INNOVATIONS IN PREGROWING AND GROWING TECHNIQUES OF BIVALVES

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Featuring innovation could be simpleness in the field applications, allowing to account in the best of natural conditions.

The new technologies increasing production are usually subordinate to climatic, geographic and mainly socio-economic conditions were they are used, therefore they cannot be always directly transferred to other countries.

Another fact could be pointed out : in high productivity areas the innovations are quite unusual ; the influence of farmers and the routine practices generally restrict the propagation of new ideas and their application ; on the other hand in the new countries or with a starting production the new techniques get the best chances to be transferred.

These last fifteen years the use of synthetic stuff has been one of the decisive factor for the launching of new techniques.

In other respects, the control of bivalves spat production (according to the work of LOOSANOFF and DAVIS, 1963 and WALNE, 1974) allow considerable progresses in nursing and grow out techniques.

I - PREGROWING, INTERMEDIATE STAGE

This step takes place from metamorphosis to intermediate size from which the bivalve will be raised at a density close to the final density to reach the commercial size.

This topic was widely discussed during the GHENT Workshop (Nursery culturing of bivalve molluscs, 1981).

The various advance technologies are carried out according to the spat size and densities showing the following characteristics :

1 - HIGH DENSITY PREGROWING

Rearing densities 10^6 to 10^4 spats/m^2.

1.1. Hatchery

The metamorphosed spat is grown up in the hatchery up to about 2 mm. This step requires food supply then the controled production of unicellular algae. The phytoplancton is brought in sea water. The temperature is closely controlled.

Two techniques are readily used according to the spat size and the different species.

- The overflow

The water flows downwards, the stream is set up either directly or using an airlift. The water circuit can be open or closed to save energy.

The rearing unit is organized with rectangular trays or cylindrical containers which respective heights are 0.15 m and 0.50 m. The spat lies on sieves which mesh is selected according to the spat size.

The sieves surfaces are in both cases about 0.2 square meters. The tanks are usually fiber glass made.

The three large families of bivalves (Ostreidae, Pectinidae and Veneridae) are concerned with this technique.

- The upflow

The water stream runs upwards with airlift or with gravity system. The cylinder-sieve is the typical raising system. Except pectinids, all the other species are concerned with.

These two systems are used in the United States as in Europe. The rearing densities are about $10^6/m^2$.

1.2. Land based operations

The rearing temperature is the ambiant seawater temperature, the food is naturally brought. The grow-out density ranges between 5×10^5 and $0.5 \times 10^5/m^2$.

The gravity effect can be obtained by pumping (BAYES, CLAUS, LEBORGNE, 1981) or by civil engineering (BOUIN*, France).

The two techniques used with pumping are the same as above : i.e. overflow and upflow.

The rearing tanks are usually cylindrical qieves with a height of 0.50 m and an opening of 0.2 m^2. The recepting tanks are made of concrete or polyester.

- The overflow

This system is essentially utilised for the pectinids up to the size of 15 mm. The flow rate is 0.7 m^3/h. The rearing density varies between 10^5 to 0.5 $10^5/m^2$ (Pectinids pregrowing from the hatcheries is widely developped in France at the Tinduff farm**).

- The upflow

This very useful technique could be applied by hydrodynamic works in the Polder areas (Holland, France).

This kind of system is being imployed in the oyster areas functionning on a gravity system, with a very reasonable investment and without energy power like in the polder areas in Holland (in Ooterschelde, for example) or the Bouin oysters areas in France.

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* IFREMER Center oyster field of Bouin basins

** Hatchery working in cooperation with IFREMER and managed by the local fisheries board of Brest. This action takes part in the scallop programme for which the spat is produced for restocking.

The upflow is utilised for Ostreidae and Veneridae. With this technique an advance technology is experimentally developped. One must use this method by sinking, sea water at constant temperature to heat natural seawater with plates exchanger. These waters, of salinity is appropriate, can be directly used in winter for phytoplancton production.

The program cost is expensive, for that reason it must be proved that the spat fed in winter gets a better growth than these raised in automn with usual techniques.

This technology has been developped in United States hatcheries ; in France at SICAMER hatchery and at the experimental farm IFREMER at Bouin.

The breeding density with performant growth is 1.25 to 0.5 $10^6/m^2$ according to the size. The flow rate by cylindrical container is 3 m^3/h.

The upflow system is mostly developped in United States and in Europe.

2 - PREGROWING AT LOW DENSITY

Breeding density : 3.10^4 to 0.2 $10^4/m^2$. The water flow is not forced, the food is natural . This method used at best of times the potentialities of the outside elements.

It can be drawn out of ground, on ground or in the ground.

