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Improved Grow-out of European Sea Bass (*Dicentrarchus labrax* L., 1781)

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Abstract

Scientist from thirteen laboratories from eight European countries common interest at the improvement of sea bass culture technologies. For the purpose of this concerned action. They have expertise in molecular genetics, population genetics, quantative genetics and husbandry, which are one, or more of the following technologies required to reach the targeted aim. Such as;

- How to collect the different populations and evaluate their variability?
- How to rear their progenies and store them with a maximum of security and sanitary quality?
- How to identify the genetic parameters of the commercial interest traits?
- How to compare their performances?

According to their significant economic impact, the selected criteria are the followings:

- Growth and shape
- Fillet quality
- Sex ratio and maturation
- Disease susceptibility

Turkey has favourable ecological conditions for marine aquaculture and also sea bass farming. But all of the marine fish farms in Turkey should be improved their technologies.

Key Words: sea bass, *Dicentrarchus labrax*, growth, culture techniques.

Introduction

Dicentrarchus labrax is distributed in the northeast Atlantic from Morocco to Norway and in the Mediterranean Sea and the Black Sea. Sea bass production in the Black Sea was 33,396 mt valued at US$ 335,707 in 1998 (FAO, 2000). Production increased to 9,000 mt in 2000 (Ministry of Agriculture). Turkey has favourable ecological conditions for marine aquaculture including sea bass farming. But all marine fish farms in Turkey should improve their technologies.

Sea Bass Farming in Turkey

Extensive systems: Turkey has a 36,500 ha of generally shallow brackish water lagoons. The fish that reside in these lagoons are caught in dalyan structures. Yields from these lagoons amount to 20-50 kg/ha. Of the 5,000 mt of fish caught from these lagoons, sea bass makes up 500-1000 g.

Semi-intensive farming in earthen ponds: Earthen ponds are more popularly used for sea bass in the Milas-Savran area, where salinity is normally 5-20‰ and water temperature is around 19ºC. Stocking densities vary between 5 and 10 kg/m^3**.** The sea bass from these ponds resemble wild fish and can be sold at higher prices. Farms in Milas produce up to 500 mt of sea bass annually.

Intensive farming in floating cages: This type of farming is more common in the İzmir-Aydın and Muğla areas although it also occurs to find in the Black Sea. Cages are more appropriate along the Aegean coast because of its topographical and ecological features. The Ministry of Agriculture has shown that 200 sea farms can produce 10,000 mt of sea bass. Due to primitive technology, sea bass farming in Turkey has yet to reach its full potential.

Consumer and Industry Demand

An in-depth transformation of market conditions is ongoing in Europe. The most important issues are the increasing role of supermarkets in the distribution chain, the development of new processing techniques like pre-packed fresh fish, the growing importance of catering, and the changes in consumer behaviour. It is then necessary to adapt the fish to the different markets. Thus, high carcass and filet yield are important factors for processed fish, and quality criteria like shape and color of the skin are important for whole fresh fish.

Consumers: a heterogeneous demand

The behaviour of seafood consumers results from contradictory attitudes such as scrutiny of the products' origin and farming process, search for the best value-for-money, need for easy-to-store and ready-to-cook fish, and desire and social image (Paquotte, 1995). These factors combined with the market segmentation make it difficult to develop a fish product that satisfies all.

In Italy and Greece, there are clearly two types of products, namely, a 'wild-looking' fish that is expensive and sold in small numbers, and a more standard product, recognized as an aquaculture product, that is cheaper. The two products are characterized by appearance (shape, color, scale pattern), shelf life, and the amount of fat. Higher muscle fat content and less visceral fat is desirable, but fat fish have a shorter shelf life. There is an attempt to reduce the gap between wild and farmed sea bass and emphasize the quality of farmed fish.

In Spain, two markets also exist, but consumers prefer the farmed type, which is easier to cook and has more muscle fat. Unlike the Spanish consumers, Italian consumers are ready to pay more money for fish with less fat.

In France, the wild sea bass from the Atlantic are usually sold at lower price (not enough fat in the muscle), and those coming from Mediterranean lagoons are sold at higher price - same as the price for 'wild-looking' bass from Italy.

In Italy, dark-green sea bass are desirable, but in Greece, white and silver fish are preferred. The color of flesh should be brilliant white, not yellow. In France, clear and metallic skin color and white flesh are preferred.

