Marine Finfish Species Diversification: Current Situation and Prospects in Mediterranean Aquaculture

Abellán E., Basurco B.

in

Abellán E. (ed.), Basurco B. (ed.).
Marine Finfish Species Diversification: Current Situation and Prospects in Mediterranean Aquaculture

Zaragoza : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 24

1999
pages 1-139

Marine Finfish Species Diversification: Current Situation and Prospects in Mediterranean Aquaculture

Results of the Survey on Finfish Diversification in the Mediterranean carried out within the framework of the CIHEAM Network on Technology of Aquaculture in the Mediterranean (TECAM)

Scientific editors:

E. ABELLAN, B. BASURCO

CIHEAM

Contents

Foreword

Aquaculture is one of the fastest growing food production sectors. Production techniques have progressed rapidly as a result of efforts from the private sector and the scientific community. To maintain this momentum in the Mediterranean Region, four international networks were established in partnership between International (FAO), Mediterranean regional (CIHEAM) and national institutions, and placed under the aegis of the Aquaculture Committee of the General Fisheries Council for the Mediterranean. These four Mediterranean networks are: TECAM (Technology of Aquaculture in the Mediterranean), SELAM (Socio-economic and Legal Aspects of Aquaculture in the Mediterranean), SIPAM (System of Information for the Promotion of Aquaculture in the Mediterranean) and EAM (Environment and Aquaculture in the Mediterranean) and have, as objectives, the promotion of co-operation in the above mentioned subjects between institutions and experts in the region.

TECAM and SELAM networks are coordinated by the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) which has been, since 1995, organizing and implementing the activities through the Mediterranean Agronomic Institute of Zaragoza (IAMZ), in collaboration with FAO and other Mediterranean institutions. At present, subjects included in the TECAM network are nutrition, health management and species diversification. Activities of the SELAM network have so far included marketing, production economics and aquaculture planning.

As regards the field of species diversification, different activities have already been organized within the framework of the TECAM Network. Among them a TECAM Workshop on Marine Aquaculture Finfish Species Diversification held in Nicosia (Cyprus), from 14 to 17 June 1995, and a Working Group Meeting held in Crete, Greece, on 8 and 9 July 1996. During the TECAM Workshop held in Cyprus, it became evident that there is an overlapping of research activities on finfish diversification in several Mediterranean countries and private and public research institutes/companies. A problem that should be avoided and can be solved by a better co-operation and communication between researchers.

In this respect, the TECAM Network, following the recommendations of the above mentioned workshop, launched a Mediterranean survey on finfish diversification. The results of this survey, which are presented herewith, are expected to facilitate a deeper insight into the main and most common constraints found in this research field, as well as to facilitate the establishment of collaborative research groups on New Mediterranean Aquaculture Finfish Species.

It is recalled that the present publication is not intended to be a scientific reference document on the culture knowledge of potential candidates for Mediterranean aquaculture. Thus, this publication after including an introductory paper on the problems involved in species diversification, presents a brief introduction to the survey and its results. For each identified finfish species a brief summary of the biological characteristics and the culture information extracted from the survey answers is included. For the reader information, a table containing all survey answers per species is presented. Finally, and with the aim of facilitating the communication between experts on this field, in Annex II and III the reader will find the addresses of Mediterranean Institutions and Companies, as well as their experts and working topics, identified during the survey.

We would like to express our gratitude to all experts who have answered this survey and also participated by assisting us in its design, by facilitating the addresses of research groups working in this field, or by encouraging others to answer it. This document is the result of valuable cooperation, which we hope will be long lasting.

Miguel Valls
CIHEAM-IAMZ Director

Mario PEDINI
FAO Fisheries Department

Finfish species diversification in the context of Mediterranean marine fish farming development

B. Basurco* and E. Abellán**
*International Centre for Advanced Mediterranean Agronomic Studies,
Mediterranean Agronomic Institute of Zaragoza, Apartado 202 - 50080 Zaragoza, Spain
**Instituto Español de Oceanografía, Centro Oceanógrafico de Murcia,
Ctra. de la Azohia s/n - 30860 Mazarron, Spain

SUMMARY - The Mediterranean aquaculture sector, mainly marine fish farming of sea bass and sea bream, has been notable for its development and growth in the last decade. However, this dramatic increase of production has occurred within a framework of technical constraints and limited markets. Following a brief discussion about technical problems affecting the development of Mediterranean mariculture, we here analyse the species development route. This route is considered within the options offering possibilities for future development, and is seen as a strategy that aims to provide diversity in the market and contributes towards the development of new markets through a product differentiation policy. The route of species diversification, its advantages and constraints, the criteria for selection of species and the necessary steps to develop a new species package are analysed and discussed.

Key words: Aquaculture, new species, diversification, Mediterranean, sparids.

RESUME *- "Diversification des espèces de poissons dans le contexte du développement de la pisciculture marine en Méditerranée". Le secteur aquacole méditerranéen, principalement la mariculture du loup et de la daurade, a été remarquable pour son développement et sa croissance pendant la dernière décennie. Cependant, cette expansion spectaculaire de la production a eu lieu dans un cadre de contraintes techniques et de marchés limités. Suite à une brève discussion sur les problèmes techniques qui affectent le développement de la mariculture méditerranéenne, nous analysons ici la voie de développement des espèces. Cette voie est considérée au sein des options qui offrent des possibilités de développement futur, et elle est perçue comme une stratégie visant à apporter une diversité sur le marché et contribuant à la mise en place de nouveaux marchés à travers une politique de différenciation des produits. La voie de la diversification des espèces, ses avantages et ses contraintes, les critères pour la sélection des espèces et les étapes nécessaires pour développer un ensemble de nouvelles espèces, sont analysés et discutés.*

Mots-clés *: Aquaculture, nouvelles espèces, diversification, Méditerranée, sparidés.*

Introduction

Marine living resources provide an important source of protein in many countries. Although marine catches have increased over the last 20 years, this tendency has changed and landings have now stabilised. Moreover, about 70% of the world's conventional species are fully exploited, overexploited, depleted or in the rebuilding process following depletion. In 1995, total world production of finfish, crustaceans and molluscs from capture fisheries and aquaculture reached 112.9 million t; 120.7 million t if aquatic plants are included (FAO, 1997). Much of the increase in annual global aquatic production is attributable to aquaculture. For cultured finfish and shellfish, the annual contribution to total finfish and shellfish production rose linearly from 11.7% in 1989 to 18.5% in 1995, a record of 27.8 million t (14.4% to 23.0% if aquatic plants are included).

When considering fish for human consumption only, aquaculture acquires greater importance since over a quarter of the total world supply was the result of aquaculture. Much of the reported increase originated from the low-income food deficit countries (LIFDCs), in particular China, and reflects the continuing trend in these countries of increased use of aquatic resources to further diversify food production (FAO, 1997).

Aquaculture in the Mediterranean region is an activity which began many centuries ago and thus has a substantial history: it is possible to find signs of aquaculture from Egyptian civilisation. Ancient

Egyptian friezes on the tomb of Aktihep (2500 BC) shows what appears to be men removing tilapia from a pond (Bardach *et al.*, 1972). During ancient Roman times sea bass, sea bream, mullets and oysters were cultivated or simply kept alive off the Italian coast (Cataudella, 1996).

Mediterranean aquaculture initially developed in coastal lagoons. Management of finfish populations and oyster culture started in these confined environments thanks to their particular ecological conditions (Cataudella, 1996). This origin strongly conditioned the beginning of modern Mediterranean aquaculture, which is characterised by the coexistence of diverse production systems that use a wide range of production techniques; from coastal lagoon management to highly intensive raceways or cage fish farming.

Mediterranean aquaculture industry: Current status

Mediterranean aquaculture production has grown steadily over the years and its production rose, from about 734,410 t in 1991 to 917,537 t in 1996, which represents a 25% increase for the period considered, and approximately 4% of the world aquaculture production. Although Mediterranean aquaculture focuses mainly on molluscs (62%), the share of fish (37%) is in constant progression, parallel to global trends of world aquaculture. Thus, during the period from 1991 to 1996 the total fish production experienced a growth of 47% (Table 1), and 14% for total mollusc production.

Given the importance of trade in goods, technology and capital, the evolution of Mediterranean aquaculture has to be analysed within the framework of a wide Euro-Mediterranean economic and politic area including both the European Union and the Mediterranean countries. Thus, Aquaculture in Mediterranean countries has been dominated during recent years by three countries France, Italy and Spain, which supplied, mainly with mollusc production, 87% of the total production in 1991. This percentage decreased to 80% in 1996 despite their increase in production. The entry of new countries into aquaculture, Greece and Turkey at the head, among others, which concentrate most of their production in marine finfish, is changing the situation significantly (Table 1). The growing in production of countries as Malta, Cyprus and Israel should also be highlighted.

As regards species commodities, molluscs (mussel, oyster, clam, etc.) were the prevailing group in 1996 with over 570,000 t of production (Table 1), showing a growth of 14% in the period 1991-1996 and a possible saturation of the market.

In the same period, the total fish production rose from 229,075 to 335,968 t (47% growth). Within this group, trout is still at the head of the species produced with about 140,000 t and steadily growing, increasing by 40% between 1991 and 1996. Another important group of freshwater species was the tilapias, which have experienced steady growth in the last decade, although their production (35,881 t in 1996) is concentrated in Egypt and Israel, who provide 95% of total production (Table 2). Carp production, a traditional practice in some countries, decreased at the beginning of the 90s (10%), mainly due to a fall in production in Bulgaria and Egypt.

Marine finfish attracted more attention in the Mediterranean region, with the highest rise of all groups (algae not included). In this group, except salmon and eels, all species (sea bass, sea bream, turbot, and mullet) have increased in production from 1991 to 1996. Sea bass and sea bream are the main species produced and have experienced the highest increase in production, 218 and 412% respectively. Both are in rapid expansion, moving from 13,088 to 59,430 t in the period 1991-1996 (Table 2). The production for 1997 has been estimated in 69,011 t (FEAP: www.feap.org).

As regards marine fish farming it should be also pointed out the production of turbot, which although only produced in Spain, France and Portugal has rose a significant 177% between 1991 and 1996, over 2,500 t in 1996. Mullet production rose during the same period by 109%, reaching a production in 1996 of 25,386 t (Table 2). Finally, within this group of marine fish there has been a decrease in eel production, probably accounted for by the lack of available seed and the conversion for some Italian eel plants to sea bass and sea bream production (Iandoli, 1997).

Crustaceans and seaweeds are recent entries into Mediterranean aquaculture and are still of limited importance; both reached 8,489 t in 1996. *Procambarus clarkii* stands out in crustacean production, but tests have been carried out for penaeid shrimp, using extensive techniques in the

northern shore and more intensive practices in the southern countries. Gracilaria is the main species of seaweed cultured in the area (Pedini, 1996).

Table 1. Comparative features of Mediterranean aquaculture production (in t) (developed from FAO-AQUAstat PC†)

Country	1996				% Increase 1991-1996			
	Fish	Molluscs	Others	Total	Fish	Molluscs	Others	Total
Albania	93	250	-	343	-53	-62	-	-60
Algeria	297	25	-	322	203	-52	-	115
Bulgaria	2,485	42	-	2,527	-68	-	-	-68
Croatia	2,637	258	-	2,895	-	-	-	-
Cyprus	758	-	12	770	506	-	-	516
Egypt	75,837	-	-	75,837	23	-	-	23
France	67,276	218,140	1,025	286,441	37	11	1667	17
Greece	29,626	10,226	-	39,852	306	73	-	202
Israel	17,568	-	-	17,568	16	-	-100	16
Italy	61,192	140,300	5,023	206,515	19	48	14674	41
Lebanon	350	-	-	350	338	-	-	338
Libya	100	-	-	100	43	-	-	43
Malta	1,552	-	-	1,552	676	-	-	676
Morocco	2,128	170	2	2,300	388	-24	-	249
Portugal	2,281	3,014	-	5,295	-15	-16	-100	-16
Spain	33,079	198,327	2,427	233,833	56	-2	5	4
Syria	6,355	-	-	6,355	101	-	-	101
Tunisia	1,341	140	-	1,481	75	-7	-	61
Turkey	31,013	2,188	-	33,201	296	-	-	324
Total countries	*335,968*	*573,080*	*8,489*	*917,537*	*47*	*14*	*250*	*25*

†FAO-AQUAstat PC records 335 different species items. Some species items include several species. Total world aquaculture production in 1996: 33,932,031 t.
http://www.fao.org/WAICENT/FAOINFO/FISHERY/statist/statist.htm

Industry constraints and development options

Successful development of the sea bass and sea bream production in the Mediterranean area has been achieved after overcoming various technical problems involved in their culture. However, the growth in supply of these species has led to a considerable decrease in market price, which provoked a crisis in this sector in the early 90s. Sea bass and sea bream production costs are very variable given the variety of countries, sites, technologies and farm sizes in the Mediterranean. This variation is all the bigger as most of the enterprises are under five years old and routine has not yet become routine. In this context, according to Stephanis (1996), Mediterranean farming can be described as being in a growing industry phase characterised by rapid growth, non generic market developments, stabilisation of production techniques, development of sophisticated management and so on. Thus, this incipient industry is facing some of the same problems that the salmon industry did years ago or will face others that are typical of mature and/or ageing industries such as reduced growth in production, control on cost and rationalisation, critical management, etc.

Whilst the industry has been quite diverse in its features and production methods, and has encompassed both commercial and artisanal forms of production, there are increasing signs of aggregations and more clear-cut division between two main sectors: large scale corporate producers using intensive methods and smaller-scale family or co-operative producers. Competition is likely to increase, and in the longer term prices and margins will tend to decline, which will demand additional efficiency and productivity. This is likely to drive industry policy in further pursuit of size.