2.1. Out of ground

- Floating system

The breading structure is framed with two wooden trugs 0.03 to 0.10 m high opposite with appropriated meshes on top and on the bottom (technique used by AGCM*).

Densities range from 3.10^4 to $5.10^2/m^2$ for the clams, and 3 $10^3/m^2$ for the pectinids. For the scallops' spat a black plastic sheet take the place of the upside mesh (SATMAR** technique).

This kind of pregrowing is applied on atlantic coast ponds and in Senegal.

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* Association Guérandaise de Cultures Marines, France

** Société Atlantique de Mariculture, France.

- Suspended system

This technique, largely used in Pacific for many years, has been valorized by nylon and plastic materials. It's mostly in Japan that it was dealt with many innovations (DAVY et al, 1982 ; VENTILLA, 1982 ; VENTILLA, 1984).

The pregrowing on lines, is undertaken on spat collectors for oysters and inside plastic collectors for scallops Patinopecten yessoensis (VENTILLA, 1982). The pregrowing can be done in pearl nets or lantern nets (Pacific pectinids or mussels).

The raft is also used with the same breeding units on long lines (oysters x mussels in Japan and Portugal, clams in France).

- Elevated system

This off bottom breeding technique is increasing for a few years. The tripode for pearl oyster table, pregrowing in the Pacific, the oysters table in France at Brest, in deep water, for spat scallops pregrowing from 3 to 30 mm (3-15 mm in plastic baskets at 9 000/m^2 ; 15-30 mm in plastic trays at 1 000/m^2). The oyster table ordinary used on intertidal areas, support collectors (natural spat) or oyster plastic pouch (hatchery spat). The plastic collector tube gives a 12 to 18 months pregrowing. For clams, the trays used in floating system are also put on oysters tables. If standard cleaning is made, this pregrowing is not stressing at densities from 3.10^4 to $10^4/m^2$.

2.2. On and in ground culture

This method is used with clams, from 3 mm size on.

Spat can be set in new type of oyster pouch (0.1 m^2) . These pouches are laid on the bottom of the ponds. This technique enable used of protected areas (ponds, "claires", swamp). The pregrowing step is also drown between two meshes of net on the beaches or in ponds. The duration of the pregrowing stage is variable and can go up to 25 mm (5 g). The optimal density is $2.10^3/m^2$.

The pregrowing stage performs the main step which could have, according to the breeding techniques used, important effects on the future life of the animal.

II - GROWTH

The growth concerns the last stage of the like-cycle of an animal until it obtains its commercial stage. During this phase, the density, if it varies, modifies to a maximum of factor 3.

The techniques are in certain cases compared to those utilised for pregrowing.

1 - OUT OF GROUND

1.1. Suspended breeding long lines and rafts

These two systems, although they have different structures, utilise breeding in most cases the same breeding structure and increase the biological interest in deep water breeding. In Pacific, particularly in Japan, these technological and bio-technical innovations (VENTILLA, 1982) are the originals of the last 15 years of important increases for the production rate strictly aquacole of Pectinids.The production rate has gone from 10 000 tons in 1971 to 60 000 in 1981 (Official statistics from the nipon Fisheries Office).

This same observation has been remarked the pearl oyster (Pintada fucata) whose production rate of pearls (42 T in 1981) stayed the same because of the innovation technique carried on this species. The spatfall of wild animals has completely replaced by the farming.

Mussel raft farming is an important activity in the Pacific (India, Japan) DAVY F.B. and al., 1982, as on the Atlantic coast (Spain and Portugal).

Farming from fixed frames has been developped a lot in low tidal areas for flat oysters and mussels (Mediteranian pords in France). The animals are stock with ciment, or polyester glue on bars on vertical ropes under the frames.

1.2. Raised farming

Most of the french oyster production comes from table farming in oyster plastic pouches. This innovation permits farming standards (better labour organisation ; biological parameters, better surroundings) if the standards are respected (breeding density good utilisation of the structures, etc...).

The spat put in pouches comes from natural spatfall or from hatcheries production. Relating to that, it is observedd in France a new culture : the use, by some oysters farmers, in spite of natural spatfall, spat from hatcheries. The SATMAR society, for four years, supply to four oysters farmers of Brittany and Normandy 26 10^6 spats, separated one by one of 6-8 mm. The spat is put at the begining of the year, at a density of 500 per pouch or either $1500/m^2$. At the end of the year, the medium weight is about 30 g or either 13 kg/pouch. The animals are scattered on the ground, and reach the weight of 60 g at the end of the following year. The survival rate is around 85 %, the annual tonnage total is 1 300 tons. In this case, the potential of natural growth are wholly preserved. The growth graph breeding draws close to the optimal natural growth graph, in respecting the standard rate of profitable breeding.