The increasing role of supermarkets in the distribution chain requires that their requirements be taken into account; particularly where genetic programs can deliver desired improvements. This might be the case for processed fish. Pre-packed fish has become a major item for Dutch and Belgian markets, and will likely become more important in other European seafood markets in the coming years. Pre-packaging of fish is the most promising way to expand the market for fish and to reach new generations of consumer. Under these conditions, attention must be focused on carcass and fillet yield.

Since different markets demand different types of sea bass, information on the different strains must be gathered for the farming industry to decide what to do.

Wild or wild-like sea bass versus farmed bass

The wild appearance of fish is considered a quality criteria in some countries. The case of Greek consumers is characteristic: they want only wild-looking fish, not 'genetically manipulated' fish. In Greece, there are strict criteria that define 'wild' - no deformity, thin, bright quality. Large price differences exist in Italy, and in Greece 'wild' fish are twice as expensive as farmed fish.

Overall, there is confusion over the definition and meaning of 'wild'. Fish caught from the wild look like farmed fish when fed farm food, and domesticated strains look wild when released in the sea. So the role of genetics in this issue seems questionable. It seems that farm conditions and nutrition are more important in determining whether a fish looks wild. However, might it be possible for sea bass to be (genetically) selected to look 'wild' after grow-out in farms?

Sea bass traits of commercial importance

Recent estimates show that less than 1% of the world's total aquaculture production is based on genetically improved stocks (Gjedrem, 1997). Only a few sea bass hatcheries sell fry produced from genetically improved broodstocks. There is a great disparity between the need for increased aquaculture production and the genetic quality of stocks available to meet that need. Ideally, a well controlled wide-spectrum genetic basis is necessary to initiate any breeding program and avoid inbreeding.

Improvement of Atlantic salmon in Norway is based on seven traits: growth rate, early sexual maturity, resistance to the ISA virus and furunculosis (a bacterial disease), filet color, total filet fat, and filet fat distribution (Gjerde and Rye, 1998). Evaluation of the different traits is conducted on fish at three points in the life cycle:

- Juveniles of ~2-3 g (4-5 months) at the end of nursery period
- Fish of ~50-70 g at the end of the first year of rearing
- Fish of market size at the end of rearing (2.5 years)

Similar criteria of significant economic impact may be used to select seabass strains:

- Growth and biomass yield
- Fish quality traits
- Disease resistance
- Survival
- Sexual maturation
- Deformities

Growth and biomass yield

Fish farmers consider growth as the priority trait to improve. Growth is a complex trait (a polygenic trait) resulting from numerous genetic and environmental factors. For instance, growth can be controlled by different genes at different periods in development. One also has to take into account whether the fish needs to overwinter.

The classical selection method consists of measuring length and weight at different times in the rearing cycle. The use of a digitized table might be helpful in such measurements. Correlations between weight and length at different stages should be determined. Measurements may have to be more sophisticated depending on particular needs and conditions.

The morphology and growth of fish affect the carcass and filet yields. The carcass yield is the proportion of useful biomass (excluding viscera and gonads) in the total weight of each fish. Carcass and filet yields are measured after slaughter. The filet yield is an important trait for fish more than 1 kg. The fish processing industry recognizes three types of filets:

- Whole filets (including skin and ribs)
- Skinless filets (including ribs)
- Trimmed filets (skin and ribs removed)

For the time being, whole fresh fish is more profitable than any processed product, but this may change. Packed filets are increasingly becoming a product of mass marketing processing units on farms, already well developed for salmonids, may become a reality for sea bass when better performing breeds are obtained through breeding programs. Thus, carcass and filet yields could be interesting traits to select sea bass in the future.

Fish quality traits

Quality assessment of fish depends on the personal perception of consumers. Thus, quality criteria change over time and space. Different traits can be used to define the quality of fish:

- External appearance like the body shape and the color of the skin
- Characteristics of the flesh: color, texture, chemical composition, and fatness

The body shape and proportions of fish are important to the market for the whole fresh fish, particularly Spanish consumers. It must be noted that farmed fish have smaller heads. Shape must be measured on market-size fish. The best way to measure quickly and precisely a number of parameters linked to shape is probably image analysis, for which a variety of software is available. Shape might be a predictor for processing-related traits if correlations can be identified.

Skin color of fish can change with environmental conditions, but genes determine the primary color. To measure color, we may build a color scale or work through photographs and image analysis. The flesh color may be adjusted to the target market; for example, the filet market requires a white and tasty flesh. Color can be assessed with a spectrocolorimeter, which decomposes color into a few parameters. Several measurements are usually done on each sample and automatic apparatuses are used in order to obtain homogeneous data from different testing sites.

