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has time come for the genetic management of sea bass?

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Since 1980 the industrial production of European sea bass has risen considerably up to at least 18,000 MT in 1996 (see also Josupeit, Aquaculture Europe 20(2):-12, 1995)). This growth is remarkable since few were able to culture the species in the seventies. Several "classical" stages of development can be observed; they are typical of a rapidly expanding bio-industry:

1) In the beginning companies cultured sea bass on an experimental level (less than 100 MT were produced in 1980). At that time, it was not clear to what extent the cultured species would fit in a market dominated by wild-caught fish.
2) A better control of sea bass spawning and rearing through environmental conditioning helped to calibrate production (3,600 MT in 1990). The market was able to assimilate the growing production.
3) Enhanced production through improved larval survival and feeding practices was accompanied by a beginning of mass selection for growth. At the same time the higher population densities induced mass infections such as by the Nervous Necrosis Virus (Nodavirus). The production was assimilated by the Mediterranean market.

With the expansion of the production developed different stages of profitability. While the species was originally an up-market product, it is more and more receding to a mid-market level. The current sale price of sea bass off farm amounts to about 7 ECU/kg. On a national level Greece (9,000 MT), Italy (2,200 MT) and France (2,300 MT) have taken the lead in production.

This increase in production at an affordable cost has been made possible by a tight control of biological and economic (production costs, marketing and ownership) factors. Considerable improvements in the husbandry, feeding, rearing and to a lesser extent disease management of the species reflect significant benefits. Conspicuous in the biological management is the nearly complete absence of selection for specific traits such as growth, age at maturity and carcass weight. One only has to look at the successes of the cattle, swine and poultry industry when it comes to a coordinated genetic management, to understand the need for such an approach. To a lesser extent this is also the case with Atlantic salmon and rainbow trout.

When it comes to the genetics of sea bass, relatively few things are known. Genetically the Atlantic, Eastern and Western Mediterranean wild populations differ from each other. This has been observed at several genetical markers and has been confirmed by several authors. The sex ratio of the sea bass varies in nature and one of either sex might dominate. In aquaculture, males tend to dominate in a more or less consistent manner, but male to female sex ratios of 1:1 or close to 1:0 have been observed. Since they mature earlier at a smaller size this is not exactly to the benefit of producers. The genetic basis of the cultured fish is virtually not documented. Most of the breeders rely on the capture of wild fish to avoid inbreeding in the broodstock but some initiated mass selection.

The following elements could contribute to the long term genetic management of sea bass (Table 1):

- Inbreeding should be avoided by all means because it affects survival, egg quality, growth and general condition. Therefore pedigree management of

Table 1. Summary of the focal points related to the genetic management of sea bass.

Aspect/problem	Technique	Gain	Comment
Environmental contamination	Sterile fish and site management	Short to mid term	Necessity to protect wild gene pool
Improved growth rate	Selective breeding	Mid to long term	Requires multiple test sites
Inbreeding	Pedigree management	Short term	
Paternity testing	DNA fingerprinting	Short term	Ideal for broodstock management
Resistance to disease	Selective breeding	Long term	
Sexual maturation	Induced triploidy	Short term	Requires knowledge of the genetic sex
Sex ratio	Gynogenesis/ hormone therapy	Short/mid term	Requires knowledge of the genetic sex

breeders, including standardisation of breeding procedures among farms and countries could be implemented. Paternity analysis is now possible by means of DNA fingerprinting and should help in assigning progeny from multiple spawnings. Moreover, the management of fingerling production among breeding farms and genetic assistance in the selection of breeders could be envisaged. The above mentioned topics have been identified as an important issue at the "Sea bass and sea bream workshop" in Verona (I) in October 1996 and have been discussed at the FAO-CIHEAM genetics meeting in Zaragosa (ES) in April 1997.

- Diseases represent a serious handicap to economic profit in sea bass breeding. One only has to think of outbreaks of Nodavirus and Pasteurella, and the accompanying economic losses. But disease and genetics are closely linked; the genetic background of diseased populations most likely plays an important role. The 1996 Nodavirus epidemic might have created a few resistant populations, but they have gone unreported. Thus disease should be managed genetically.
- Chromosome set manipulation generates a lot of interest because of its promises to deliver potential significant gains in the short term. Sex control can be achieved by genetic and physiological methods. Unisex populations might be realised by gynogenesis while the control of maturation is likely to be realised through the induction of triploidy. Although methods exist for the direct feminisation and masculinisation of sea bass by hormone therapy, experimental protocols need to be optimised. Moreover, the genetic basis of sex determination is still unknown.
- Domestication through selection is the long term aim of any genetic programme. First, performance analysis of the existing breeds and wild populations will identify suitable breeding strains as a basis to start selection on growth, maturation, fertility, sex ratio, flavour and carcass weight. Establishment of lines for long term quantitative selection under various environmental conditions will initiate a domestication process. It is beyond any doubt that without domestication no long term sustainable industry can be envisaged. This has also been identified as an important issue at the "Sea bass and sea bream workshop".
- Finally, the impact of aquaculture on the environment should be managed. From a genetic perspective mass escapes of cultured sea bass may interfere with native sea bass. We refer to the impact of cultured Atlantic salmon on wild populations in northern Europe.