2 - IN THE GROUND

This technique concerns the Venerides species, of commercial interest, like the clams in the U.S.A., the cockles and the clams in the Pacific and Europe.

In the U.S.A., the clam and, in France, the Manila clam are the techniques being developped to inspire market-gardening practice.

Predators is the main problem with this breeding. The main predators are the crabs and sometimes fishes.

Two types of protections have been adapted : the horizontal protection and the vertical protection.

2.1. The horizontal protection

In this case, the breeding is covered by a grating surface or a net. The major inconvience of this method is the difficulty of an exact sampling because access to brood areas is particularly difficult.

Two adaptations are applied to the clams breeding, Ruditapes Philippinarum : breeding in cases under the ground on under a net.

The case is netted on the underside and filled with sediment, after its covered with a sieve after put in the place of the spat. The surface is $0.3m^2$, the density is around $700/m^2$. The breeding cycle is from

24 to 28 months to get 17 to 20 g in long line. The cages can be harvested at high tide. In this case harvest is simplified, hoisted on the bridge of a boat and washed with a hose pipe. The meshes on the underside filter the sediment and keep the manila clam in. This quite compelling technique is put into work in France by some manila clam farmers (France, Gulf of Morbihan 10 to 12 T/an).

The breeding under nets, experimented in USA in the "Puget Sounds", R. philippinarum (ANDERSON and al, 1982), has not yet been an object of important production. In France, this technique permits extention but is evolutive. It has the advantage to be mecanisable (seeding and placed on net) on hard ground. Its great interest is to offer no resistance to all types of weather and streams. A negative net effect is observed in growing ; this slow down is given to unevitable fouling of surfaces even with an intensif brushing 20 grams are actually obtained in 26 months.

2.2. The vertical protection

This technique, more difficult to put into work in the open sea areas and at high currents, presents the advantage of not being stressful for the breed, who, if the optimal density is respected, increases naturally in parks where access and control are extremely easy.

The method of the enclosure is developped in the USA on the Virginia coast (CASTAGNA and al, 1981) for the clam. The tide level being fable in this region (3 m). The enclosure is placed high to avoid entrance of a swimming crab, the blue crab, Callinectes sapidus and the eagle ray Rhinoptera binasus. The efficiency of the protection is increased to the contribute of fine gravel (KRAEUTER and al, 1980).

This technique is being developped in France on the Atlantic coast in the tidal areas, between +2 and +2.50 m above the zero of maps, for the breeding of the clam R. philippinarum. In this case, the principal predator is the green crab Carcinus maenas climber and non swimmer. The breeding is effectuated in the enclosure. The efficiency of the fence (45-50 cm) is increased by placing a plastic element (plastic cloth turned up like a drop of water) which if well looked after stops the passage of predators. The efficiency of the protection is increased by the contribution of fine-gravel which limits the predators and the development of young crabs in the interior structures. This protection supplement is also efficient against the attacks of fishes (Sea Bream, Flat Fishes).

If the period of on growing at the beginning of the year is respected, the cycle is 20 months (for a medium weight of 20 g) for a density of breeding of 250 manila clam/m^2.

CONCLUSION

The list of innovations about pregrowing and growing of bivalves is not exhausted, because the variations are very nomberuse.

Scientific work and techniques do not permit outlet on the applications of technical and economical reasons.

In effect all innovations whatever are utilised to not perturb the biological results, but must use the best of the potential of natural growth. The experiments must not be carried out in short period of the life of bivalves.

The drop of biological out put means to say the flattening of the growth graph can have 3 main reasons :

1) negative effect of the technique on the harmonious development of the considered species,
2) the degradation of the biological capacity of the surrondings,
3) the degenerate of the cultivated stock.

In the most of the cases, point 1 is the release more or less of causes 2 and 3. One remarks very rapidly a degeneration in the quality of the products most important influence of diseases capable of destroying the breed in a little time.

It seems better to invest in a first step in a standard biotechnique following the development rather than solve the problems afterwards because at this moment the ways to implement are extremely high to assume.

For this reason it is necessary to set up simple zootechnical references, in close connection with the related professions, drawing up reference grow-out graphs at the international scale for species raised in different geographical areas then at the country scale for the different sites and techniques used. It is fundamental for the farmers to be able to ckeck their own datas in comparison with standards available in their local reprensative branches (cooperative registered offices, regional boards and so on).

Moreoever I suggest, for the pregrowing stage of different reference species to set up a study concerning the effects of nursing techniques on the subsequent grow out to fix quality labels for the spat. It is advisable for that to have, beforehand, reference graphs taking into account the individual and annual variabilities. This involves a standardization of techniques and frequent exchanges between the concerned countries laboratories.

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