Texture is measured in market-size fish. The texture of both raw and cooked flesh samples can be measured as the pressure resistance of the flesh or by quantifying the water retention after cutting the myomeres. The chemical analysis permits accurate assessment of the proportion of crude protein and the ash content of the flesh.

Finally, sensorial analysis can be used to characterize the quality of flesh and filet according to specific descriptors, including the smell, flavour, and texture. A list of criteria describes the intensity of each descriptor. Sensorial analysis has to be done by a specialized jury.

Disease resistance

Wild and farmed sea bass have to face diseases and parasites that vary by geographic origin. The main pathologies are induced by bacteria like *Vibrio* spp., *Pasteurella* sp. and *Aeromonas* sp., by viruses like nodavirus, and by parasites like *Diplectanum* sp. At present, vibriosis and pasteurellosis are the most economically important diseases in sea bass. Veterinary products can solve problems, but there may be constraints on the use of antibiotics and vaccines on industrial scale. Moreover, there are few efficient therapeutic products commercially available for sea bass.

What can be the input of genetics? It is not known whether significant differences in resistance to disease exist among wild sea bass populations. If so, maintaining genetic variation is an important long-term defence strategy against pathogens and their increased aggressiveness.

Evaluation of disease resistance is justified between 10 g and harvest; during this period, 20-25% of the fish can die from diseases. Immunity appears early in sea bass, in fish around 1 g, and vaccination at this stage is common.

Sea bass is very sensitive to stress, which is a general indicator of disease resistance and disease incidence. Stress response should be measured under the advice of specialists and the best ways to measure both acute and chronic stress must be developed. Sensitivity to stress is indicated by external signs of disease among fish reared in locations where there is a history in a specific disease. Stress levels may be different between wild and captive stocks and domestication selection in captive stocks may select for less stress. Testing and selection must be done on different populations, including long-term hatchery stocks.

Survival

Survival rates are good indicators of the capacity of different sea bass strains for artificial propagation and farming. Survival of fish results from several factors -- disease resistance, cannibalism, stress in a given rearing condition - and the importance of these factors depend on the development stage. Survival is also correlated with disease resistance, and the economic value of survival differs with age. Survival should be monitored during larval rearing, weaning, and grow-out. Survival during the last period of growth is the most important economically.

Sexual maturation

A positive correlation exists between fast growth and precocity of sexual maturation, which are antagonistic breeding criteria. Sexual maturation is usually attended by growth depression, higher sensitivity to disease (observed in salmonids), and deterioration of flesh quality (increased water content) during the breeding season. Control of reproduction may prevent or inhibit sexual maturation such that food is converted into somatic growth instead of gonads. One-way is to produce sterile fish by triploidy; triploid individuals are partially or completely sterile in many farmed fish. In female salmonids, inhibition of first maturation can also be achieved by manipulation of photoperiod.

Age at first maturation is not homogeneous in a cohort of sea bass; males mature at 1-3 years of age, mostly at 2 years, and females mature at 2-4 years. Delaying first maturation is a method of getting 1 kg fish without the gonads. Age at first maturation is a trait to select for if it is shown that some strains do not mature under certain conditions or are genetically programmed for later maturation.

To measure sexual maturation, there must be ways to record and control the chronology of the sexual cycle. The simplest methods consist of stripping males and doing biopsies or measuring plasma vitellogenin in females. The sexing period depends on the water temperature and the photoperiod; under natural photoperiod, the best time is winter. Another method involves slaughter of the fish, measurement of gonad and liver weight against body weight, and a histological study of the gonads from fish of different size and age. Other methods are currently being tested to characterize sexual maturation: plasma concentrations of sex steroids (oestradiol in females), vitellogenin in females, and lipids and thyroid hormone at different seasons.

During testing and selection, correlations between sex and the selected traits must be determined because many characters vary by sex. Females grow better than males, produce larger gonads, but mature later. Delayed maturation in males may be selected to improve growth.

Deformities

Deformities generate losses both for hatcheries and on-growers. Since the definitive morphology of sea bass is usually reached at 3 cm long, deformities can be assessed during early development. Anomalies in newly hatched larvae include body or jaw twist and uncoupling of the oil globule. Deformities in older fish include the absence of a functional swim bladder, the presence of urinary calculi, and defective jaws, operculum, and vertebral column. Deformities do not systematically lead to death. There is still no evidence to suggest any genetic basis for deformities. Rearing conditions could explain at least partly the occurrence of these deformities.