Table 2. Mediterranean aquaculture production in year 1996 (in t) by countries and species (Developed from FAO-AQUAstat PC†)

Species	AL	DZ	BG	HR	CY	EG	FR	GR	IL	IT	LB	LY	MT	MA	PT	ES	SY	TN	TR	Total Sp.
Sea bass	-	10	-	172	100	977	1,997	11,662	66	3,800	-	-	621	600	302	693	-	210	5,210	26,420
Sea bream	-	-	-	80	527	1,457	486	13,799	633	3,650	-	-	931	600	410	3,818	-	299	6,320	33,010
Mullet	-	26	-	-	-	20,101	-	502	1,232	3,100	-	-	-	-	5	125	-	295	-	25,386
Trout	20	-	585	308	105	-	52,743	1,927	770	40,702	350	-	-	92	1,325	25,000	-	-	18,510	142,437
Carp	73	238	1,900	1,938	-	23,439	5,055	207	8,163	600	-	100	-	750	-	-	4,702	228	780	48,173
Tilapia	-	-	-	-	-	27,854	40	-	6,399	-	-	-	-	-	-	-	1,588	-	-	35,881
Salmon	-	-	-	-	-	-	800	9	18	-	-	-	-	-	4	726	-	-	193	1,750
Eel	-	17	-	6	-	-	160	584	-	3,000	-	-	-	60	83	249	-	158	-	4,317
Turbot	-	-	-	-	-	-	225	-	-	-	-	-	-	-	144	2,189	-	-	-	2,558
Other fishes	-	6	-	133	26	2,009	5,770	936	287	6,340	-	-	-	26	8	279	65	151	-	16,036
Total fishes	*93*	*297*	*2,485*	*2,637*	*758*	*75,837*	*67,276*	*29,626*	*17,568*	*61,192*	*350*	*100*	*1,552*	*2,128*	*2,281*	*33,079*	*6,355*	*1,341*	*31,013*	*335,968*
Mussel	250	10	42	214	-	-	61,962	10,194	-	100,000	-	-	-	-	136	188,462	-	140	1,918	363,328
Oyster	-	-	-	44	-	-	152,129	10	-	-	-	-	-	160	662	3,720	-	-	-	156,725
Other molluscs	-	15	-	-	-	-	4,049	22	-	40,300	-	-	-	10	2,216	6,145	-	-	270	53,027
Total molluscs	*250*	*25*	*42*	*258*	-	-	*218,140*	*10,226*	-	*140,300*	-	-	-	*170*	*3,014*	*198,327*	-	*140*	*2,188*	*573,080*
Crustacean	-	-	-	-	12	-	925	-	-	23	-	-	-	2	-	2,427	-	-	-	3,389
Algae	-	-	-	-	-	-	100	-	-	5,000	-	-	-	-	-	-	-	-	-	5,100
Total country	*343*	*322*	*2,527*	*2,895*	*770*	*75,837*	*286,441*	*39,852*	*17,568*	*206,515*	*350*	*100*	*1,552*	*2,300*	*5,295*	*233,833*	*6,355*	*1,481*	*33,201*	*917,537*

†FAO-AQUAstat PC records 335 different species items. Some species items include several species. Total world aquaculture production in 1996: 33,932,031 t. http://www.fao.org/WAICENT/FAOINFO/FISHERY/statist/statist.htm

AL: Albania, DZ: Algeria, BG: Bulgaria, HR: Croatia, CY: Cyprus, EG: Egypt, FR: France, GR: Greece, IL: Israel, IT: Italy, LB: Lebanon, LY: Libya, MT: Malta, MA: Morocco, PT: Portugal, ES: Spain, SY: Syria, TN: Tunisia, TR: Turkey

In this context, the constraints for future development of the Mediterranean aquaculture industry can be grouped in different categories, each of them requiring not only specific action but also co-ordination. Table 3 summarises the main characteristics and constraints of the sea bass and sea bream. Although, not the aim of this work, it is convenient to mention that the categories of the constraints (Muir, 1996; Pedini, 1996; Stephanis, 1996) which should be addressed are related to:

(i) Biological and technical aspects, mainly referring to disease problems, but also including diversity concerns due to the introduction of new species in the region and quality control problems.

(ii) Zootechnical constraints such as seasonality of production facing different seasonal fluctuations of the demand.

(iii) Environmental concerns linked to the location of farms and the impact of their effluents on the surrounding environment.

(iv)Limited availability of information for planning and for day to day operation of the farms.

(v) Scarcity of potential sites for new aquaculture projects.

Table 3. Sea bream and sea bass production characteristics and constraints

Market characteristics	Product availability	Production
• Although changing, specialised markets based on relatively high priced products	• Seasonal availability, although gradually extending	• Reduction in production cost, though still high • Relatively short operation times of marine hatcheries (high cost)
• Mainly, a single product form (fresh whole fish)	• Limited sizes and product forms	• Diseases • Environmental concerns: - Effluent impact - Biodiversity

Independently of the fast rise of the sea bass and sea bream production, prices for these two rather similar high value commodities are dependent on the relatively small size of the total market supply including capture fisheries and aquaculture and where aquaculture production has taken the lead as supplier (Pedini, 1996). Sea bass and sea bream are thus losing their luxury image and are becoming commodity items.

In this context, there is only a limited number of strategies that producers may follow in order to maximise their profitability and thus ensure a continuous expansion of the Mediterranean aquaculture industry, in an ever more competitive market. Table 4 summarises the range of options, both market and production strategies, potentially available for the development of this sector. The main strategies include: (i) decrease in production cost; (ii) increase in selling prices; and (iii) answer to the diversity of the demand.

It should be mentioned that these strategies do not exclude other alternatives. For example, a reduction in production cost, successfully achieved by the salmon industry (through improvements in feeds, disease control and prevention, genetics and breeding, management, automatization, etc.) may be accompanied by sophisticated marketing methods, where product differentiation played a significant role.

As for the decrease in production cost, there is still room for improvements in farm management, automatization, health management, more and better performance feeds, genetics and breeding, etc. All these factors make it possible to maintain margins in a competitive sector. Thus, although prices for sea bream and sea bass have become somewhat stable during these last two years, they will most probably decline again, as has happened before with salmon.

As for the second strategy, the increase in selling prices, although possible, seems difficult to achieve, because sophisticated methods of marketing and commercialisation of the product are required. The need for the Mediterranean producers become organised is a pre-requisite and the advantages of co-operation should be considered very seriously (Bakela and Paquotte, 1996).

Table 4. Range of options potentially available for Mediterranean marine aquaculture development

Market strategies	Production strategies
• Introduction into new markets • Development of local markets • Improving product quality image: - Application of identity and designation of origin - Health - Eco-labelling • Increasing the variety of output within the same species: - Fish size diversification • Diversification in the presentation and supply of value-added products	• Reduction of production cost: - Better management - Nutrition - Genetics - Pathology, etc. • Diversification of production systems: - Off-shore cage culture - Recycling systems • Species diversification: - Within similar groups - Within different groups

Another very important perspective is not only to enlarge the existing markets, but also to develop prospects for penetration into new markets. For future growth, the Mediterranean aquaculture industry should emphasise more sophisticated methods of marketing and base them on market research studies (Paquotte *et al.*, 1996).

For the expansion of the supply, the diversification of production systems (off-shore cage culture, recycling systems, etc.) offers at present and more in future, viable alternatives of production in the Mediterranean, where the scarcity of potential sites for new aquaculture projects is one of its main constraints.

For the expansion of markets, the diversification of products may play a significant role in the development of the sector. This diversification of products may refer to: (i) different market products for a given aquaculture species, called product diversification, e.g. different size, different manufacturing process, different presentation, different quality, etc.; and (ii) production of new cultured species, called species diversification. The ability of the producers to distribute other species than those traditionally marketed, would attract new consumers and fetch higher prices, especially for species under innovation in their culture.

It is not possible to say that the new species in Mediterranean aquaculture respond totally to the demand for differentiated products, and other factors are also required in all market segments for seafood. In order to ensure the viability of new domesticated species, they should be controlled from a zootechnical point of view and clearly positioned from a marketing point of view. As for the latter, view three criteria should be considered when selecting a new species to be domesticated: image, expected production cost, expected market acceptance and price (in consideration of wild capture supply and potential fluctuations due to the entry of aquaculture product) and ability to give a range of products. When starting commercial production of a new aquaculture species, with a certain price level, the species price and its market potential may be affected easily, so production costs have to be under control. Their combination will help to assess the market potential.

In this paper, from the previously explained strategies, we review the species development route, its peculiarities, the research groups at present working on this topic and the present culture status and knowledge about new Mediterranean finfish species.

Species diversification

Introduction

The overall trend of diversifying the number of cultured species and simultaneously increasing the production of mainstream species is a tendency in world aquaculture. Although the actual number of species utilised for aquaculture may be higher than reported, just over 250 species were already reported in 1995 (Rana, 1997).

Opportunities for diversification and culture of new species to exploit new national and international markets were also evident from several first-time reports of species and rapid increase in production of selected species by countries in 1995. This was most evident in China which reported for the first time, the production of 37,500 t of mandarin fish, *Sniperca chuatsi*, a carnivorous freshwater perch-like fish which is widely distributed in Chinese reservoirs (Rana, 1997).

Mediterranean aquaculture statistics show production data for a high number of species (freshwater fish, marine fish, molluscs, crustaceans, etc.). Fish production is only significant for about 10 species or group of species: sea bass, sea bream, mullet/s, trout/s, salmon, carp/s, tilapia/s, eel and turbot (Table 2). There are other less significant species; Most of them are freshwater and are cultured in few countries: European perch, Northern perch, pike-perch, sturgeon, tench, etc.

Most of the marine fish species cultured in the Mediterranean area are also supplied through capture fisheries and both enter the same or similar markets. It is to be highlighted that FAO statistics record 212 different species items for the Mediterranean and Black Sea. Within this context, aquaculture production accounts for an increasing share of the total supply, which in fact increasing due to the aquaculture production. For instance, in 1996 the total sea bream capture supply in the Mediterranean and Black Sea was 4620 t (Table 5), and for aquaculture the production in the same area was 28,499 t. Table 5 presents the evolution from 1989 to 1996 for the top 22 species items landed in the Mediterranean and Black Sea, where sea bass and sea bream are included thanks to aquaculture production. In the survey carried out by the TECAM network group on species diversification, whose results are included in this publication, more than 20 marine finfish species were identified as being at different stages of investigation to develop production packages. Table 6 presents the landings of most of these species and their ranking position in the year 1996. There, we observe the low landings of these species, and how thus, at present, they have a limited market scale. This is an important aspect, which should be evaluated when considering and developing the culture of potential candidates for aquaculture, as the expected price and acceptance of a given species could be correlated with their fisheries counterparts, unless that a clear market strategy is followed.

Species diversification: Objectives, advantages and constraints

The assessment of diversification of cultured species must aim at winning more important markets in order to ensure a large-scale development of the Mediterranean aquaculture. Thus, this is a strategy looking for: (i) the expansion of the market; (ii) the spreading of risk; and (iii) the increasing of efficiency.

The expansion of the market

The possibility of offering new species may help to enlarge existing markets and develop prospects for market penetration. This form of diversification will certainly enlarge the offer of aquaculture products, and so facilitate the expansion of the whole aquaculture supply in a growing sector.

In order to ensure the image of the sector, the aquaculture sector should be developed responsibly and sustainably. Although introduced species have significantly increased production in many parts of the world, they are now recognised as one of the main threats to aquatic biodiversity. Thus, it is preferable to supply new local species rather than introduced foreign species, as genetic effects may arise from the interaction of wild fish species and damage to the recipient ecosystem may be caused by the introduction and use of exotic species (Bartley, 1998).

In addition, new species should match the wild fish standards and have the same organoleptic properties of their wild counterparts. In this sense the high quality of aquaculture products is secured.

