase, the productions were 2 to 4 tons/ha/year of 10 - 20g prawns with 60 - 80% survival and conversion ratio of food around 3. In the continuous production trials, survivals were lower (20% to 50%), yields 1 to 2 tons/ha/year and conversion ratio over 4.

After all these trials on public budget, the decision was taken to transfer the technology to the private sector. A site was selected and an economic feasability study based on the following parameters of production was done :

	phase 1 : nursery	phase 2 : growing
initial density (n/m2)	100	20
mean weight at harvest (g)	1	15–20
expected survival (%)	70	60–70
conversion ratio of food	1	3
duration (months)	2–3	8–10

The rate of profit from this study appeared satisfactory and so the decision was taken to build a 10 ha farm.

DESCRIPTION OF THE FARM

- Location :

    The farm is located at Teahupoo (Tahiti Island), at the mouth
of the Vaiavaro river, 80 km from Papeete. Heigth of rain per year was
4 658 mm in 1974, 3 082 mm in 1975. Flow of the river : -1974 mean
0,536 m3/s ; maximum 1,65 m3/s in January ; minimum 0,2 m3/s
in August -1975 mean 0,465 m3/s ; 3,28 m3/s in December ; 0,115 m3/S
in July.

- Ponds - Networks   :

    Six nursery ponds up : unit surfaces about 2 000 m2 ; total
surface 11 800 m2. Seventeen growing ponds down : unit surfaces
about 5 000 m2 ; total surface 90 300 m2. Dykes and bottom are
made of earth. The mean depth is 1m. Each pond is equipped with
two outflow pipes, one for surface and the other for deep water.

    The water is collected from the river in a concrete tank covered
with an iron gate and flows to the ponds by gravity through PVC pipes.

- Buildings - Equipments - Personnel :

    Buildings consist of an air-conditionned room for storage of the
pellets and an open shed for the rest of the material.

    The main equipments are :
    - 3 nets (a 25 m X 2,5 m seine with a 4 mm mesh for sampling and
    harvesting nursery ponds;a 60m x 2m seine with a 14 mm mesh
    and a 100 m X 2 m seine with a 20 mm mesh for harvesting the
    growing ponds) ;

    - a 15,5 H.P. tractor and a pick-up car.

    The staff includes one manager and 4 workers.

POND MANAGEMENT

The ponds are filled with water some days before stocking of prawns.

The daily mean rate of water renewal is 10%. The water temperature varies from 20°C to 30°C at different months (from 20°C to 25°C during the cold season from June to October and over 25°C the rest of the year). pH at start is near 8 ; then it grows up and can reach 9,5. Correlatively the disappearance depth of Secchi disc lowers until less than 30 cm when the rearing goes on.

Exceptionnally some other measurements can be done : oxygen, dissolved salts, organic matter, pollutants... The prawns are fed once a day at 4-5 p.m. five days out of 7, with ROCOP pellet 1 mm in diameter in nursery ponds and 4 mm in diameter in growing ponds : the daily ration is calculated from the estimated total weight of shrimp and a theoretical daily feeding rate and then controlled by the observation of remains from the dyke or underwater. The days when many moultings occur, no food is given. The observation of prawns and measurement of growth is realized through periodic seining (every second week) of samples including some hundred shrimps from 2 different locations of the pond.

For selectively harvesting, once or twice a month, the 20 mm mesh seine is pulled successively in two halves of the pond. The final draining of the pond is made through a net that retains the shrimps.

RESULTS AND PROBLEMS ENCOUNTERED

- Farm construction : The whole construction of the ponds was performed in eight months, slightly disturbed at the end by the rainy season. Some ponds present a high rate of percolation and have not been used till recently when a layer of clay was added. The dykes broke around the outlet pipes in two ponds unequipped with a concrete water stop system : 300 000 post-larvae were lost. In case of heavy rains, the water intake system may be completely covered by stone blocks and clogged by dead leaves : it must be cleaned regularly.

