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The state of the art of IFREMER in tropical aquaculture

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Abstract — IFREMER, a french governmental agency, is engaged in research on tropical aquaculture since 1971, with the aims to develop new activities in French overseas territories and to export French technology to foreign countries. With 80 searchers and technicians the « Centre Océanologique du Pacifique » is the main IFREMER's centre involved in tropical aquaculture.

The research has been focused on the complete control of the whole cycle : constitution of broodstock, maturation and reproduction, larval rearing, grow-out. The results are :

— **Edible molluscs** : *Saccostrea echinata*, *Crassostrea gigas*, *Crassostrea rhizophorae*, *Perna viridis*. The reproduction in captivity, the larval rearing, the settlement and the pregrowing are under control. The main problem is the poor productivity of the water in tropical islands.

— **Freshwater prawn** : *Macrobrachium rosenbergii*. Larviculture : the C.O.P. has defined an intensive technique in recirculated water. The production is 80-100 post-larvae per litre. Grow-out : two techniques are used continuous grow-out : 1.5 to 2.5 t/ha/yr. Discontinuous grow-out : 1 to 2 t/ha/yr. In 1988, 188 t have been produced in the French overseas territories.

— **Seawater shrimp** : four species have been selected : *P.monodon*, *P.indicus*, *P.vannamei*, *P.stylirostris*. Constitution of broodstock, maturation and spawning : the C.O.P. is now working on a routine basis with animals of the 10th to the 13th generation in captivity. Larviculture : production of 80 to 100 post-larvae per litre in closed (or open) system with algae artificial feeds and artemia. Grow-out : semi-intensive : 2 to 4 tonnes/ha/yr. Super-intensive : 15 to 30 tonnes/ha/yr. AQUACOP has formulated different artificial feeds for the 4 species. In 1988, 262 tonnes of shrimps have been produced in the French overseas territories. The transfer of technology has been made in different tropical countries (Asia, Africa, South-America).

— **Finfish** : At experimental scale the selection of species is under progress. The most suitable for tropical aquaculture seem to be *Lates calcarifer* and *Sciaenops ocellatus*. In 1988, the first spawning of captive broodstock of *Lates calcarifer* has been obtained. The commercial size (500 g) is reached by one year, in floating cages (15-30 kg/m³) with an artificial food formulated by AQUACOP. Shrimp and prawn technologies have yet reached the commercial scale. In the next future, finfish culture should reach the pilot scale in French overseas territories.

RATIONALE AND GOALS

IFREMER is engaged in research on tropical aquaculture since 1972 with aims to develop new activities in French overseas territories and to export French technology to foreign countries (AQUACOP, 1974).

THE WORKING TOOLS

With 80 people the « Centre Océanologique du Pacifique » is IFREMER's main centre involved in tropical aquaculture. Different experimental or predevelopment stations in French overseas territories (New-Caledonia, French Guayana, F. West Indies) allow the adaptation of the techniques to the local conditions and the transfer to the private sector.

THE STRATEGY

The work strategy on molluscs, crustaceans and fishes is to obtain the complete control of the biological cycle. This approach is the only one which opens the way to genetic improvement possibilities. These ones will without any doubt bring repercussions as important as those recorded in terrestrial rearing productivity. On the other hand the control of the whole life cycle allows the most performing species spreading for culture in the whole intertropical zone, and the regular supplying of juveniles, base of any profitable enterprise management.

The main steps of the rearing are :

the constitution and the maintenance of the broodstocks,
the induction of the maturation and spawning in captivity,
the larval rearing to produce spats, post-larvae or fry,
the pregrowing to provide good quality juveniles,
the grow-out to reach the commercial size,
the fixing and transfer of the different techniques follow four different steps :

- the experimental step in small tanks and ponds to precise the zootechnical standards;
- the pilot step in the C.O.P. or in the different transfer stations to prove the technical feasibility and to fix the production cost scales;
- the demonstration step occurring in production units conceived for this special purpose, having a participation of private and public funds side by side; this step must lead to prove the economical feasibility of the project;
- the development step which carries along the increase of production units; the C.O.P. or transfer stations will not be involved any more, except by helping to face new difficulties. In foreign countries the transfer of technology is done through France-Aquaculture, subsidiary company of IFREMER.

MOLLUSC REARING

Species : Green mussel from the Philippines : *Perna viridis*
Rock oyster : *Saccostrea echinata*
Japanese oyster : *Crassostrea gigas*
Mangrove oyster : *Crassostrea rhizophorae*
Clam : *Ruditapes philippinarum*

The species selected are : *P. viridis*, *C. rhizophorae* and *S. echinata*.

Concerning the others species, different tests were not successful : the Japanese oysters showed particularly important mortalities at high temperatures.

Are now well controlled :

- the constitution and maintenance of broodstocks,
- the maturation and spawning (thermic shock),
- the larval rearing (AQUACOP, 1977, 1979),
- the nursing to furnish 10 mm spat.

The growing is done in bays or lagoons (AQUACOP and de Gaillande, 1979). But there are few suitable sites in tropical islands due to the very low productivity of the seawater. Concerning the pearl oyster *Pinctada margaritifera*, the C.O.P. has essentially worked on reproduction in hatchery. Some results were obtained at the experimental scale : maturation and spawning but the larval rearing realized only produced some spat.

FRESHWATER PRAWN REARING

The C.O.P. has worked on two species : *Macrobrachium lar*, the Tahitian species and *M. rosenbergii*. *M. lar* has not been chosen because of its inclination to escape from the ponds. *M. rosenbergii* has been selected.

Are now well controlled :

- the constitution of the broodstock,
- the mass production of post-larvae (AQUACOP, 1975, 1977, 1987); a new technique has been developed by the C.O.P., this technique in recirculated water allows high reliable production of post-larvae with 70 to 80 % survival, 80 to 100 PL/litre; this technique has been adapted to large production hatcheries.