The spreading of risk

Widening the offer of aquaculture products may certainly contribute to reducing the risk of income fluctuation. In this sense, a preferable alternative is that of developing the culture of species differentiated from those already cultivated. As for Mediterranean mariculture the development of non-

Table 5. Top 22 species items landed (in t) in the Mediterranean and Black Sea ranked with respect to 1996 total landings (last columns) (Source: FAO-FISHstat PC†)

Species items	Species common name	1989	1990	1991	1992	1993	1994	1995	1996	%	Ranking
Engraulis encrasicolus	European anchovy	237,728	170,786	164,762	274,216	319,188	418,904	511,398	389,328	22.28	1
Sardina pilchardus	European pilchard(=Sardine)	272,316	246,767	237,670	251,695	253,646	265,424	242,581	222,948	12.76	2
Mytilus galloprovincialis	Mediterranean mussel	128,889	143,005	132,277	144,108	151,671	138,267	163,539	162,697	9.31	3
Osteichthyes††	Marine fishes nei	107,493	96,126	96,408	77,671	92,576	93,986	92,680	88,904	5.09	4
Venus(=Chamelea) gallina	Striped venus	39,051	35,587	40,288	55,289	60,550	52,184	45,655	48,532	2.78	5
Sardinella spp††	Sardinellas nei	26,187	29,118	31,503	28,111	32,197	30,304	47,134	46,059	2.64	6
Merluccius merluccius	European hake	38,197	33,441	38,173	44,556	52,339	53,151	53,379	45,312	2.59	7
Tapes spp††	Carpet shells nei	7,116	16,110	20,007	27,710	38,920	54,900	65,800	40,300	2.31	8
Mugilidae††	Mullets nei	17,727	20,176	23,816	22,856	21,241	24,433	27,813	34,150	1.95	9
Sparus aurata	Gilthead seabream	6,220	7,484	9,302	12,787	15,757	24,869	26,124	33,119	1.90	10
Trachurus spp††	Jack and horse mackerels nei	26,682	23,945	24,745	23,703	24,367	28,537	33,389	30,231	1.73	11
Boops boops	Bogue	33,526	29,715	33,102	32,313	38,591	39,727	32,724	29,641	1.70	12
Sprattus sprattus	European sprat	105,368	53,920	18,565	20,348	14,896	18,522	21,818	28,260	1.62	13
Merlangius merlangus	Whiting	23,827	21,925	22,777	21,624	21,279	17,423	18,675	22,059	1.26	14
Mullus spp††	Surmullets (=Red mullets)	17,823	18,833	18,336	19,055	20,283	20,349	19,291	21,542	1.23	15
Trachurus mediterraneus	Mediterranean horse mackerel	109,563	78,629	32,455	29,702	17,199	23,762	20,162	21,002	1.20	16
Dicentrarchus labrax	European seabass	3,154	4,542	6,547	9,797	14,424	14,802	19,237	20,641	1.18	17
Thunnus thynnus	Northern bluefin tuna	16,664	16,237	17,310	17,844	18,353	29,231	23,941	19,705	1.13	18
Scomber japonicus	Chub mackerel	31,710	23,758	19,615	26,601	31,629	34,481	28,224	19,529	1.12	19
Micromesistius poutassou	Blue whiting(=Poutassou)	10,281	9,265	11,418	15,832	18,792	19,403	17,929	18,613	1.07	20
Sarda sarda	Atlantic bonito	12,296	22,059	25,996	15,370	25,698	15,930	15,348	17,246	0.99	21
Octopus vulgaris	Common octopus	22,590	20,029	20,848	23,350	19,266	16,117	16,526	17,209	0.99	22
Sparus aurata†††	Gilthead seabream (catches)	3,746	3,586	4,196	5,174	5,252	6,047	4,881	4,620		
Dicentrarchus labrax†††	European seabass (catches)	1,189	898	775	990	1,446	612	736	546		

†FAO-FISHstat PC records 212 different species items for the Mediterranean and the Black Sea (FAO Fishing Area 37). Total landings (1,747,055 t in 1996) includes both catches and aquaculture production. http://www.fao.org/WAICENT/FAOINFO/FISHERY/statist/statist.htm

††These species items include several species

†††Catch values of *S. aurata* and *D. labrax* have been calculated subtracting the aquaculture (FAO-Aquaculture PC, area 37) production from total landing values

Table 6. Mediterranean and Black Sea landings (in t) of finfish species analysed in the survey study (Source: FAO-FISHstat PC[†]). Last two columns give % and ranking with respect to total landings

Species	1989	1990	1991	1992	1993	1994	1995	1996	%	Ranking
Balistes capriscus	-	-	-	-	34	23	59	38	0.00	146
Coryphaena hippurus	599	616	610	367	514	700	768	706	0.04	103
Dentex dentex	3,339	6,808	4,148	5,276	2,996	3,225	3,003	2,210	0.13	69
Diplodus sargus	563	500	575	617	692	629	539	409	0.02	120
Epinephelus aeneus	425	442	384	371	373	336	253	411	0.02	119
Epinephelus marginatus	2,949	3,240	2,774	2,955	2,791	2,730	2,301	1,387	0.08	81
Lithognathus mormyrus	24	32	39	54	45	24	919	718	0.04	101
Mugil cephalus	6,245	6,598	8,751	8,824	8,975	8,505	10,329	13,034	0.75	27
Mullus surmuletus	9,948	9,565	10,262	12,255	12,643	13,119	12,022	11,889	0.68	31
Pagellus acarne	145	156	166	242	133	112	445	400	0.02	122
Pagellus bogaraveo	1,262	1,332	1,239	1,209	1,300	1,392	1,312	1,212	0.07	84
Pagellus erythrinus	3,370	3,634	3,172	3,609	3,176	2,165	3,543	3,989	0.23	56
Pagrus pagrus	2,509	2,551	2,185	3,698	4,120	4,187	4,022	3,378	0.19	60
Polyprion americanus	12	30	24	23	29	16	8	10	0.00	160
Seriola dumerili	284	308	361	454	316	380	611	996	0.06	92
Solea vulgaris	9,021	9,450	9,685	9,640	8,962	8,405	9,435	7,062	0.40	39
Spondyliosoma cantharus	751	603	687	561	804	1,795	498	570	0.03	108
Umbrina cirrosa	492	709	479	993	803	903	207	215	0.01	131
Sciaena spp.[††]	1,187	1,050	1,073	929	906	1,069	1,091	717	0.04	102
Siganus spp.[†††]	120	125	105	90	91	82	-	2	0.00	172

[†]FAO-FISHstat PC records 212 different species items for the Mediterranean and the Black Sea (FAO Fishing Area 37). Total landings (1,747,055 t in 1996) include both catches and aquaculture production. http://www.fao.org/WAICENT/FAOINFO/FISHERY/statist/statist.htm. The following species, which are included in the survey study, do not appear in the FAO-FISHstat PC database in the Mediterranean and Black Sea (FAO Fishing Area 37): *Diplodus vulgaris, Epinephelus alexandrinus, Diplodus puntazzo, Solea senegalensis*. Finally, *Pagrus major*, *Paralichthys olivaceus* and *Sciaenops ocellatus* do not appear in the "FAO identification sheets for fishery purposes of the Mediterranean and Black Sea"

[††]Includes different species belonging to that genus

[†††]Includes different species belonging to that genus

sparids (i.e, seriola, groupers, or sole) offers a better alternative than new sparids, as for these it is likely that will be a high degree of covariance between prices of sea bream/sea bass. Although new species may be risky to develop (e.g., *Puntazzo puntazzo*) they may be of value for a company that is able to produce more different marine finfish species than a competitor, as there is always some degree of diversification. This similarity makes the need for promotion or market studies for these new species more necessary, in order to obtain a reduction of prices on the market as soon as possible.

To the extent that different species are probably not subject to the same major disease problem, this is probably a way of reducing risk against serious disease. Recently, in 1994-95 the Mediterranean mariculture sector suffered a very serious outbreak in sea bass species caused by a nodavirus. The possibility to switch part of the production capacity to sea bream, which was not affected by the disease, reduces not only company losses, but also the effect of this disease on prices and total production of marine fish.

The increasing of efficiency

For sea bream and sea bass hatcheries, the possibility of working with other species that can be reared in different seasons and with similar technology (e.g. new sparids) may mean a more efficient way of using resources. The new offer of fry of species with similar rearing requirements may likewise contribute to the reduction in existing seasonally in sea bream and sea bass production.

As regards Mediterranean aquaculture, the past dependence on wild seed for sea bass and sea bream is almost over. In most countries industrial hatcheries (with production of over 2 million fry per year) have been built, and with emerging models using large volume tanks as suitable technological choices for enterprises requiring lower levels of production. Thus, nowadays more than 300 million fry of sea bass and sea bream are produced in about 90 hatcheries (Table 7). The technologies developed for these hatcheries are applicable, with adaptations, to several of the species being tested in the process of diversification, mainly sparids.

Constraints

A fundamental constraint to the diversification of species is the limited market scale of the species involved and that they will tend to occupy similar market niches to the species, which are already produced, and that substantial changes will further congest an already crowded market. In addition the time and cost required to bring new species into effective production is likely to enjoy a honeymoon period when initial prices, at least, will remain high (Muir, 1996).

Table 7. Sea bream and sea bass fry production (in million fry) in Mediterranean countries, in year 1997

Country	No. hatcheries	Sea bream	Sea bass	Total country
Croatia	2	3	3	6
Cyprus	3	10	1	11
France	11	16	11	27
Greece	25	60	40	100
Israel	2	5	0	5
Italy	20	28	28	56
Malta	1	1	0	1
Morocco	1	3	6	9
Portugal	3	4	4	8
Spain	8	41	6	47
Tunisia	2	1	4	5
Turkey	14	3	45	48
Total	*92*	*175*	*148*	*323*

Source No. Hatcheries: Paquotte (IFREMER, personal communication)
Source fry production: FEAP, except Malta (Agius, 1998) and Cyprus (Stephanou, 1998)

As said above most of the species cultured in the Mediterranean area are also supplied through capture fisheries. Both fish supplied by capture fisheries and fish supplied through aquaculture enter the same or similar markets (mainly as whole fresh fish), which is important for price formation. In the Mediterranean the retail price of sea bass and sea bream are no doubt lower and have been lower for a few years, than what it would have been in the absence of aquaculture production. Those who plan the culture of new -although endemic- species, should take these aspects under careful consideration. The smaller (in terms of volume) the original market for the fish, the lower the retail price levels will be for these new aquaculture products (Pedini, 1996). All of this emphasises the importance of market studies and promotion in order to avoid a drop in prices, particularly when starting commercial production, where production costs are normally high. For sparids, where at the beginning of production and commercialisation the new species, e.g. *Puntazzo puntazzo*, could fetch prices in the market-place similar to or lower than sea bream, but with higher production costs.

At the present time, the market for fresh fish is characterised in southern European countries by a large number of species. There is a connoisseur's market of consumers who are looking for specific species, as well as for a wide range of species available on the stall (Paquotte, 1998). Connoisseurs are very demanding consumers, and tend to require fish with exactly the same characteristics as the wild product, which is not easy to deliver. That is why it seems more necessary to achieve differentiated products. However, in the case of sea bream, in some Mediterranean markets, there is a possible level of replacement between this species and other sparids with similar characteristics (mainly colour).

Potential Mediterranean species for intensive marine fish farming: Constraints and advantages

Recent years have seen a significant increase in the number of studies and publications related to the cultivation of new species and today there are more than 20 fish species being studied throughout the Mediterranean (Barbato and Corbari, 1995; Kentouri *et al.*, 1995; Lensi, 1995). Among all the alternatives of diversification, those related with high growth, medium-high priced fish (*e.g. Thunnus tynnus, Coryphaena hippurus, Seriola dumerilli*) and with lower growth, better priced fish (*Pagrus pagrus, Dentex dentex, Puntazzo puntazzo, Solea* sp., *Epinephelus* sp.), are further discussed. Some of the new species, mainly sparids, are nearing production on a commercial scale, e.g. *Puntazzo puntazzo*, while others still need more research work, e.g. *Seriola dumerilii*.

Within all candidates, those different from sparids (e.g. Groupers, Seriola, Flatfishes, etc.) offer very interesting opportunities from the marketing point of view. They are well differentiated products, with a potential high unit price. However, the research needed for the optimisation of their culture may be time consuming (long term) and may involve substantial risk of cost and technical development.

Sparids can be found within the group of high-priced species and average growth. Possible drawbacks of these species are that they are all similar to sea bream; this presenting possible competition from the previous species unless clear market and promotion strategies are followed (Table 8). The companies offering a range of sparids could obtain an added value for their products, as they can offer a higher number of species than their competitors. On the other hand, as they are similar species, the advantage is that many of the production techniques and culture knowledge aspects on reproduction, larva rearing, on-growing, etc., may, in principle, with the necessary modifications be applied to theses species. The former makes research and development on these species easily affordable by private companies.

Stages for technical and production development of new species

As with the sea bream and sea bass during the seventies and eighties, at present, the main limiting factor for the introduction of new fish cultivation is the lack of biological knowledge. Therefore, for most of the new species, there are problems to control the production cycle particularly, at the larva rearing stage, or reproduction control. However, it is important to consider that when selecting and developing the culture of a new species, it is necessary to likewise consider technical, economic and market parameters, which could make the rearing of the species in question not only technologically feasible but profitable.

The process for potential development of aquaculture species includes different steps which have been described by different authors. Thus, Tarifeño *et al.* (1996) described five phases: (i) preliminary search for potential species based upon their life cycle, general ecology, potential market demands and profit; (ii) scientific and technical studies on reproduction, growth rates, feeding requirements and pathologies under laboratory conditions; (iii) studies at pilot scale on the production process; (iv) commercial trials to predict market demands; and (v) technological transference of the best production processes.

Table 8. Constraints and advantages of potential species for Mediterranean aquaculture

Constraints	Advantages
Same species groups Aiming for similarities in production systems and operational requirements (e.g. Sparids: *Dentex dentex, Pargus pargus, Puntazzo puntazzo, Diplodus sargus, Pagellus bogaraveo*, etc.)	
• Limited market scale of the species involved	• Research is cheaper and progresses more quickly since similar techniques and production systems can be applied or developed, easily undertaken (not all aspects) by private sector
• Possible competition with species already produced facing market problems	• May offer increasing year-round availability of similar products (species) • May become added-value
• Need for market research, economic feasibility studies and promotion	• Increases operation times of marine hatcheries (lowering cost)
Different species groups (e.g. Groupers, Seriola, Flatfishes, etc.)	
• This research may be time consuming (long term) and may involve substantial risk of cost and technical development. • Needs also market research, economic feasibility studies and promotion	• Offer of a well differentiated product with a potential high unit price

In this study we divided the development process of the cultivation of a species into three well-differentiated stages: (i) an initial species selection; (ii) a research and development stage; and (iii) a pilot and commercial stage. Table 9 outlines these typical stages for the development of the culture of a new species. It is pointed out that these times are shortening to some extent, as knowledge can be transferred from one species to another in different fundamental issues such as reproductive, behavioural, physiology, feed formulation and system design. Anyway, there are still sizeable periods between initial stages and the development of a distinctive and a sustainable production sector. Clearly the process is not cumulative, as many stages may have already been covered and/or can be developed in parallel. However, it is common for many marine species to require some 5-10 years of focused development before a significant sector can emerge (Muir, 1996). Not all phases described in the Research and Development section should be completed for the culture of a species to be profitable. For example, in the case of species with a high market value, they can be on-grown from wild fry, without having to keep strict control of aspects such as feeding or reproduction (e.g. seriola or tuna). Aspects which can affect the speed and scale of development of the production of new species are: the price of the species in question, the intensity of research, the development of the sector in a given country, and the extent to which they may be complementary in terms of efficiency of resource use and combining already existing technology and resources (Sutherland, 1997).