- Nursery results : The survivals in nursery ponds (table 1) were lower than expected (from 17% to 76%), making it impossible to fill out all the growing ponds in 1982 at the normal density. When diving in the nursery ponds some hours after seeding, we observed a lot of dead post-larvae ; the cause of this mortality was recently discovered :the increase of the hatchery production had lead to shorten the delay of acclimatation of the post-larvae from hatchery conditions to pond conditions. A 12 hours stocking with progressive decreasing of the salinity and temperature must be applied to avoid such problem.Numerous dragonflies have been recorded, mainly in the ponds with low survival at seeding ; in normal density conditions, it seems the post-larvae control this potential predator.

The growth curves in figure 1 show that 1g mean weight from post-larvae is usually reached within 2 to 4 months : the slower growths are that of cold season and higher densities.

- Grow-out results (Table 2)

Mortality : The survival rates range from 39 to 86%, averaging 58%. During all these trials, we never observed dead animals at sampling or harvesting ; the prawns health stays very good : firm body without necrosis and lost appendages. We are suspecting that most of the losses are due to predators : eels whose stomach was always found to contain shrimps and, more dangerous, sea birds which catch the animals moulting on the sides of the ponds. It is difficult to evaluate precisely this predation but it is undoubtly high.

Mean growth : From 0,5 to 3g, the mean growth rates are 1g/month in cold season and 2-3g/month in hot season. Over 3g, the growth rates are generally comprised between 2,5 and 5g/month according to shrimp density and quantity of food.

Feeding rates : The daily feeding rates range from 1% to 3%, varying with the density of shrimp, the size of shrimp, the temperature. An average scheme of distribution is presented in Table 3 'assuming the first 2 months below 25°C}.

Shrimp stock management : It is advisable to seine early the biggest animals that inhibit the smaller ones and show higher mortality rates and food conversion ratios. At Aquapac, the selective seining starts when the mean weight reaches 8 to 10g (4 to 5 months after 1g) and then goes on once or twice a month. The draining of pond is done 4 to 6 months after the first seining when the density has fallen down to 5/m2.

Yield and feed conversion ratios (see Table 2) : The annual yields of the 17 rearings considered range from 0,9 to 3,1 tons/ha/year assuming the ponds empty 10% of each year. The average is 1,8 Ton/ha/year. The food conversion ratios are in most trials under 3. They deteriorate in the last trials.

The draining of water for the final harvest is uncomplete in some ponds presenting a bad slope and as a consequence remaining shrimps must be picked by hand.

The percolation through some ponds and the losses of post-larvae have not allowed to manage the farm as wished and lead to a total production of only 11 tons in 1982.

- Prospectives :

A simplified production model computed from the best 1981,1982 rearings is presented in Table 3 and figure 2. 20/m2 shrimps are seeded at 1g ; 1/m2 is supposed to disappear each month (dying or predated) which gives 60% survival the 8th month and 50% the tenth ; from the 4th-5th month on, 1/m2 25g shrimp is selectively seined. In 1981 - 1982 the draining of the ponds was done when 5 prawns/m2 were left. Applied to the whole farm, this model would lead to a harvest harvest/ha growing pond/year of : 2,63 tons (the ponds assumed to be empty 10% of each year) and a total harvest of 23,7 tons/year on the whole farm.

However, it is clear from the figures that in terms of yield and food quotient our interest is to empty the pond early (the 7th or 8th month) provided that 15-17g mean weight shrimps can be sold totally at good price. This is why the 20 mm mesh seine will be replaced by a 18 mm mesh seine in 1983.

ECONOMIC ELEMENTS

The total investment was about 500.000 US $ 36% of which borrowed for 15 years at 7% annual interest.

Post-larvae are bought 10 $/1000 from the COP hatchery.

The pellet is bought 0.60 $/kg from the "Huilerie de Tahiti".

Monthly salaries vary from 480 $ for a worker to 1.200 $ for a farm chief (plus 22,25% social charges to be paid by the employer).

The prawns are sold about 10 $/kg mainly to a wholesaler, that price being inferior to import price for shrimps.

The first two years 1981 and 1982 were expected to show a deficit ; a benefit is waited in 1983 for a production of 20 tons.

