Some Possible Ways Forward Development of Aquaculture

Abstract
Aquaculture has concentrated on the production of some high commercial value species. Other species may be high success, but we do not control their biological cycles. It is important to know precisely the optimal combinations of salinity and temperature at each stage of their life cycles. It is suggested to bring together into a common system available information, past and present, currently disparate and dispersed, and direct future research towards common goals, with a harmonisation of methods. Moreover the composition of the new compounds foods require new basic research efforts. Restocking operations from hatchery production will pay the utmost attention to the consequences of restocking on the ecosystems in which these are carried out restocking.

Introduction
Place of aquaculture in food consumed by humans
Today, more than half of what humanity consumes as aquatic food comes from aquaculture. That activity produces 70 million tonnes per year, while global fisheries leveled for over 10 years at around 90 million tonnes 11 million tonnes for inland and 79 million tons for sea fishing (FAO, 2014). Due to the continued exploitation of natural populations through fisheries, aquaculture will continue to grow ineluctably, under the combined effects of the increasing world population, a higher protein consumption per capita better information for consumers who want a balanced diet. Aquaculture is developing in many countries of the world, and it causes significant efforts in scientific research, progress in animal husbandry and breeding techniques. Despite the experience gained in previous decades to achieve new knowledge in biology, in technical and economics of aquaculture enterprises, it is always risky to engage in farming of new marine species because they require new progress in basic sciences, original farming techniques and a new coastal management, adaptation to market needs, physical and financial infrastructure, etc. Curiously, several areas of this research were not sufficiently developed in recent years, so they could provide very important information to enhance the success of aquaculture, both in the field of basic knowledge in commercial applications. In addition, some of the new results obtained could also be used to analyze the functioning of natural ecosystems. The purpose of this short review is to attract the attention of researchers on few subjects that should allow for better progress in the results of aquaculture. It is necessary to clearly differentiate extensive aquaculture, in which the higher organisms must feed themselves from the natural environment resources, intensive aquaculture, in which these organizations receive food provided by humans. When the species reared receive, indirectly or directly, their food provided by humans in addition to those they find in nature, we are dealing with a semi-intensive aquaculture. The hyper intensive aquaculture is one in which the animals reared only receive food provided by humans, and in a closed environment, whose characteristics are well controlled. In practice, there are no clear boundaries between these different types of aquaculture, some operations taking place in the open sea, or in more or less closed bays or lagoons. In any case, we must rely on more fundamental research results, including physiology, biochemistry [1] and molecular biology.

Knowledge of biological cycles of aquatic species
Our knowledge about species that have been well studied because they are consumed by humans, are sometimes not sufficient. And they are even less for species that are not consumed. In many cases, we do not even know the life history of species yet mundane structure marine ecosystems and often fished. And when we know empirically some biological cycles, we do not control in artificial conditions controlled. Then, when these biological cycles are mastered in the laboratory new steps (mass production, optimization) to be reached significant productions and organizations for trade and consumption. So far, marine aquaculture was mainly confined to high demand of the market species and therefore under the direct influence of eating habits, which vary greatly from country to country. Thus, Western consumers rather consume sea bass, sea bream, red mullet, sole, flounder, turbot, penaeid shrimp, lobsters and lobsters, while in Japan, for example, in addition to these species, many other varieties are eaten. These specific requests have led, in this country, the creation of special aquaculture enterprises, like certain species of seaweed (nori, wakame) of puffers (fugu), tunicates (hoya), sea urchins (uni), which are raised by producers, let alone species from fisheries that are rarely consumed in other countries, such as cod gonads (mentaiko), whale meat (kujira), gonads males of many species of fish (Shirako), fry sardines (chirimen jako), jellyfish (kurage), sea cucumbers (namako) and all sorts of crabs, fish and shellfish. For each species which are already high in aquaculture, it was necessary to know in great detail each step of the life cycle of the species, to reproduce in hatcheries in artificial conditions. Control of biological cydes of sea bream, sea bass, penaeid shrimp, sea urchins, abalone,
for example, are well known and controlled, requiring only a few minor improvements. For other species, work is under development such as sea cucumbers Apostichopus japonicus in Hokkaido (Sakai, 2015) and in the prefectures of Miyagi and Iwate.

But for many other species, for which a large market potential exists, like lobster or tuna, for example, the complete life cycle has rarely been achieved and controlled. This is the case for all larval stages of five species of lobsters, which Palinurus elephas, successfully by Kitaka et al. [2] and, more or less completely, according to the different species of this zoological group [3-5].

It is therefore necessary, even essential, to have available a larger number of experimental laboratories sufficiently advanced, controlling many abiotic factors, breeding of marine species so that we can ascertain the full life cycle many species. Evidently, there are already some very good research aquariums in many countries USA, Canada, Great Britain, France, Japan, Australia, Japan, New Zealand, Spain, etc. But the experimental conditions do not allow to precisely regulate the variables that are subject marine species in their natural environment and especially in the new current conditions.