Initial species selection

There must be a multidisciplinary approach in the selection of species and therefore the species introduced have to be selected under economic and biological limitations. Preliminary market and economic analyses to assess prices (present and its possible evolution), demand, economic analysis

to assess the demand, commercial value (present price, price evolution) and the existing and potential markets, etc. should precede the selection of new species. The biological limitations concern the rearing of the species: reproduction, growth, easy culture adaptation, endemic species, etc. should be then investigated. Furthermore, with the idea of maintaining a good image of aquaculture products, it is important to bear in mind that new species to be cultured should conserve the same characteristics as they have in the wild.

Table 9. Stages for technical and production development of new species (modified from Muir, 1996)

Initial species selection	Research stage	Pilot & Commercial stage
• *Market research* Prices, size, species image, market distribution (international or locally known), fisheries production, potential demand for the product, etc. • *Biological characteristics* growth rate, size, fecundity, mortality, age at maturation, etc. • *Habitat characteristics* (autochthonous, depth, temp, oxygen, etc.),	*Some fundamental research topics* • Management of breeders for the continued obtention of viable spawn and quality • Larval and post-larval management • Definition of the feeding sequence for larva culture • Establishment of optimum environmental factors (temperature, photoperiod, light intensity, etc.). • Establishment of weaning technique. • Determination of nutritional needs in pre-ongrowing and ongrowing. • Determination of optimum environmental conditions (temp., oxygen, light, etc.) • Determination of stocking densities, etc.	• *Pilot feasibility studies* - Estimation of operating production cost (in relation to fry supply, survival rates, feed conversion and feed cost, stocking rates, etc.) - Expected market prices • *Risk assessment* • *Market research and promotion*

Later, the biological characteristics that could have an influence in the culture should be investigated. Supply of juveniles and/or broodstock, speed of growth, size, fecundity, viability of the larva culture and mass production of juveniles, efficiency of feed conversion, resistance to disease and stress, mortality, age at maturation, etc.

As for environmental or habitat characteristics of the potential species to be selected and in order to minimise adverse environmental impacts and to protect aquatic biological diversity, these should be local species, avoiding the temptation to introduce exotic species (Bartley, 1993, 1998). Likewise, the species to be selected should be adapted to sites that will potentially be used for their cultivation, and therefore the oxygen, temperature and habitat depth requirements should be studied (Lejarcegui, 1997).

At this initial stage, research must be conducted on a large number of species as regards the biological parameters applicable to the culture with the purpose of facilitating the selection process and determining that the species need more concrete studies and research before beginning studies on a pilot scale. This first "screening" is normally carried out by public institutions and focus on "Experimental rearing of wild stocks, adaptation to captivity, and defining life-cycle features".

Concerning the private businesses, the main criteria to follow when selecting a marine species to cultivate, is directed towards the possibility of being able to conduct pilot trials and taking into account the following points:

(i) Economic and commercial interest (market).
(ii) Degree achieved in culture technology of the species in question.
(iii) Degree achieved in culture technology of the similar species and larva or fry culture.

Finally, it is appropriate to repeat the selection process and/or evaluation of potential species besides being a multidisciplinary process in which biological, technical, economic criteria etc. is a continuous process in which it is necessary to update knowledge on different criteria to be considered. For example at a given moment of time, a species could be ruled out since it may have a very low market value which would make it commercially unviable however this value could increase in the future, thus justifying an investment in this species. Another case could be that of a lack of biological knowledge on reproduction or nutrition for example for a given species. Years later, more information could be available, as knowledge can be transferred from one species to another. For example, initially, many of the growth curves come from studies of maritime ecology with populations of wild fish. These curves can vary significantly with fish in culture conditions that have already been selected with better diets. The same thing could occur with the rates of fecundity and survival.

Research stage

Like sea bass and sea bream during 70s and 80s, the limiting factor for the successful introduction and culture development of new aquaculture species is the lack of biological knowledge for the control of the whole production cycle, especially in the field of reproduction control and the larvae rearing. However the information, as well as other biological data on the culture of new species of interest for the Mediterranean aquaculture has been increasing at a fast rate during the last years. Recently different meetings have been organised in order to revise and discuss the progress on the knowledge on new species of interest for Mediterranean aquaculture, such as the TECAM Workshop on Marine Aquaculture Finfish Species Diversification held in Nicosia (Cyprus) from 14 to 17 June 1995, and the International Symposium on New Species for Mediterranean Aquaculture held in Alghero (Italy) from 22 to 24 April 1998.

A peculiar characteristic of the research on new species in Mediterranean countries, e.g. Italy and Greece, is that a lot of the research is done by and in commercial plants. This is due mainly to the lack of facilities in many research centres. Thus, many public institutes or university groups concentrate their research efforts in basic aspects of biology, e.g. reproductive biology, histology, nutritional requirements, etc., whereas research carried out in private plants or applied research stations tends to be more applied, e.g. determination of optimum culture conditions, feeding, etc.

Once a species has been selected, it becomes necessary to widen existing knowledge on the biological parameters as well as the culture technology necessary for the total control of production. Normally the main objectives fixed are:

(i) Reproduction control and management of broodstock for the continued obtention of viable and quality spawn.
(ii) Management of larvae and postlarvae.
(iii) Definition of feeding sequence for larva culture.
(iv) Establishment of optimum environmental factors (environment, photoperiod, light intensity etc.).
(v) Establishment of weaning techniques.
(vi) Determination of nutritional requirements in pre-ongrowing and ongrowing.
(vii) Determination of optimum environmental conditions (temperature, oxygen, light, etc.).
(viii) Determination of stocking densities.

Pilot and commercial trials

As mentioned previously, before carrying out pilot trials, the following points must be considered: (i) economic and commercial interest (price, etc.); (ii) the degree reached in culture technology of the species in question; and (iii) the degree of achievement of the culture technology of similar species, and of the production of larvae or fry pilot studies are concentrated on the opitmization of the production cycle, whereas the commercial trials seek to predict market demands.

The assessment of the production cost of the ongrowing of a certain species is not only based on the calculation of operation costs from own trials, but also in the assumption of certain operating costs estimated from already commercially cultured species or other production systems, as the most effective method of production is also pursued.

These trials aim to identify the estimated cost structure for the on-growing of a new species. The possibility that potential species showing good biological performance for aquaculture may not have all the requirements for commercial production, emphasises the importance of these studies. Thus, important technical parameters are: survival rates; feed conversion, growth rates and stocking density rates. This information will allow the calculation and evaluation of economic parameters, such as the maximum price which the on-grower can pay for juveniles, maximum allowed mortality rates, feeding cost and labour and management costs, health management costs, etc. As regards the revenues, different options -more or less conservative- have to be considered for the species market prices, which will then allow the calculation of profits and margins. The investment and capital requirements for hypothetical on-growing units with specific production systems should be also assessed.

Some requirements in pilot trials -before a commercial production can start- are: a successful early rearing, acceptable survival levels, an acceptable ongrowing performance, the assurance of sufficient quantities of juveniles for initial production, etc. Many of these aspects have been described by Muir (1996).

A fundamental constraint for the carrying out of pilot and commercial trials is the availability of a sufficient number of juveniles. This availability should be ensured before the commercial production of a species can start, and should be ensured not only in number but also in quality. In this sense, most efforts should be put into the establishment of a high quality broodstock and in the development of an efficient hatchery system. Thus, although semi-intensive hatchery systems seems not to be the ideal system for commercial operation, they may be a viable system providing enough quantity of quality juveniles for initial commercial production, before an intensive hatchery system is achieved, and hatchery management more controlled.

When establishing a broodstock population, special care should be taken in proper broodstock selection. Care will need to be taken to ensure adequate levels of genetic diversity in farmed strains in order to avoid future inbreeding problems (Bartley, 1998). Reference points can be established as a precaution against the loss of genetic diversity in farmed stock. Moreover, an appropriate selection of broodstocks will be the basis of a future breeding programme.

In initial commercial trials, emphasis should be also placed on market research and promotion. New species have been defined as "imitative" products since they are known by the consumer but new for the firm producing it (Mason *et al.*, 1998). As said above, most of the species cultured in the Mediterranean area are also supplied through capture fisheries and the analysis of the catches shows a decrease for most surveyed Mediterranean species with a considerably yearly variability. Thus, those planning the culture of new species should consider these aspects, which is important for the formation of price. Mason *et al.* (1998) suggested that the market for these new products is potentially lively, and that their prices should decrease with the growth of supply without a loss of profit for fish farmers due to the potential expansion of the demand. However, at the present stage of development there already exist some examples of difficulties in the introduction of new species, which either are not well accepted by the consumer or have some low prices in the market. Thus, the production of *Pagrus major* in Cyprus has been stopped not only because it is a non endemic species but also because of its bad acceptance in the market, mainly due to body colour (Stephanou, personal communication). Some Mediterranean companies which started pilot trials and commercial production of *Puntazzo puntazzo* also stopped this production because the market prices obtained could not justify production costs.

Pilot and initial commercial trials should also assess the potential risks and uncertainties existing in the whole production cycle, such as in the regular provision on juveniles or in the control of mortalities through the larval culture and weaning. This will help in overcoming the identification of problems before a new species can be seen as a viable alternative of production. Moreover, pilot and commercial trials should also aim to identify primary topics for research. This research will normally look for applied aspects, such as developing a basic compound feed, management of broodstock (spawning control, etc.), without forgetting basic aspects.

References

Agius, C. (1998). Strategies for Aquaculture Development in a Small Mediterranean Island State: Malta. Proceedings of the SELAM Workshop on Aquaculture Planning in Mediterranean Countries,

Tanger (Morocco), 12-14 March 1998. *Options Méditerranéennes, Série Cahiers* (under preparation).

Bakela, Z. and Paquotte, P. (1996). Mediterranean Marine Aquaculture Sector. Present State of Development and Perspectives on Cooperation. In *Proceedings of the VIII Annual Conference of the European Association of Fisheries Economist,* Barcelona (Spain), 13 April 1996. Ministerio de Agricultura Pesca y Alimentación, Madrid, pp. 45-66.

Barbato, F. and Corbari, L. (1995) New species in Italy. Proceedings of the Seminar of the SELAM Network of the CIHEAM, Montpellier (France), 17-19 May 1995. *Options Méditerranéennes, Série Cahiers*, Vol. 14. CIHEAM/MEDRAP II (FAO/UNDP)/IFREMER, Zaragoza, pp. 123-128.

Bardach, J.E., Rythe, J.H. and MacLarney, W.O. (1972). *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organism*. John Wiley & Sons Inc., New York, London.

Bartley, D.M. (1993). Utilization and conservation of aquatic genetic resources - Developing guidelines. *The FAO Aquaculture Newsletter*, 4: 10-14.

Bartley, D.M. (1998). A precautionary approach for the introduction of new species in aquaculture. In *33rd International Symposium on New Species for Mediterranean Aquaculture,* Alghero (Italy), 22-24 April, 1998. (Book of abstracts).

Cataudella, S. (1996). *Description of main Mediterranean aquaculture systems*. Notes from the TECAM Advanced course on Food and Feeding of Farmed Fish and Shrimp, Alexandria (Egypt), 27 April - 8 May 1996. CIHEAM, FAO, NIOF and University of Alexandria.

FAO (1997). *Review of the state of world aquaculture,* FAO Fisheries Circular, No. 886, FIRI/C886, Rev.1. FAO, Rome.

Iandoli, C. (1997). Status of Aquaculture in Italy. Notes from the *2nd Meeting of the Aquaculture Observatory for the Mediterranean,* ICRAM, Bari (Italy), 5-6 March 1997.

Kentouri, M., Papandroulakis, N. and Divanach, P. (1995). Specific diversification in Greek finfish mariculture. In Aquaculture Production Economics, Proceedings of the Seminar of the SELAM Network of the CIHEAM, Montpellier (France), 17-19 May 1995. *Options Méditerranéennes, Série Cahiers*, Vol. 14. CIHEAM/MEDRAP II (FAO/UNDP)/IFREMER, Zaragoza, pp. 129-136.

Lejarcegui Maestro, J.A. (1997). La base animal en acuicultura continental. In *Producción Animal Acuatica. Tomo XII. Zootécnia. Bases de Producción Animal*. Ediciones Mundi Prensa, Madrid, pp. 51-71.

Lensi, P. (1995). La politique de diversification de l'aquaculture en Corse. La demarche "nouvelles espèces". Proceedings of the Seminar of the SELAM Network of the CIHEAM, Montpellier (France), 17-19 May 1995. *Options Méditerranéennes, Série Cahiers*, Vol. 14. CIHEAM/MEDRAPII (FAO/UNDP)/IFREMER, Zaragoza, pp. 137-148.