The break-even point of profit should correspond to an annual farm production of 15-20 tons depending mainly on survival rates and food conversion ratios.

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CONCLUSION

From the results of the first two years, it appears the farm
should generate a good return when reproductibility of yields over
2,5 tons/ha/year of 15-20g animals will be obtained. This objective
can be reached in 1983 when a production of 20 tons is expected : efforts
will be focused on the prevention of sea birds predation and adjustment
of food.

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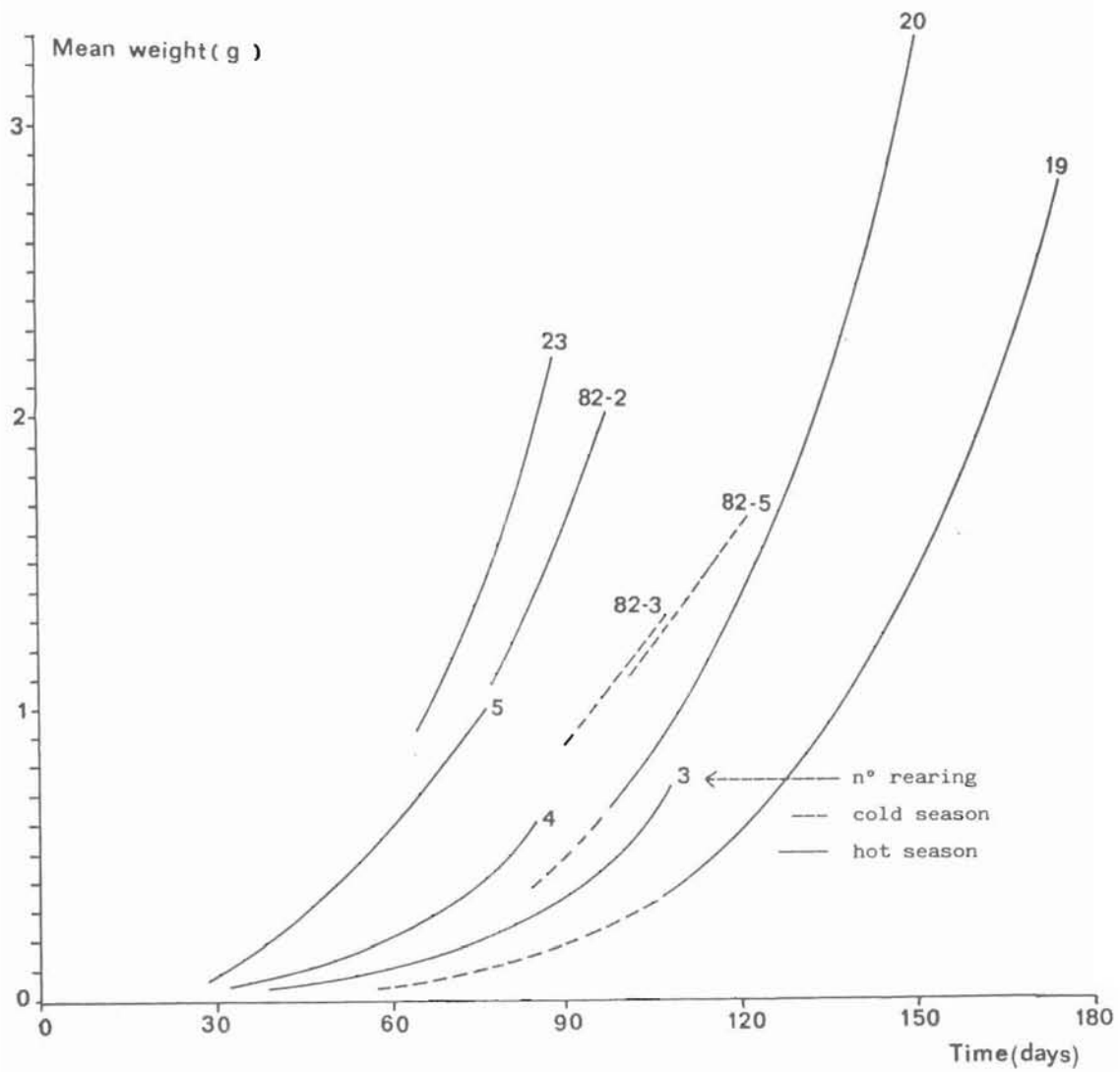
Fig. 1 : NURSERY GROWTH CURVES

Table 1. — NURSERY SURVIVALS.