This is all the more necessary that the natural environment will see their temperature increase, salinity vary accordingly, and that their pH will acidify. Despite some important fundamental ancient and recent work [6-13] there is still much research to achieve to establish the life cycles of many marine species. Moreover it is essential to know the optimal conditions for survival and growth of each larval and juvenile stages of many species. Finally, to complete the cycle, we must ensure the most favorable environmental factors to condition females (temperature, lighting, food, environment) to get them to produce good quality eggs, which will give perennial larvae. There is an obvious gap in our knowledge. Finally, the results obtained in this work-oriented aquaculture will better know the duration of each larval stage, and therefore their distribution by currents in the marine space, over time [14,15], ensuring the recruitment of the species.

Survival and growth based on the salinity and temperature

In general, the growth and survival of marine animals are better when they live in slightly desalinated sea water: they must fight against the invasion of their internal medium by salt and maintaining the physiological function has a high energy cost. A decrease in the salinity is favorable. Serrano et al. [16] showed experimentally that the fish Lutjanus griseus chose the less salty waters and that choice varies with circadian light.

Conversely, marine species poorly regulate when placed in hypersaline waters, which is for them a very harmful environment. Many studies have been devoted to the maximum thermal limit at which the different marine species were able to survive. But this temperature sensitivity varies depending on the salinity. Their adaptation to different temperatures varies with different zoological taxa and sometimes even within the same genus, according to the different species [17,18]. While many data exist in the literature [19-21] they need to be much more accurate.

Changes of physiology and osmoregulation are very well known in salmon, shad, eels and other migratory species. But on a smaller scale, physiology successive stages of development of many organisms also varies depending on the larval stages considered [10,22] which often explains the migration of these stages in the areas of estuaries, less salty, which move in seeking their optimum salinity for a given temperature [23].

Others have pointed out that the biology of the animals was amended by the pH and by air CO2 content by decreased oxygen [24-26]. Which is valid in the natural environment, but will also be true in the water used in aquaculture. It should not be forgotten too, as aquaculture in the study of unconfined ecosystems, the possible arrival of parasites some stages swimmers can be active or inactive according to the characteristics of the environment where they are [27-30]. New work, very important, open in this field of research.

This new field is of utmost importance because of global warming seriously affecting marine areas, particularly coastal areas. It is important now to establish precise graphs and abacus of survival and optimal growth for each species and each larval stage, taking into account both changes in temperature and salinity. It is from this database that we can better understand the effects of changes in water quality and dissolved gases as well as in aquaculture to better analyze trends in ecosystems.

Progress in the formulation of foods for intensive breeding

Food is one of the major problems in aquaculture, which is becoming more and more for a number of years with no real good solution. Most high marine species are currently fed compound feed containing fishmeal from the operation of natural stocks of “forage fish” pelagic relatively low cost (sprat, anchovy, sardine, blue whiting, etc.) serving as prey to predatory species [31] and enriched in marine oils in polyunsaturated fatty acids omega-3. It is estimated that fishing of “forage fish” represent in the world, about a third of the tonnage of professional fishing. It became too much and today, as it is currently overfished, it must be controlled and limited. Furthermore, withdrawals by humans in natural populations strongly disturbs, now, the balance of pelagic ecosystems, depriving natural predators (carnivorous fish, birds, sea turtles, marine mammals, etc.) of their usual prey [32,33]. Fishing, which is suitable for use, even rational, wild ecosystems, necessarily enter into decline. It is therefore urgent to establish and use reliable indicators to measure this reduction and identify the critical phases of such future imbalances before serious irreversible crises occur. A more accurate assessment of global needs for fish meal should be carried out based on global aquaculture development in the world and potential of natural ecosystems to provide forage fish.

It will aim to limit catches to adjust aquaculture production to the possibilities of production by the ecosystems exploited for making fishmeal, as a first step towards global management of marine natural resources.

It has therefore become imperative to replace the marine components of compound feed for rearing fish and shellfish, with land-based components mainly from agriculture soybean meal, corn, rapeseed, sunflower, pea, lupine beans, sesame, sorghum, etc. experienced in many countries of the world, depending on their availability, their price, their composition, for example, and consumption time experimental diet [34-36]. The issue is whether;
when they have been consumed by animals, digestive enzyme
equipment of these species will be suitable for optimal digestion
of basic compounds from agriculture. Inside the same zoological
group, as among the penaeid shrimp for example, protein needs
can be very different from one species to another and it would
be interesting to establish a quantitative measure of their
carnivornicity. Dupont Nivet et al. [37] found genetic variations in
the response of trout consuming more or less rich in compound
feed fishmeal. Moreover, these very new foods to their diets modify
the flora of the digestive tube [38-40], opening paths to new
research. For carbohydrates, marine species have evolved out of
contact with starches from seeds from land, usually graminaceae.
Also feed efficiency starches in compound feed is not very high
[41]. It seems that animals like lobsters grow better when they
consume glycogen from other marine organisms such as mussels
[42]. Finally, we must know precisely the extent and composition of
the residues of uneaten food that have passed through the
digestive tract and which will inevitably end up in the marine
environment, often changing, more or less strongly, the normal
functioning of ecosystems where farms are installed. The food
in excess and feces are most often used as food for other species
outside the cages, which increases biodiversity and biomass in
natural environments. Other solutions are moving towards the
installation of individual artificial reef located below or adjacent
cages, offering specific habitats to ecosystem species considered
most requested by the market. The integration of aquaculture
in the natural environment deserves renewed attention, deeper
than the salmon cages in the fjords of Scandinavia.