Deformed jaws and operculum can be measured directly. Vertebral column defects can be observed through the transparent body wall in larvae until the appearance of scales (~3 cm) and by radiography in larger fish (soft X-rays for fish 3-10 cm, classical X-rays for fish over 10 cm).

Other traits

Scales are generally smaller in farmed sea bass but scale size is not seen as a priority trait for selection. Feeding-related traits such as ability to adapt to artificial diets may be important. Hatchery-related traits are not an economic factor for the time being, unless the *Artemia* supply becomes limited.

An Example from Sea Bass Farm

Year of establishment: 1994
Capacity: 200 mt fish/per year (100 ton sea bass-100 ton sea bream)
Location: Muğla- Bay of Güllük- Sıralık Area
Production area: 5000 m^2 in the sea
Number of cages: 30 nursery cages (5x5x6 m)
24 octagonal cages, each side 5 m
Stocking density: 10-15 kg/m3
Variation of temperature: Figure 1
An example of production parameters in two sea cages is given for comparison in Table 1
Growth of fish, cage 5: Figure 2
Growth of fish, cage 6: Figure 3
Manpower: 1 Agricultural Engineer (Manager)
1 Aquaculture Technician
1 Accountant
4 Workers

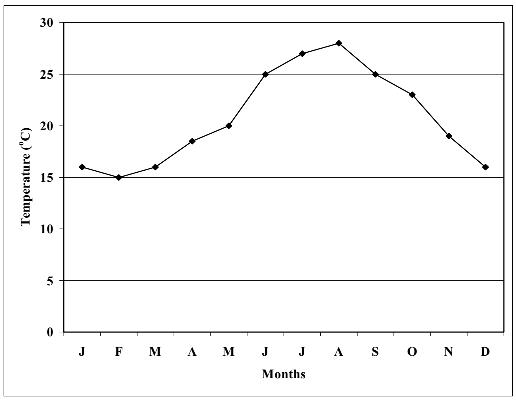

Figure 1. Mean variation of water temperature in Aegean Sea.

Table 1. Basic production parameters in two sea cages.

	Cage 5	Cage 6
Number of fish stocked:	21,700 (20 Apr. 2000)	20,000 (20 Apr 2000)
Number of fish now:	19,350 (20 Sept. 2001)	18,800 (20 Sep 2001)
Total feed consumption	12,280 kg (until Oct. 2001)	12,306 kg (until Oct 2001)
Conversion ratio:	1.71	1.75
Mortality:	10.8%	6%
Production cost (US$):	2.35	2.35
Larvae:	3.3 x $0.17 = 56 cents	3.2 x $0.17 = 54 cents
Feed:	71.8 x 1.71 = 123 cents	71.8 x 1.75 = 126 cents
Labor:	35 cents	35 cents
Other cost:	21 cents	21 cents

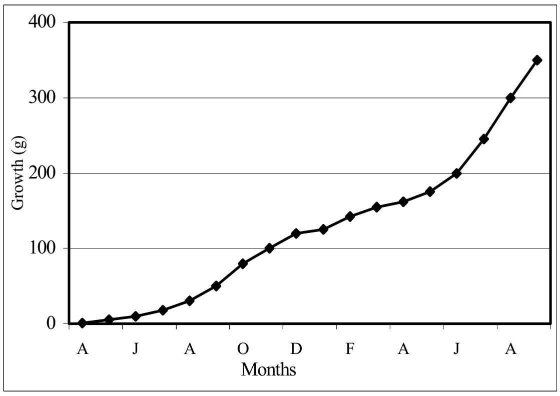

Figure 2. Growth curve for cage no: 5.

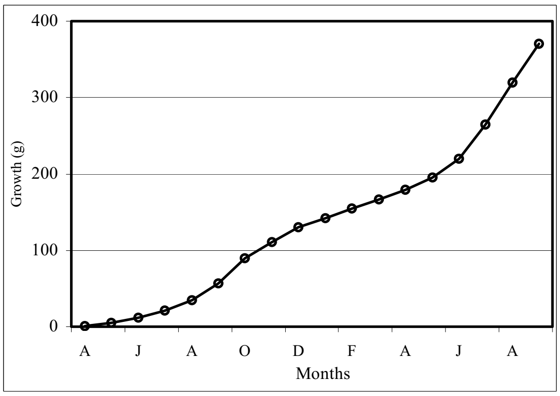

Figure 3. Growth curve for cage no: 6.

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Note : Mostly text of this presentation was taken from Assessment of procedures for the development of a European standardised multi-site testing programme: Application to sea bass, *Dicentrarchus labrax* published by IFREMER (2001).