Mason, M., Prestamburgo, S. and Zolin, B.M. (1998). Marketing strategies for the development of new Mediterranean sea species. In *33rd International Symposium on New Species for Mediterranean Aquaculture*. Alghero (Italy), 22-24 April 1998. (Book of abstracts).

Muir, J. (1996). Mediterranean Aquaculture: crisis or challenge? In *Proceedings of the VIII Annual Conference of the European Association of Fisheries Economist,* Barcelona (Spain), 13 April 1996. Ministerio de Agricultura Pesca y Alimentación, Madrid, pp. 31-43.

Pedini, M. (1996). Aquaculture in GFCM countries: Its evolution from 1984 to 1994. *The FAO Aquaculture Newsletter*, 14: 18-24

Paquotte, P., Bakela, Z., Franquesa, R. and Basurco, B. (1996). Economic aspects of Mediterranean aquaculture production. *MEDIT*, 3/96: 4-13.

Paquotte, P. (1998). New species for Mediterranean aquaculture: It is an answer to the market demand for differentiated products? In *33rd International Symposium on New Species for Mediterranean Aquaculture*. Alghero (Italy), 22-24 April 1998. (Book of abstracts).

Rana, K. (1997). Recent trends in global aquaculture production: 1984-1995. *The FAO Aquaculture Newsletter*, 16: 18-24.

Stephanis, J. (1996). Mediterranean aquaculture industry trens in production, markets and marketing. In Marketing of Aquaculture Products, Proceedings of the Seminar of the SELAM Network of the CIHEAM, Thessaloniki (Greece), 11-13 October 1995. *Options Méditerranéennes, Série Cahiers*, Vol. 17. CIHEAM/IMBC, Zaragoza, pp. 93-102.

Stephanou, D. (1998). The experience of offshore fish farming in Cyprus. In Mediterranean Offshore Mariculture. *Options Méditerranéennes, Série Cahiers* (under preparation).

Sutherland, R. (1997). Review of the economics of potential systems for farmed production of Atlantic halibut. *Aquaculture Europe*, 21(4): 6-11.

Tarifeño, E., Chong, J., Troncoso, L., Gonzalez, P. and Castro, J. (1996). The flatfishes, *Paralichthys microps* (Gunter, 1981) and *Paralichthys adspersus* (Steindachner, 1867), potential species for intensive fish culture in Chile. In *Improvement of the Commercial Production of Marine Aquaculture Species. Proceedings of a Workshop on Fish and Mollusc Larviculture*. Gajardo, G. and Coutteau, P. (eds). Impresora Creces, Santiago, Chile, pp. 85-95.

TECAM survey on Mediterranean marine fish farming diversification

Introduction

Although there is still a significant lack of biological knowledge for the control of the whole production cycle of new Mediterranean marine finfish species, information on the culture of new species has fast been increasing over recent years. Besides scientific papers in different aquaculture journals and proceedings of aquaculture meetings, recently, several thematic meetings have been organized in order to revise and discuss the progress on the knowledge of potential new species of interest for Mediterranean aquaculture. Among them, the TECAM Workshop on Marine Aquaculture Finfish Species Diversification held in Nicosia (Cyprus), from 14 to 17 June 1995, and the International Symposium on New Species for Mediterranean Aquaculture held in Alghero (Italy) from 22 to 24 April 1998.

During the TECAM Workshop held in Nicosia, Cyprus, it became evident that there is an overlapping of research activities on finfish diversification in several Mediterranean countries and private and public research institutes/companies. This is a problem to be avoided and can be solved by a better cooperation and communication between researchers. For this purpose, the Network on Technology of Aquaculture in the Mediterranean (TECAM), which is coordinated by the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) through the Mediterranean Agronomic Institute of Zaragoza (IAMZ), following the recommendations of the above mentioned workshop, launched a Mediterranean survey on finfish diversification. The results of this survey, which are presented herewith, are expected to facilitate a deeper insight into the main and most common constraints found in this research field, as well as to facilitate the establishment of collaborative research groups on New Mediterranean Aquaculture Finfish Species.

Survey implementation

Following the recommendations made during the TECAM Workshop held in Cyprus, an ad hoc group meeting [M.T. Dinis (University of Algarve, Portugal), G. Marino (ICRAM Rome, Italy), P. Pousao-Ferreira (IPIMAR/CIMSUL Olhao, Portugal)] took place at the end of the Workshop in order to work on the design of the survey. The draft elaborated there was later revised [I. Arnal (IEO, Madrid, Spain), G. Marino] and improved. Annex I presents the Questionnaire distributed for the survey study. Once the questionnaire was elaborated this was submitted to more than 55 persons belonging to research and development institutions and firms from 16 different Mediterranean countries. The addresses used for the survey distribution were identified and selected at the Workshop held in Nicosia, and also through some TECAM participants and other contacts from several Mediterranean countries. Thirty-two replies to the survey have been received (59% of the total number sent), from 13 countries. Some answers are concerned with species which are not contemplated in the survey, such as Tilapia (from Egypt and Turkey), and therefore they have not been included in this analysis.

An initial analysis of the survey took place at the TECAM Working Group Meeting held in Crete, Greece, on 8 and 9 July 1996. Following this meeting the survey was revised and updated, and additional replies have been incorporated into this study. As a result more than forty firms and research groups working with new Mediterranean finfish species or with previous experience have been identified.

The analysis of the survey replies is presented in the following two chapters.

The first chapter, "Summary Table of Aquaculture Knowledge of New Mediterranean Marine Finfish Species", aims to summarize the knowledge status and main constraints of the finfish species identified during this survey. Species have been classified by families, and within families according to their Latin names.

The second chapter, "Survey Results Classified by Family and Species", brings together all information received for each species. This chapter commences with a table of keys for the

interpretation of survey replies, which the reader can use when consulting the tables that follow each species description. E. Abellan has elaborated the species description based on the survey replies. Each species description contains:

(i) Names in Latin, English, French, Italian, Portuguese and Spanish.
(ii) A drawing of the species.
(iii) A written summary of biological and habitat characteristics.
(iv) A brief description of the current situation of the culture, including the names of the groups working on it.
(v) A table which compiles all the replies per species.

With the purpose of ensuring the confidentiality of the groups that have replied to the survey, the names of the group have been eliminated from the table of the individual replies and thus no individual details from the survey are released. The group name, when mentioned in the chapter as working in a given species, is included with the sole purpose of facilitating contacts.

It should be mentioned that during this survey, information was compiled for two alochthonous species: *Pagrus major* and *Paralichthys olivaceus.* These two species, which are already under culture in other countries (e.g. Japan), have been included in this survey study as some groups are working or have worked on them. They could be potential species for culture in the Mediterranean, or may simply be used as technical reference examples for the optimization of the culture of related local species. *Pagrus major* has also been left in as some commercial trials have been conducted with this sparid.

Another non-Mediterranean sparid, *Acanthopagrus bifasciatus*, has been included in this study. This species found in the Red Sea is studied locally in Eilat, Israel.

It is also highlighted that although some answers have been received for mullets, these have not been included in this document so as not to present an incomplete analysis of the situation. This is because this species is traditionally produced semi-intensively and therefore there is a possible gap in information as a new species may not have been considered when completing questionnaires.

Some tuna species are known to have been under research for the last two or three years in several Mediterranean countries, e.g. Spain and Morocco, but they have not been included in the present survey which was distributed in 1996.

Following these two chapters analysing the survey results, three annexes are included. Annex I presents the questionnaire used for the survey distribution. Annex II compiles information about different Mediterranean institutions, firms, experts and their related working topics on finfish diversification. Annex III is a Directory of Mediterranean institutions and firms working on finfish diversification identified during this survey.

The following section gives some general considerations and briefly explains some of the main constraints related to most species detected through the survey.

General considerations

The fact that fifteen of the addresses in the survey correspond to private firms (34%) emphasizes the importance that the sector is giving to species diversification as a production strategy for Mediterranean marine aquaculture development. As regards private firms, the degree of culture technology achieved in sea bream and sea bass production techniques, and its possible application to other similar species and larva or fry culture, has made the diversification option an easier strategy for the Mediterranean marine sector to undertake in comparison with that of salmon, whose culture technology cannot be transferred to other cold marine water species.

Endowed with this knowledge, Mediterranean marine hatcheries have a great potential for applied research work on the development of culture techniques of new finfish marine candidates. Moreover, this is an excellent opportunity for firms and public research groups to collaborate with each other. Both can thus interact, giving public institutions the possibility to work, not only in applied R&D, but

also to concentrate on more fundamental and basic aspects, such as in reproduction biology, nutritional requirements, etc.

An important observation is that, in most of the studies conducted, there was a general lack of market research studies, which are of utmost importance during the initial process of screening and selection of potential species. It is important to point out that this initial screening and selection process is carried out by both private firms and public institutions without apparent coordination, with few exceptions.

From the survey we have observed how many businesses or research groups either conduct or have conducted studies on a wide range of species (5 to 10). This means that in principle it is easy to relate a particular group with a certain species, however, in fact, this group may have dropped such species from their research in order to concentrate on just a few.

Concerning the main constraints detected on the broodstocks, we can clearly differentiate two groups of species: sparids and others. Thus, for sparids most of the problems are related with broodstock management and with optimal and controlled reproduction (e.g. regular spawnings). As for other species (seriola, groupers, etc.) common constraints lie in the difficulty in obtaining fish for the formation of broodstock, the lack of maturation under culture conditions and controlled reproduction. Despite hardly being mentioned during this survey, the importance of taking genetic/breeding criteria for broodstock formation is underlined. Comparative performance studies of different populations should thus be considered.

In larvae culture, many problems appear to be related with nutritional requirements or various aspects of management, such as water quality, thus making larvae of potential species more sensitive to diseases (cannibalism, pathogens, heavy metals, etc.), or resulting in low quality larvae. Some differences with the culture technology/procedures used for sea bass and sea bream have been observed. While larvae-intensive systems have not yet been developed, some groups are using semi-intensive larvae systems (mesocosm) to overcome problems during this phase. During weaning most of the problems found during the larvae stage reappear and most efforts are made towards achieving better survival percentages. A particular case is that of sole, for which reproduction and larval rearing has been managed successfully, but its growout, starting during the weaning stage, presents problems mainly relating to nutrition and husbandry techniques.

As regards ongrowing, experimental, pilot and small commercial trials are carried out both in tank and cage conditions, either from wild juveniles or individuals from controlled reproduction. Most problems deal with appropriate rearing techniques (optimal densities, feeding regimes, etc.). It is also important to determine the nutritional requirements and the pathological problems.

References

Names

The word list of Latin, English, French, Italian, Portuguese and Spanish names, with a few exceptions, comes from the "*Multilingual Illustrated Dictionary of Aquatic Animals and Plants*". Fishing News Books. Office for Official Publications of the European Communities. Brussels, Luxembourg, 1993. 518 pp.

Biological and habitat characteristics

The different sources used for the biological and habitat characteristics are listed below:

Bauchot, M.L. and Pras, A. (1987). *Guía de los peces de mar de España y Europa*. Ed. Omega, Barcelona.

Fischer, W., Schneider, M. and Bauchot, M.L. (1987). *Fiches FAO d'identification des especes pour les besoins de la peche. Mediterranée et Mer Noire. Zone de Pêche 37*. FAO/CEE, Rome. Vol. II: 761-1530.

Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J. and Tortonese, E. (eds) (1986). Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol II: 517-1007.

Drawings

The fish drawings included in this publication, have been kindly provided by the Food and Agriculture Organization of the United Nations: "FAO Identification Programme of Species".

Summary table of aquaculture knowledge of new Mediterranean marine finfish species

Summary table. Aquaculture knowledge of new Mediterranean marine finfish species

Family	Species	Reproduction		Larval culture		Ongrowing	
		Knowledge status†	Main constraints	Knowledge status†	Main constrains	Knowledge status†	Main constraints
Balistidae	*Balistes carolinensis*	-	Suitable techniques	-	NS	-	Type of diet Suitable techniques
Carangidae	*Seriola dumerili*	-	Spawning failure Sexual maturity in captivity	-		+ [+/-]	Nutritional requirements Type of diet Pathology
Coryphaenidae	*Coryphaena hippurus*	+/-	Broodstock management	-	Nutritional requirements Low survival Low growth	+/-	Low survival Type of diet Pathology
Mullidae	*Mullus surmalletus*	+/-	Broodstock management Nutritional requirements	-	Nutritional requirements Feeding sequence Low survival	-	NS
Sciaenidae	*Scianea umbra*	+	Spawning control	+/-	Nutritional requirements Feeding sequence	+/-	Nutritional requirements Type of diet Low growth
	Umbrina cirrosa	+/-	Broodstock availability Spawning control Nutritional requirements	+/-	Nutritional requirements Pathology Low survival	+/-	Type of diet Nutritional requirements Pathology
Serranidae	*Epinephelus aeneus*	-	Sexual maturity in captivity Nutritional requirements	-	Scarce data Cannibalism	-	Suitable techniques
	Epinephelus alexandrinus	-	Spawning control	NS		NS	
	Epinephelus marginatus	-	Broodstock availability Broodstock management Sexual maturation in captivity	-	Scarce data	-	Nutritional requirements Type of diet Low growth
	Polyprion americanus	NS		NS		-	Suitable techniques
Siganidae	*Siganus rivulatus*	+/-	Broodstock availability Spawning control & management	+/-	Suitable techniques Nutritional requirements Appropriate live food	+/-	Suitable technics Nutritional requirements Type of diet

Summary table (cont.). Aquaculture knowledge of new Mediterranean marine finfish species