The genetic management is strongly dependent on factual knowledge about the genetics of sea bass (otherwise said what is so typical for the genes of sea bass). Fortunately, it can take advantage from existing schemes developed for farm animals and salmonid aquaculture. In ten generations gains of more than 50% in growth rate have been made in Atlantic salmon.

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transgenic fish: major changes for the aquaculture?

By: Katinka Waelbers

The production of transgenic fish has increased substantially during the last couple of years. Scientists are modifying the genetic information of fish in order to make them more suitable for the use in aquaculture. It is possible that transgenic fish will be the first animal product that enters the market for consumption. The first taste-test of transgenic trout has already been carried out by the company Aqua Bounty Farms. It involved a transgenic trout with an extra growth hormone gene. Expression of this gene has led to salmons ten times heavier than their siblings. Another example is the transgenic Atlantic salmon which produces Anti Freeze Protein, to make them more suitable for cultivation in the colder areas (see review of Hew & Fletcher: 'Transgenic fish for aquaculture' in Chemistry & Industry Magazine No. 8, 1997, p.311-314).

On behalf of a study being performed at the University of Utrecht, I am interested in the opinion of people, working in the field of aquaculture, concerning these developments. Therefore, I would like to take this opportunity to ask the readers of this magazine about their opinion concerning the introduction of transgenic fish in aquaculture. Anonymous reactions are also welcome, but I would like to know what profession you perform.

The questions I would like to ask are the following:

- What do you think are the possible advantages and/or disadvantages of introducing transgenic fish in fish farms for the farmer?
- If they become available in a couple of years, would you be interested in breeding transgenic fish, supposing you have a fish farm? Why would or wouldn't you?
- Do you expect that the industry will become too dependent on the scientists or do you think that there will not be any difference with the present-day situation? Why do you think so?
- Do you expect that the development of transgenic fish will lead to increased or decreased profits for aquaculture on the long term?
- What do you expect of the role of the consumer? Do you expect the consumer to accept transgenic fish for consumption, or not? Why do you think that?
- What are the consequences, for the economic structure of the line of business, of the introduction of transgenic fish for aquaculture, according to your opinion? (For instance: do you think that big, wealthy fish farms will monopolise the business because they can make the investments that are required for the breeding of transgenic fish while little companies cannot? Do you think that the fish farms will become much wealthier?

You can send your reaction to:

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Group on Crustacean Nutrition of the World Aquaculture Society. The book contains twenty chapters that were written by twenty-five authors representing ten countries and is divided into three parts, classical nutrition, practical nutrition, and future trends. The classical nutrition part contains fourteen chapters that include research methodology, amino acids, energy and protein energy ratio, phospholipids and sterols, fatty acids and triacylglycerols, carbohydrates and fiber, vitamins, minerals, carotenoids, digestibility, anatomy and physiology of the digestive system, chemoattraction and feeding stimulation, larval nutrition, and broodstock nutrition and maturation diets. Part II contains chapters on feed ingredients, standards for assessing quality of feed ingredients, feed formulation principles, and the commercial pelleting of crustacean feeds. The final two chapters found in Part III address future directions for research in Asia and in the Americas. All chapters are thoroughly referenced and generally concentrate on those species of crustaceans that are commercially cultured throughout the world. This book is an excellent resource and teaching tool for anyone interested in the nutrition of crustacean species.

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buyer's guide '97 and industry directory

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The 'Buyer's Guide '97 and Industry Directory' contains:

- Status of world aquaculture: 1996
- Aquaculture in Latin America and the Caribbean
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- Reaching your market
- Investing in aquaculture
- Directory of products and services: aquatic species, baits, consultants, feeds, medications/chemicals, products, services
- Trade shows and conventions
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- Extension contacts in aquaculture
- Diagnostic services
- Aquaculture centers

(genetics and seabass, continued from p.47)

In addition, the salmon mapping programme (SALMAP), which will support enhanced selection, builds on the knowledge acquired in cattle and pig mapping. To this purpose a Concerted Action funded by the European Union and entitled "Assessment of procedures for the development of a European standardised multi-site testing programme: application to sea bass, *Dicentrarchus labrax*" has been launched.

The expected benefits of such a scheme can be viewed on the short term and on the long term. Short term benefits include parentage assignment of progeny, the typing of suitable broodstock, the authentication of broodstock (very often the genealogy of parental fish is rather obscure) and guidelines for the selection of suitable breeders especially in order to avoid inbreeding. Long term economical benefits are mostly related to the establishment of selected lines which may give perspectives on the control of sex ratio, body mass at maturation, flavour, and so on. Transgenesis is not considered in this scheme because of its highly experimental status and its sensitivity to the public.

The transfer of these benefits to the industry strongly depends on the interactions between science and industry. The presence of few fingerling producers facilitates genetic management, while the transfer across regions of uncharacterised broodstock complicates management. A central professional body could improve the quality of the interactions.

In conclusion, the maturity of the aquaculture industry of sea bass (and to the same extent of sea bream) is such that a genetic management programme is timely. It is sufficient to look at the gains which have been made during the relatively short history of the salmon selection programme, to understand that sea bass aquaculture would be in a gain position. Of course efforts on other aspects of its biology (such as pathology, nutrition and maturation control) would be part of the continuous efforts towards improvement.