Aquaculture Restocking

When some species have been too much exploited, one
can imagine that we can sometimes build up populations by
restocking swarming in large amounts of post-larvae or juveniles
who grow up in areas that have been overshifted [43]. There is
no need to stress here the great stocking operations taking place
in the US Canada and Japan for salmon. Good progress has been
made in this area in the past [44,45]. However, we are still far
replenish forage fish populations, which are generally close to
the base of the food web, but we do not control mass production of
larval forms, post-larval and juveniles. For a long time, Japan
has an extensive network of dozens of hatchery production and
stocking, which for many years [46,47] rejected billions post-
larvae and juveniles at sea of different marine species appreciated
by the domestic market, especially salmon and more recently
other species such as red sea bream, shrimps, gray sea bream,
abalone, sea urchins, etc. Restocking of juvenile crabs Portunus
trituberculatus are performed every year by Japanese production
hatcheries in Osaka Bay, using established techniques [40].

These operations were carried out under pressure from
fishermen and the political and administrative power without
first giving precise estimates of the effects of these massive
releases on local ecosystems that have been affected [49]. These
ecological studies were undertaken later, relying in particular on
the identification of populations by DNA markers [49-52]. Much
remains to be done and urgently if we do not want to destroy so
perhaps ultimately these pelagic ecosystem.

Future development of the coastline necessarily include
restocking operations from hatchery production. But it will first
choose and decide on major orientations choice of species to
produce and disseminate, preparation of habitats needed for good
survival of the species, releases of fry or post-larvae in marine
protected areas, or equipped not of artificial reefs influence of
releases on the functioning of natural ecosystems.

Many of these items were discussed in Japan, for example when
stocking penaeid shrimp in various parts of coastal zones, or gray
sea bream on the coast of Hiroshima or sea urchins in various
sites of the coast of Hokkaido or abalone (Haliotis) in several
parts of the country choice of the date of the releases, optimal
size at which it will perform restocking, artificial management to
create habitats. Similar consultations took place in France during
the lobster restocking trials, species whose detailed behavior is
not yet very well known despite numerous observations. After
several programs of restocking recently, some release of a few
dozen individuals took place in France or in connection with the
activities of the Océarium Croisic. On another scale, and after
numerous releases programs in Canada, Nova Scotia ans United
States, recently, experts from New Brunswick as a precaution,
release at sea each year 300,000 post-larval lobsters, to try to
stabilize the recruitment of this species. To ensure good survival
of post-larval lobsters just after metamorphosis, artificial reefs
trials were conducted in Canada [53,54]. On a smaller scale,
small concrete shelters were made in France and experimentally,
Japan, Sanriku. The management of sea bottoms is a prerequisite
because it is necessary that young forms, which molt frequently,
can find shelter against predators to pass the time during which
their exoskeleton is very soft and they are defenseless [55-59].

Final Thoughts

To continue to grow in various areas, aquaculture still has
progress to make. Control of breeding new species require good
knowledge of the life cycles of many aquatic species, whether
sought today by man or are later used in human food. Some
species such as rock lobsters are characterized by numerous
larval stages, and little is yet known on their general physiology
and digestive biochemistry. New well equipped laboratories will
have to address the original research programs to develop such
knowledge’s. To complete biological cycles it will be necessary
also to know the best possible conditions for maintaining females
and parents, in order to obtain eggs and larvae of good quality.
Moreover, it is surprising that there has not established mostly
survival charts and abacus and optimal growth of larval, juvenile
and adult based on combinations of salinity and temperature.
Many scientific studies (see above) approached this area in
very different disparate point of views. One might suggest that
all existing data are collected in order to have general summary
information for each larval or juvenile stage, species by species.
This information will be extremely useful for both aquaculture
and for the evolution of ecosystems, when water temperatures
continue to rise and as their characters (pH, dissolved gases, etc
vary with global change. Replacing fishmeal in compound feed for
aquaculture should be made at very short notice, otherwise it will
be pelagic ecosystems that will be heavily affected and with them,
all marine populations that depend on them will suffer. A global
management of these natural richness of the oceans become
necessary. Moreover, restocking fish farms intended to modify
natural ecosystems for species requested by the traditions and
culture of human populations consuming must be carried out.
with maximum care so as not to disrupting the functioning of natural ecosystems. The ecological impact of aquaculture cages that receive all usable food supplement should be studied carefully to quantitatively measure their effects on biodiversity and local production, which will necessarily be changed. Finally this modest work has deliberately left out several aspects that are part of the foundations of aquaculture as the functioning of the digestive tubes, pigmentation, the role of light, chronobiology, to mention only these important areas of research.

References

Some Possible Ways Forward Development of Aquaculture