Family	Species	Reproduction		Larval culture		Ongrowing	
		Knowledge status†	Main constraints	Knowledge status†	Main constrains	Knowledge status†	Main constraints
Soleidae	*Solea senegalensis*	+/-	Broodstock management Spawning control Nutritional requirements	+/-	Suitable techniques Inert food Feeding sequence	+/-	Nutritional requirements
	Solea vulgaris	+/-	Spawning control	+/-	Nutritional require. Pathology	-	Suitable techniques Nutritional requirements Low survival
Sparidae	*Acanthpagrus pifasciatus*	+/-	Nutritional requirements Feeding regime	+/-	Nutritional requirements Feeding regime	+/-	Low growth
	Dentex dentex	+/-	Spawning control Nutritional requirements Feeding regime	+/-	Nutritional requirements Low survival & quality Cannibalism	+/-	Nutritional requirements Type of diet Pathology
	Diplodus puntazzo	+/-	Spawning control Sexual maturity in captivity Nutritional requirements	+/-	Suitable techniques Nutritional requirements Low survival & quality	+/-	Nutritional requirements Pathology Low growth
	Diplodus sargus	+/-	Spawning control Nutritional requirements Feeding regime	+/-	Nutritional requirements Low survival Suitable techniques	+/-	Low growth Nutritional requirements
	Diplodus vulgaris	+	Spawning control	NS		+/-	Low growth
	Lithoghnathus mormyrus	+/-	Broddstock availability Maturation control	+/-	Suitable techniques	+/-	Suitable techniques Type of diet Nutritional requirements
	Pagellus acarne	-	Broodstock management Spawning & maturation control Feeding regime	-	Scarce data Suitable techniques	-	Suitable techniques Low growth Type of diet
	Pagellus bogaraveo	+/-	Broodstock availability Maturation control	+/-	Suitable techniques	+/-	Suitable techniques Type of diet Nutritional requirements

Summary table (cont.). Aquaculture knowledge of new Mediterranean marine finfish species

Family	Species	Reproduction		Larval culture		Ongrowing	
		Knowledge status†	Main constraints	Knowledge status†	Main constrains	Knowledge status†	Main constraints
Sparidae (cont.)	*Pagellus erythrinus*	+/-	Spawning control Feeding regime	-	Scarce data Larval quality Feeding sequence	-	Suitable techniques
	Pagrus major	+		+/-	Suitable techniques Cannibalism Feeding sequence	+/-	Nutritional requirements Cannibalism Pathology
	Pagrus pagrus	+/-	Broodstock availability Spawning control Nutritional requirements	+/-	Suitable techniques Nutritional requirements Low survival	+/-	Suitable techniques Nutritional requirements HighFCR
	Spondyliosoma cantharus						

†See complementary table below
NS: Not studied

Knowledge status criteria

Mark	Reproduction	Larval culture	Ongrowing
+	Control on maturation and spawning	Repeatible and acceptable survival	High growth, survival and FCR
+/-	No control on spawning	Low and/or variable survival	One of previous conditions fails
-	No spawning	Very low (or no) survival	2/3 of previous conditions fail

Survey results classified by family and species

Table of keys for the interpretation of survey replies*

Market knowledge:

Market study (S):
- N = Market study not done
- Y = Market study done

Local market perspectives (L):
- U = Unknown perspectives
- M = Medium perspectives
- G = Good perspectives

Regional market perspectives (R):
- U = Unknown perspectives
- M = Medium perspectives
- G = Good perspectives

Price (P): XXX = 1995 local market price in USD/kg

Broodstock management:

Rearing system (RS):
- C = Cage
- T = Tank
- P = Pond

Fish origin (FO):
- WJ = Wild juveniles
- WA = Wild adult
- RE = Controlled reproduction

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 1 = Breeders availability
- 2 = Broodstock management
- 3 = Sexual maturation in captivity
- 4 = Control of spawning
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 19 = Others

Larvae culture:

Rearing system (RS):
- SV = Small volume total/partial closed system
- SVO = Small volume open system
- LV = Large volume: mesocosm

Knowledge status (KS):
- 0 = No data
- - = Constrainst
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropiate larval rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Live food
- 9 = Inert food
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 14 = Egg quality
- 15 = Larval quality (morphological anomalies)
- 19 = Others

Weaning:

Rearing system (RS):
- SVR = Small volume total/partial recirculation
- SVO = Small volume open system
- LV = Large volume

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropriate rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Type of diet
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 16 = Different growth rate within group of same origin
- 19 = Others

Ongrowing:

Rearing system (RS):
- C = Cage
- T = Tank
- P = Pond

Fish origin (FO):
- WJ = Wild juveniles
- RE = Controlled reproduction

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropiate rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Type of diet
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 16 = Different growth rate within group of same origin
- 17 = Poor feed conversion
- 18 = Precocious sexual maturation
- 19 = Others

Scale of production:

Type:
- ES = Experimental or laboratory scale
- PS = Pilot scale
- SC = Small commercial scale

Tons: XXX = Please, indicate the 1995 / 6 production (tons) at your facilities.

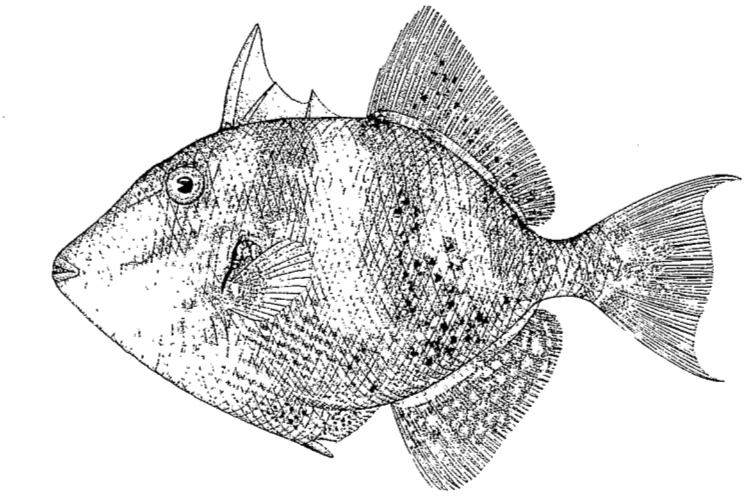
Research:
- NP = National projects
- IP = International project

*The reader will find a copy of this table at the end of the book. Detach this copy for on-hand reference to the compilation tables for each species.

FAMILY BALISTIDAE

Balistes carolinensis (Gemelin, 1789); *Balistes capriscus*

English name(s)	Grey triggerfish; clown triggerfish
French name(s)	Baliste arbalétrier; baliste gris; baliste cabri
Italian name(s)	Pesce balestra
Portuguese name(s)	Cangulo cinzento
Spanish name(s)	Pez ballesta; pejepuerco blanco



Belonging to the balistidae family, this species is characterized by its shape; oval, high-bodied and laterally compressed. Both head and body are covered by a shield of small, thick scales, united but not welded. Colouring is grey with green or yellow reflexions, purplish on the dorsal part. It can reach a maximum size of 45 cm, but average sizes range from 15 to 35 cm.

This species lives on rocky bottoms, in relatively shallow waters between 10 and 100 m deep. It reproduces in the summer and feeds on benthic invertebrates, essentially molluscs and crustaceans.

Its distribution includes the Atlantic, from Angola to the English Channel and the Mediterranean where it is relatively common.

Although there are no market studies on this species, whose perspectives are therefore unknown, this species has low prices referenced in Spain (Mallorca, Spain).

Current situation of the culture: Ongrowing experiments have been started in Spain (Est. Acuicultura Mallorca), in cages, using wild juveniles. A broodstock is kept, originating from adults captured at sea, but larval culture has not been carried out.

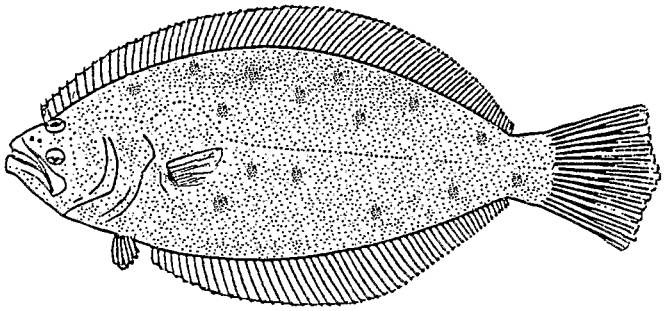
Species: *Balistes carolinensis*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	U	U	4	P, C	WA	-	19							C	WJ	+/-	8, 19	ES		

FAMILY BOTHIDAE

Paralichthys olivaceus (Temmick and Schlegel, 1846)

English name(s)	Olive flounder; bastard halibut
French name(s)	Hirame; cardeau olivâtre
Italian name(s)	Hirame
Portuguese name(s)	Falso alabote japonês; carta-alabote japonesa
Spanish name(s)	Falso halibut del Japón



An alochthonous species belonging to the paralichthydae family. It is a flat fish, dark brown on the left side and white on the right.

This species can reach maximum sizes of 80 cm and 5 kg in weight. Adults live on sandy bottoms at depths between 100 and 200 m. They migrate to shallow zones between 20-40 m deep in the spawning season. The female reaches sexual maturity at 4 years old and the male, at 3 years old. Breeding takes place between February and May south of Japan and between May and July in the North.

This is a very appreciated species in Japanese markets.

Current situation of the culture: This species is under study in Italy (COISPA Bari), where its biological cycle has been successfully closed and good results have been achieved at the different stages of its culture. Research in currently being carried out on nutritional and environmental requirements during larval stages.

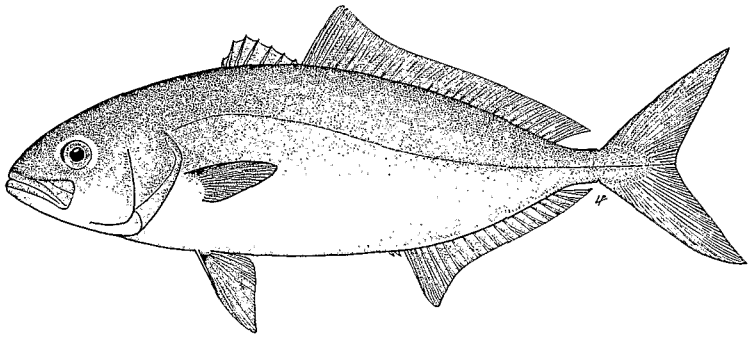
Species: *Paralichthys olivaceus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	U	19	T	RE	++		SVO	+	19	SVO	++		T	RE	++		PS	1	IP

FAMILY CARANGIDAE

Seriola dumerili (Risso, 1810)

English name(s)	Greater amberjack
French name(s)	Seriole; seriole couronne
Italian name(s)	Ricciola
Portuguese name(s)	Charuteiro-catarino
Spanish name(s)	Medregal coronado; seriola mediterránea



This species is found in the Atlantic and is rare at the north of the Bay of Biscay; it is less rare in the Mediterranean. The Mediterranean yellow tail belongs to the Carangidae family. It presents a bluish grey or purplish colour with yellow flanks; the youngest bearing dark vertical stripes. This is a very fast-growing fish reaching large sizes. The average size ranges from 30 to 50 cm with maximum sizes up to 190 cm. It is both epibenthonic and pelagic that lives from 20 to 70 m deep. Reproduction occurs in summer months. It feeds on fish and invertebrates.

It is found either regularly or occasionally in the markets of Mediterranean countries and is marketed fresh, chilled or frozen for prices which fluctuate between 5 and 18 USD/kg, depending on the region and selling season. Only one market study has been conducted, at the University of Palermo. Market perspectives seem to be good both at local (Italy and Spain) and regional levels. Flesh quality is good and other characteristics are potentially acceptable to consumers.

Current situation of the culture: Considerable work has already been carried out on its culture, not only in the Mediterranean area but also in some Asian countries. Experiments on the culture of this species are being conducted in Croatia (IOF Dubrovnik), France (Univ. Montpellier, SCORSA Aleria), Greece (IMBC, Selonda, Nireus), Italy (ENEA Rome, NCR Messina, Univ. Palermo, ICRAM Rome), Malta (NAC) and Spain (IEO Murcia, IEO Tenerife, Est. Acuicultura Mallorca).

At present, production is based on fry collected from the wild, but these are becoming scarce. Nutrition today is mainly based on low-priced fish and partially on moist diets. As regards culture experiments more work must be carried out on reproduction and larval rearing. The situation is the following:

- Reproduction: Breeders are kept in tanks and cages and originate from wild juveniles and adults. The achievement of spawning is the main difficulty in Seriola culture. Thus, although males can reach a certain degree of maturity, female growth ceases before final maturation age (final maturation of oocytes cannot be achieved). Therefore the main objective is to achieve sexual maturation in captivity and control spawning. There are handicaps in the supply of breeders and investigation into nutritional requirements is equally important.

- Larval culture: Due to the lack of successful spawning, only a few experiences on larval culture have taken place (for instance in the NCR Messina and Est. Acuicultura Mallorca). This culture is conducted in small volumes and in open or closed systems. There is no data on the techniques applied or results obtained and it is difficult to get to know the problems involved at this stage of culture.

- Weaning: When this has been effected, it has been done in small volumes in open systems. The

problems are as yet unknown but research could be aimed towards the establishment of an adequate diet-type and towards the solution of pathological problems (Mallorca).

- Ongrowing: It is carried out in cages and tanks, starting from wild juveniles. As regards nutrition, research has been conducted (e.g. IEO Murcia) for testing different diets (raw fish, moist pellets, dry pellets and extruded pellets. Although good initial results have been obtained with dry pellets, it is necessary to optimize the type of diet and feed regime, to establish the nutritional requirements and to solve pathological problems. In pilot scale experiences, they have managed to produce up to 6 tons in the University of Palermo.