Two grow-out systems are used (AQUACOP, 1983, Lacroix D., J.M. Griessinger, J.C. Falguière and Th. Pollet, 1988) :

- continuous method : the yields are 1,5 to 2,5 t/ha/year,
- discontinuous : 1 to 2 t/ha/year.

These two systems of production correspond to different sites, water quality and marketing conditions. The results are still submitted to changes and important management programmes of the ponds are under exami-

nation : water exchange, aeration. The harvesting technique remains to be improved.

The C.O.P. has formulated different artificial feeds for larvae, juveniles and adults and the production has been transferred to a local feed mill (AQUACOP, 1983).

Presently, *Macrobrachium* culture is at the commercial scale in the French overseas territories. The goals are to satisfy the different local markets and to reach through improvements of the techniques the world market. The small sized farms up to 3 ha in a secondary activity state have proved their profitability. The larger sized farms running in single activity must prove their ability to maintain a stable production. AQUAPAC in Polynesia is the prototype of this sort of farm.

In 1988 the French overseas territories have produced 190 tonnes of freshwater prawn.

PENAEID SHRIMP CULTURE

A selection done over more than 10 species allowed to select four of them as the more suitable for tropical aquaculture (AQUACOP, 1984)

Penaeus monodon and *P. indicus* are originated from Asia, *P. stylirostris* and *P. vannamei* from Latino-America.

These four species require different temperatures, rearing and feeding conditions and each species gives a specific product in size and color. So it is possible to make a choice according to the environmental conditions and market.

Are now well controlled :

- the constitution of captive broodstock,
- the induction of maturation and spawning in captivity (and the artificial insemination) (AQUACOP, 1975, 1979, 1983),
- the mass production of post-larvae (AQUACOP, 1983, 1987),
- according to the different sites two growout systems are used :
 - semi-intensive in large surfaced sites at reasonable cost (New Caledonia). The yields are 2 to 4 t/ha/year (Goxe et al, 1987).
 - intensive growout in small surfaced area at high cost (F. Polynesia). The yields are 15 to 30 t/ha/year (AQUACOP, Patrois J., Barret J. and Mazurié J., 1987); the feeding formulae have been set up for the different species and stages, from available products and by products in each zone; the formulation has been transferred to a commercial feed mill.

Presently the penaeid culture is at a commercial scale in French overseas territories. In Tahiti three intensive farms (1 ha each) are in production and the local governmental hatchery is under construction. The goal is to satisfy the local market. In New Caledonia 175 ha of semi-intensive ponds are in production. In 1988 Tahiti and New Caledonia have produced 260 tonnes of shrimps.

The transfer of technology concerning *Macrobrachium* and penaeid cultures has been made in different tropical countries through the subsidiary France Aquaculture. Asia : India, Sri Lanka, Vietnam, Philippines, Malaysia, Indonesia. Fiji in the South Pacific. America : Ecuador, Colombia, and the French overseas territories of F.W. Indies and Guayana. Africa : Senegal.

FINFISH CULTURE

Presently the work is focused on the selection of species.

The criteria chosen are :

- ability to reproduce in captivity,
- possibility of mass larval rearing,
- good growth rate with artificial food,
- ability of high density growth in floating cages.

After tests realized on the local species as Carangidae (AQUACOP, 1975), Lutjanidae, Siganidae in French Polynesia and Martinique no species revealed favourable selection criteria.

So foreign species have been selected : *Lates calcarifer* in Tahiti and *Sciaenops ocellata* in Martinique (Soletchnik P., Thouard E., Goyard E., Baisnee D., 1987; Soletchnik P., Thouard E., Goyard E., Yvon C., Baker P., 1987). But other species are under study :

- in Polynesia, the grouper *Epinephelus microdon* and the dolphin fish *Coryphaena hippurus*.
- in Martinique, the red tilapia (*Oreochromis* sp.).

The sea bass *Lates calcarifer* is hermaphrodite protandric. The broodstock was constituted from fry imported in 1984 from the P.P.D. of Singapore. In 1987 the first sexual reversal was observed and 20 spawnings were obtained in 1988. The larval rearing is under progress. The chief problem being mortality after 12 days of rearing.

This species is well adapted to net pen culture : at biomass of 20 to 30 kg/m³ the commercial size (500 g) is obtained after 12 months. Artificial feeds are used in the different stages : larvae, juveniles, adults (AQUACOP and Fuchs J., 1986).

In Martinique, the species *Scianops ocellata* from the U.S. seems to be well adapted to intensive net pen culture. The commercial size 500-700 g is reached on 12 months.

The potential of net pen culture development in tropical islands seems good for several reasons :

- lagoons are sheltered sites where it is easy to install floating cages,
- an interesting local market exists,
- the cultured fishes will be free from ciguatera.

The following years should see the implementation of pilot production units.

CONCLUSION

Now, we just emerge from the pure zootechnical phases, which allowed us :

- to select different species suitable for culture,
- to constitute and train teams which have now acquired experience,
- to construct the work tools,
- to start the first production projects.

We come now in the phases where the supporting of fundamental research teams is necessary.

To improve the productivity and to decrease the production costs we need better knowledge in various fields.

- Physiology : the hormonal control of crustaceans and fish reproduction, cryopreservation of gametes and embryos.
- Genetic : polyploids, incorporation of genes.
- Pathology : a better knowledge of the specific bacteria populations linked to the rearing conditions; the setting up of immunodiagnosics.
- Nutrition : the setting up of artificial food to replace the live prey during the larval rearing; the precise nutritional needs for the animals. A better knowledge of the growth factors.

I hope these workshops will bring fruitful answers to these questions.

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