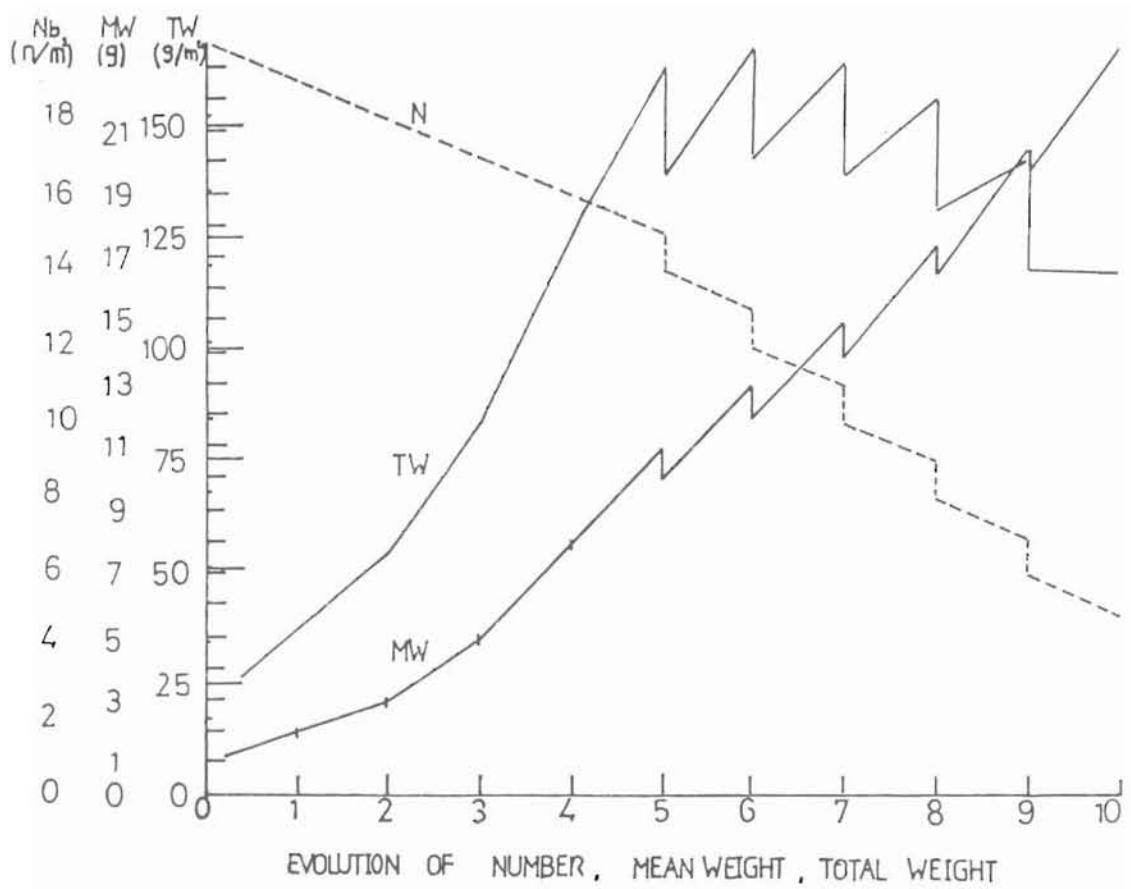| N°	1	3	4	5	6	19	20	23	82.2	82.3	82.4
initial density (n/m2)	119	193	183	180	166	124	94	130	106	103	90
survival (%)	51	76	75	34	48	35	18	35	25	43	17

FIG 2 : GROWING MODEL FROM THE BEST 1981 — 1982 REARINGS.