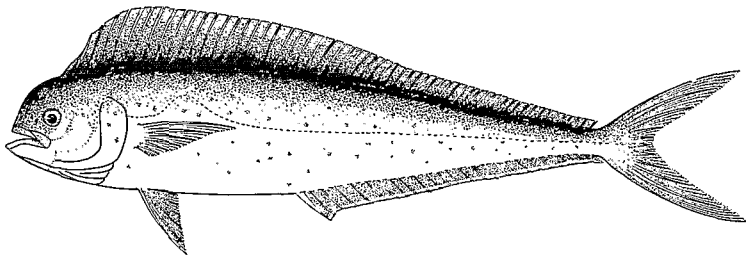
Species: *Seriola dumerili*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	20	C/T	WJ	+/-	3		0			0		C/T	WJ	++		ES		NP
Respondent 2	N	G	G	8	T	WJ	0			0			0				0				
Respondent 3	Y	M	M		C	WA	0	2	SVO	-	5	SVO	0		C	RE	0	5	ES		NP
Respondent 4	N	M	M	7	C/T	WJ	-	3, 6		0			0		C/T	WJ	+/-	6, 7, 8	PS	-	NP
Respondent 5	N	G	G	18	T	WA, WJ	+/-	3		0					T	WJ	0	6, 12	ES		NP
Respondent 6	Y	M	G	16	C	WJ	+	3, 4							C	WJ	++	8	PS	6	NP
Respondent 7	N	G	M	15-18	C/T	WA	+/-	2, 3, 6		0			0		C/T	WJ	+	6, 10	PS	5	NP
Respondent 8	N	G	G		T	WA	-	3, 4													
Respondent 9	N	G	G	10	C/T	WJ	0	3							C/T	WJ	0-	8	PS	3	NP
Respondent 10	N	G	G	5-13	T	WJ, WA	+/-	3, 4, 6		0			0		T	WJ	+/-	6, 8, 10,16	ES, PS		NP, IP
Respondent 11	N	G	G	13	P/C	WA	+/-	3	SV	-	7, 14, 15	SVO	-	8, 10	C	WJ	+	8, 10	SC	2	NP
Respondent 12	N	G	G	7	T	WJ	-	2, 3		0			0								NP

FAMILY CORYPHAENIDAE

Coryphaena hippurus (Linnaeus, 1758)

English name(s)	Dolphinfish; common dolphinfish
French name(s)	*Coryphène; grande coryphène*
Italian name(s)	Lampuga; corifena
Portuguese name(s)	Dorado; sapatorra
Spanish name(s)	Lampuga



Belonging to the coryphaenid family, it has a characteristic turquoise blue colour with yellow spots and vertical strips which are more or less visible. It is a oceanic epipelagic species, with a wide range of distribution in tropical and sub-tropical seas. This fast-growing pelagic fish reaches large sizes: its maximum 200 cm, the average ranging from 50 to 100 cm. Its maximum weight is 50 kg. In the Mediterranean, it is fished occasionally along the whole littoral zone. The spawning season in warm waters coincides with the hottest months.

Its market appreciation is not homogeneous in all Mediterranean countries. It is found regularly in Tunisian markets and occasionally in other Mediterranean markets. It is marketed fresh or chilled, at prices ranging from 3 to 7 USD/kg. No market study has been conducted and the perspectives are considered to be average.

Current situation of the culture: This is a fast-growing species, for which reproduction, larval culture and ongrowing experiences have been conducted in Tunisia (CNA Monastir) and ongrowing trials have been carried out in Malta (NAC) and Spain (Est. Acuicultura Mallorca).

- Reproduction: Reproduction is not as successful in Mediterranean hatcheries as in the USA and other countries. Adults may be difficult to find (e.g. Mallorca). Breeders originate from juveniles captured at sea and are kept in ponds. It is considered necessary to solve broodstock management problems (e.g. cannibalism).

- Larval culture: It is implemented in small volume tanks and in closed system. Techniques are underdeveloped and nutritional requirements must be established as well as measures to prevent cannibalism, improve survival rates and increase growth rates.

- Weaning: It is carried out in small volumes and in closed systems. There is no data available. It is necessary to fix nutritional requirements, formulate a proper diet, solve cannibalism problems and achieve better survival percentages.

- Ongrowing: It has very fast initial growth rates. Handling may result difficult. Mortalities have been observed in winter time when temperatures go down. Ongrowing is successfully conducted in ponds (Tunisia) and not so successfully in cages (Spain) from wild juveniles. It is advisable to formulate an adequate diet, prevent cannibalism, increase survival rates and solve pathological problems.

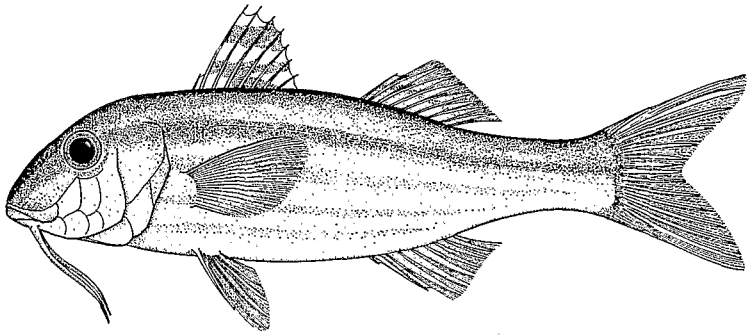
Species: *Coryphaena hippurus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	M	M	3, 5	P	WJ	+/-	2, 19	SV	+/-	6, 11, 12, 13	SV	-	6, 8, 11, 13, 16	P	WJ	+	8, 11, 13	PS	-	IP
Respondent 2	N	M		6-7				1							C	WJ	-	10, 13, 19	ES		
Respondent 3	N	G	U	3	C	WJ	+/-	19							C	WJ	+/-	5	PS	1	

FAMILY MULLIDAE

Mullus surmuletus (Linnaeus, 1758)

English name(s)	Red mullet; surmullet; striped red mullet
French name(s)	Rouget de roche; surmulet; rouget barbet de roche
Italian name(s)	Triglia di scoglio
Portuguese name(s)	*Salmonete legítimo; salmonete vermelho*
Spanish name(s)	Salmonete de roca; salmonete rayado; salmonete de buena casta



This species belongs to the mullidae family. Its body is quite compressed. Colour is reddish and generally a dull red strip runs from the eye to the tail fin above three yellow lines along the flanks. Maximum size is 40 cm and average sizes range from 10 to 25 cm.

A demersal species, it lives on rocky bottoms of course sand (gravel), less than 10 m deep in the Mediterranean and at greater depths with increasing age (up to 400 m) in the Atlantic. Its behaviour is gregarious and reaches first sexual maturity at one year of age (14 cm), breeding between April and June. It feeds on benthic organisms, especially shrimps and amphipods, equinoderma and small fish.

It is distributed in the eastern Atlantic, from the North Sea as far as Senegal and is quite common in the Mediterranean.

Although there are no market studies, perspectives are considered to be good. It is sold fresh or chilled.

The current situation of the culture: Trials have been conducted in Spain (IEO Murcia). Spawning has been achieved from breeders captured at sea. The larvae whose feeding was successful, only survived for a few days.

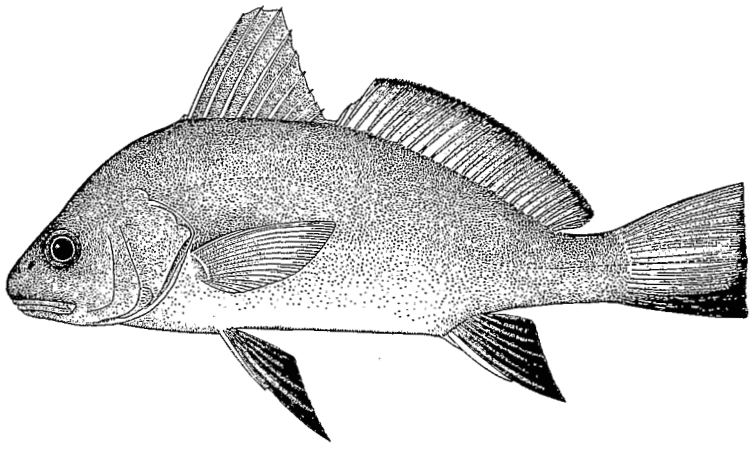
Species: *Mullus surmeletus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	5-20	T	WA	-	1, 2, 6	SV	-	6, 7, 8		0				0		ES		NP

FAMILY SCIAENIDAE

Scianea umbra (Linnaeus, 1758); *Corvina nigra*

English name(s)	Brown meagre
French name(s)	Corb commun; corb; corbeau; loup des roches
Italian name(s)	Corvo; corvina
Portuguese name(s)	Roncadeira preta
Spanish name(s)	Corvallo



This high-bodied fish of a moderate size belongs to the Sciaenidae family. Colours go from dark grey to dark brown (or uniform dull brown with metallic or gilt reflexions), dark fins and spiny rays from the anal to the pelvic fin.

Common sizes range between 20 and 35 cm, reaching a maximum of 70 cm.

It lives in shallow coastal waters at depths between 20 and 180 m, mainly on rocky and sandy bottoms. It reaches first sexual maturity at around 30 cm total length and breeds between March and August (Mediterranean). It feeds on small fish, crustaceans, molluscs and polychaeta.

This species is found on the Atlantic coast from the English Channel to Senegal (including the Canary Islands) and the Mediterranean where it is quite common.

Current situation of the culture: Trials have been conducted in France (Société 3A SARL Antibes) and Italy (Itticca Mediterranea).

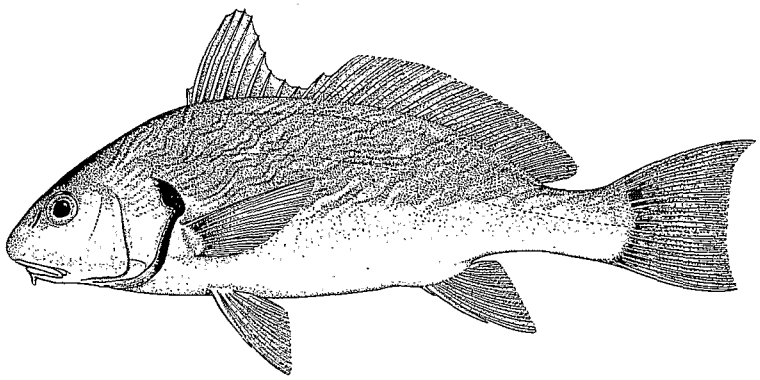
Breeders come from adults captured at sea and are kept in tanks. There is spawning in captivity, and larval culture presents nutritional requires and feedings regimes problems. Ongrowing, which has been done in ponds, presents low growth problems, and there is the need to define nutritional requirements, and the type of diet.

Species: *Scianea umbra*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	M	M	17	T	WA	+	4	SVO	+/-	6, 7	SVO	+/-	6	P	RE	+/-	6, 8, 12	PS		

Umbrina cirrosa (Linnaeus, 1758)

English name(s)	Corb; croaker; shi drum
French name(s)	Ombrine; ombrine commune; ombrine côtière
Italian name(s)	Ombrina
Portuguese name(s)	Calafete de riscas
Spanish name(s)	Verrugato; verrugato común; verrugato de piedra; corvinato; berruguete



This is a large species belonging to the Sciaenidae family, with a high compressed body. It is a metallic bluish-grey colour with oblique sinuous upward stripes, from the back to the tail. Its maximum size is 100 cm but the average size ranges from 30 to 80 cm. It lives in coastal waters, up to 100 m deep, on rocky or sandy bottoms. It reaches its first sexual maturation at 35 cm long and breeds in spring and summer. It feeds on fish and benthic invertebrates and algae.

Its area of distribution comprises the tropical Atlantic, as far as the Bay of Biscay and the Mediterranean, where it is quite frequent.

In the Mediterranean this fish is mainly marketed fresh in Morocco, Greece, Turkey and Cyprus. Market studies have only been conducted in Italy (Maricoltura) and future perspectives are good; the selling price in Italy being 20 USD/kg.

Current situation of the culture: Culture trials have been conducted in Cyprus (Aquaculture Technologies) and Italy (NCR Venezia, Ittica Mediterranea, Ittiomar II).

- Reproduction: Breeders come from juveniles or adults captured at sea and are kept in tanks. There is a good status achieved regarding broodstock upkeeping techniques, There are problems with the availability of breeders as well as with sexual maturation and control of spawning in captivity. Besides these aspects, research is also demanded in all aspects related to nutrition and feeding.

- Larval culture: It is conducted in small volume tanks in open systems. The results obtained can be considered to be good in Italy (Maricoltura) and more troublesome in Cyprus (Aquaculture Technologies). An improvement of survival rates is demanded and measures should be taken to overcome pathological problems, determine nutritional requirements and establish adequate feeding sequences.

- Weaning: It is carried out in the same tanks as larval culture (small volumes and open system). A formulation of a proper diet is required and pathological problems must be solved.

- Ongrowing: It is conducted in cages, tanks and ponds. Good results have been achieved in Cyprus, although the need to define nutritional requirements, the type of diet and a solution for pathological problems is still present.