Table 2. – MAIN FIGURES OF THE 1981, 1982 GROWINGS.

N°	A2	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A21	A22	A24	A82₁1
Average weight at stocking (g)	1	0,1-0,2	0,1-0,4	0,1-0,2	0,13	0,2-0,6	0,13	0,4	0,5 - 1	0,6 - 1	0,6-1,4	0,8 - 8	0,7	6	1,6-3,6	2,8 - 3	0,6-2,(
Stocking density (nb/m2)	24,6	20,3	15,8	5,1	16,4	14,8	15,3	17,3	17,4	16,4	15,5	13	4	9,8	16,6	13,9	16
Duration (days)	225	405	324	181	342	279	203	390	267	365	358	215	164	96	281	243	270
Av. weight of harvested prawns	12,8	22,3	25,2	18,9	27,3	19,9	20,2	23,4	20,6	22,7	25	21,2	20,7	17,0	20,5	22,0	19,0
Survival (%)	86,4	45,5	54,3	65	47	53	41,3	58,7	63,4	78,4	55,4	39	73	89	50,3	55,5	44
Yield (tons/ha/year) (1/10 empty)	2,2	1,6	2,1	0,9	2,0	1,8	1,6	1,9	2,7	2,5	1,9	1,2	1,1	3,1	1,6	1,7	1,3
Food conversion ratio	2,7	4,2	2,6	0,6	2,9	2,8	2,5	3,3	2,3	2,3	2,7	2,3	0,9	1,9	4,9	6 .	5,9

Table 3. - GROWING MODEL FROM THE BEST 1981 - 1982 REARING

DATE	dt (days)	Nb (n/m2)	MW (g)	TW (g/m2)	Pdt/dt (g/m2/d)	Pt/t	Rdt/dt (g/m2/d)	DFR (%/d)	GR (g/mo)	FQdt	FQt
1 7		= 20.0	1.0	20.0							
	30				.6		.4	1.4	1.0	.7	
31 7		= 19.0	2.0	38.0		.60					.67
	30				.5		.7	1.5	1.0	1.3	
30 8		= 18.0	3.0	54.0		.57					.97
	30				1.0		1.4	2.0	2.0	1.4	
29 9		= 17.0	5.0	85.0		.72					1.15
	30				1.4		2.7	2.5	3.1	1.9	
29 10		= 16.0	8.0	128.0		.90					1.44
	30				1.2		3.7	2.5	3.1	3.0	
28 11		= 15.0	11.0	165.0							
		- 1.0	25.0	25.0							
		= 14.0	10.0	140.0		.97					1.84
	30				1.0		3.9	2.5	3.1	4.0	
28 12		= 13.0	13.0	169.0							
		- 1.0	25.0	25.0							
		= 12.0	12.0	144.0		.97					2.21
	30				.7		3.1	2.0	3.1	4.4	
27 1		= 11.0	15.0	165.0							
		- 1.0	25.0	25.0							
		= 10.0	14.0	140.0		.93					2.45
	30				.6		3.0	2.0	3.6	5.1	
26 2		= 9.0	17.5	157.5							
		- 1.0	25.0	25.0							
		= 8.0	16.6	132.5		.89					2.67
	30				.4		2.8	2.0	4.1	7.2	
28 3		= 7.0	20.6	144.2							
		- 1.0	25.0	25.0							
		= 6.0	19.9	119.2		.83					2.90
	30				-.0		2.3	1.9	4.0	-345.0	
27 4		= 5.0	23.8	119.0							
		- 5.0	23.8	119.0							
		= 0.0	0.0	0.0		.75					3.21

LEGEND :

dt : number of days between two dates

Nb : number of shrimp (n/m2)

MW : Mean Weight (g)

TW : Total Weight (g/m2)

Pdt/dt : Average production during dt period (g/m2 d.)

Pt/t : Average production from the first day (g/m2/d)

Rdt/dt : Mean ration on the period (g/m2/d)

DFR : Daily feeding rate (%/d)

GR : Growth rate of mean weight (g/month)

FQ dt : Food quotient on the period