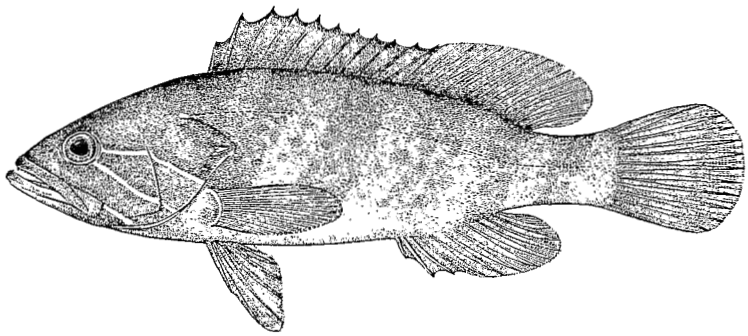
Species: *Umbrina cirrosa*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	Y	G	G	20	T	WA	+	6/7	SVO	+	6/7	SVO	+/-	8	C/T	RE	+-	8	PS		
Respondent 2	N	U	M		T	WJ	+/-	1	SVO	+/-	13	SVO	+	6	T	RE	+	6	ES		NP
Respondent 3	N	G	G	20	T	WA	+/-	1, 4	SVO	+/-	10	SVO	+/-	10	P	RE	+/-	10	PS		NP
Respondent 4	N	M	M		T	WA	+	4													

FAMILY SERRANIDAE

Epinephelus aeneus (Geoffroy St. Hilaire, 1817)

English name(s)	White grouper
French name(s)	Mérou blanc; tiof
Italian name(s)	Cernia bianca; cernia
Portuguese name(s)	Garoupa legítima
Spanish name(s)	Cherna de ley



It is a serranid fish, of a large size, ranges from 30 to 80 cm, with a maximum size of 115 cm. It is greenish-yellowish brown or greyish with a dark red shade, frequently white-spotted and marked with wide vertical dark strips which are more or less visible and two or three oblique whitish lines on the cheeks. This species most often lives on sandy and clayey bottoms from 20 to 200 m deep. It is a protogenic hermaphrodite and reaches its first sexual maturity at around the age of five years (50 cm), sexual inversion occurring when they reach a size close to 100 cm. It reproduces in spring and in summer. It feeds mainly on fish, cephalopods and crustacea.

Although there are no market studies, the perspectives -as for most groupers- are good. It is appreciated in almost all Mediterranean countries. It is marketed fresh, chilled and frozen, at prices which range from 8 to 12 USD/kg, depending on the area of sale, and in certain seasons over 20 USD/kg.

Current situation of the culture: Most of the existing data comes from Israel (NCM, Eilat). Some experiments have been also conducted in Greece (IMBC). In general, the culture knowledge about this species is very restricted. A batch of 10,000 fish was produced at the NCM, Israel, and a few thousands juveniles were reared in 1995 in an intensive pond (about 5 tons), where they reached over 1 kg at the age of 1 year. However, the broodstock as well as the batch above were destroyed by a Viral Nervous Necrosis (VNN) outbreak. The situation is the following:

- Reproduction: Breeders originate from captured juveniles and adults and are kept in tanks. The knowledge regarding broodstock management is very restricted and it is necessary to investigate on nutritional requirements and to develop sexual maturation and spawning control techniques. Broodstock building is also a main constraint.

- Larval culture: This phase seems to be the bottle neck for the domestication of this species. It has been implemented in small volumes in open systems. There are problems with live food due to very small hatchlings, and cannibalism problems have been confirmed. This stage of culture demands development of appropriate technology.

- Weaning: It takes place in larval culture tanks. Data is practically non-existent. There is a need to develop techniques and formulate an adequate diet.

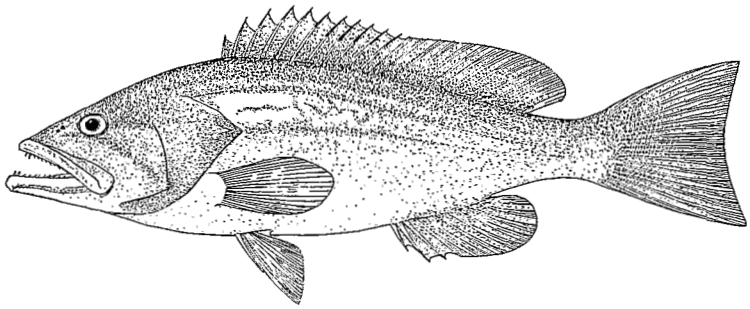
- Ongrowing: This has been carried out in Israel, from fry born in captivity, using ponds. It has a fast growth rate (1 kg in 1 year feeding with *Sparus aurata* feed) and good feed conversion coefficient. Research is necessary on nutritional requirements and towards the development of appropriate ongrowing techniques. It is believed this species is suitable to culture conditions in intensive ponds and in sea cages.

Species: *Epinephelus aeneus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	12	T	WJ	-	1, 2, 3, 4	SVO	-	8, 11	SVO	+/-	6, 8	P	RE	+, +/-	10	ES		NP
Respondent 2	N	G	G	8	T	WA	-	3		0			0				0				

Epinephelus alexandrinus (Valenciennes, 1828)

English name(s)	Golden grouper
French name(s)	Fausse badèche; mérou d'Alexandrie
Italian name(s)	Cernia dorata; cernia
Portuguese name(s)	Mero amarelo
Spanish name(s)	Mero de Alejandría



Belonging to the Serranidae family, this fish is large, elongated and moderately compressed. It is dull yellow or sepia in colour with darker longitudinal lines over the body with two oblique black lines on the operculum, very clear in young fish but not distinguishable in adults. It reaches a maximum length of 100 cm and even up to 140 cm. The most common sizes range between 30 and 70 cm.

This demersal species lives on sandy, silty or rocky bottoms and on submarine meadows at depths between 10 and 30 m but is found in greater abundance at 100 m. Young fish, in particular live in small groups. It is hermaphrodite and spawning takes place in the summer. The first sexual maturity is reached at the age of 4 years at an approximate size of 33 cm. A voracious predator, it preys on fish, crustaceans and cephalopods.

Its area of distribution includes the eastern Atlantic, from Gibraltar to Nigeria and the Mediterranean (except the North).

Although no market studies have been conducted for this species, it has very good market prospects and prices reach 17 USD/kg in Greece. This species is found in Cyprus, Greece, Morocco and Turkey, where is sold fresh, chilled or frozen

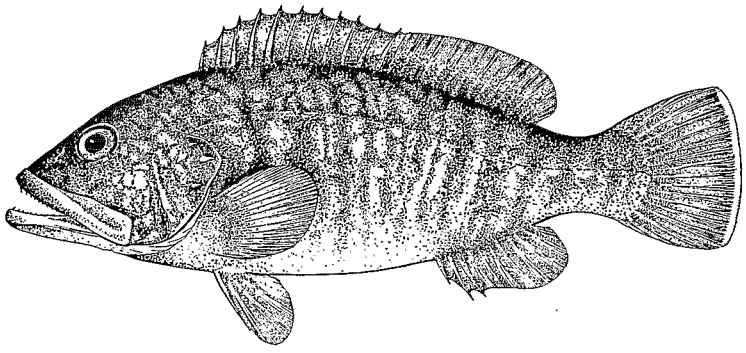
Current situation of the culture: There is almost no data. Only one group in Greece (Nireus) keeps broodstock of this species. Although spawning has not yet been achieved, fish have matured. In this company, work continues in broodstock management and spawning control, as well as collection of more individuals of this and another epinephelus species.

Specie: *Epinephelus alexandrinus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	17	T	WA	+/-	4											ES		

Epinephelus marginatus; *Epinephelus guaza* (Linnaeus, 1758); *Epinephelus gigas; Serranus gigas; Cerna gigas*

English name(s)	Dusky sea perch; dusky grouper
French name(s)	Mérou commun; mérou des provençaux; mérou sombre; mérou de Méditerranée
Italian name(s)	Cernia mediterranea; cernia
Portuguese name(s)	Mero legítimo; mero
Spanish name(s)	Mero



A large sized-fish belonging to the Serranidae family, it is brown in colour and in some cases is dark grey and reddish with white irregular spots often in the shape of diffuse vertical strips. The adults, of a larger size, have a uniform dark brown colour. The caudal fin is white-fringed. The average size ranges from 20 to 80 cm and it can reach 150 cm. Its maximum weight is 65 kg.

It lives in the Atlantic Ocean (they are rare at the north of the Bay of Biscay) and the Mediterranean (not very common species). They are sedentary demersal fish which live on rocky bottoms at a depth from 20 to 200 m. They are protogenic hermaphrodites and reach sexual maturity from 9 to 12 years old (40 cm) as females and when they reach 80 cm they are males. They reproduce in summer. They feed mainly on fish, cephalopods and crustaceans.

This species is highly appreciated in almost all Mediterranean countries. Except in Spain (University of Barcelona) no market studies have been carried out, but perspectives at regional and local levels are, as a rule, good. It is commonly found in markets in Israel, Turkey, Cyprus, Greece, Morocco, Italy and Spain, and prices range from 12 to 27 USD/kg. Although it is generally believed that this species has a good potential market, this is difficult to assess as present catches are low.

Current situation of the culture: Culture experiments have been carried out in Croatia (IOF Dubrovnik), Cyprus (Aquaculture Technologies), France (Cyclope), Italy (COISPA Bari, ICRAM-Rome, and Ittica Mediterranea) and Spain (Univ. of Barcelona, Univ. of Cadiz, Est. Acuicultura Mallorca).

Present research on the culture of this species refers to broodstock formation, maturation spawning and on the growout to commercial size. Today fry is obtained only from wild. More research is needed in all aspects of its culture. It is also a species considered for restocking programmes and coastal zone management, as well as for aquaculture. Recent results are encouraging. Different levels of success have been achieved in certain stages of culture or integrated culture.

- Reproduction: The breeders always come from the sea (juveniles or adults) and are kept in tanks. Although spawning has been achieved in captivity (in Italy, by hormonal induction), there is hardly any data on broodstock management and therefore knowledge is very restricted. The major problems faced in reproduction are the difficulties in obtaining breeders (mainly males), sex inversion (cause and timing), maturation control and spawning. Research should focus on spawning induction, sex reversal, etc.

- Larval culture: The experiences carried out in Cyprus and Italy (Bari) have taken place in small volumes and open systems. There are problems at first feedings as standard rotifers are too small for

larvae. Investigation focuses on the establishment of alternative live feeds, an adequate feeding sequence and the development of appropriate technology.

- Weaning: Just as with larval culture, it takes place in small volumes and open systems and it is necessary to develop adequate techniques.

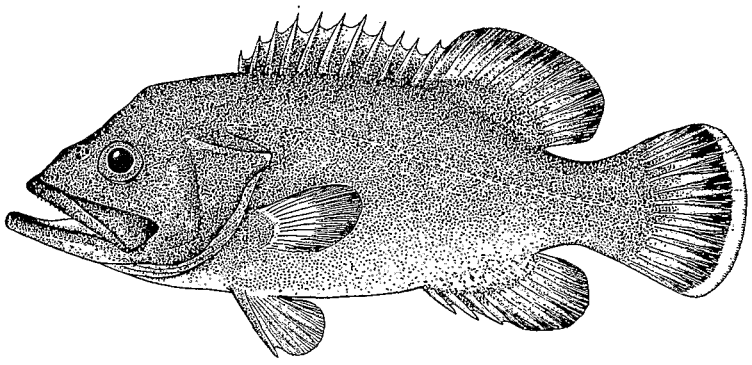
- Ongrowing: It takes place in tanks from wild juveniles, or fry born in captivity (Cyprus). Juveniles grow as fast or faster than sea bream if cultured in optimal conditions. It is necessary to gain more knowledge about nutritional requirements, type of diet and the development of adequate techniques. There are some problems of slow growth.

Species: *Epinephalus marginatus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	25	T	WJ	-/0	1	SV	0		LV	0		T	WJ	+		ES	NP	
Respondent 2	N	U	U		T	WJ	-	2	SVO	+/-	7	SVO	+/-	5	T	RE	+/-	8	ES		NP
Respondent 3	N	G	G	16	T	WA	+/-	1, 3	SVO	-	8	SVO	0		T	WJ	+		ES		NP
Respondent 4	N	G	M	15-18	T	WA	+/-	1, 3		0			0		T	WJ	+/-	5, 6	ES		NP
Respondent 5	N	G	G		T	WA	+/-	3, 4													
Respondent 6	Y	G	G	25											T	WJ	+	5, 6	ES		NP
Respondent 7	N	G	G		T	WJ	0														
Respondent 8	N	G	G	20				1							C/T	WJ	+/-	8, 12			

Polyprion americanus (Bloch and Schneider, 1801); *Polyprion cernium*

English name(s)	Stone bass; wreckfish; wreck bass
French name(s)	Cernier commun; cernier brun; mérou des Basques; cernier atlantique; fanfre
Italian name(s)	Cernia di fondale; cernia; dotto
Portuguese name(s)	Cherne
Spanish name(s)	Cherna



This is a large-sized serranid fish, tall and with a strong body. Its maximum size is 200 cm. and average sizes are approximately 80 cm. This demersal fish lives on rocky and sandy sea-bottoms from 40 to 400 m depth (normally from 100 to 200 m depth). It reproduces in summer and feeds on crustaceans, molluscs and fish (carnivores).

It is regularly marketed in Italy and occasionally in Morocco, Greece and Turkey (chilled, fresh or frozen). No market studies have been conducted and perspectives seem to be good. In Spain (Mallorca), it fetches prices up to 20 USD/kg.

Current situation of the culture: This is a fast-growing species, whose ongrowing has been carried out only in tanks and cages, and from wild juveniles, in Spain (Est. Acuicultura Mallorca). Mortalities have been observed with temperature increases. There is little data available. In general it is necessary to develop culture techniques.

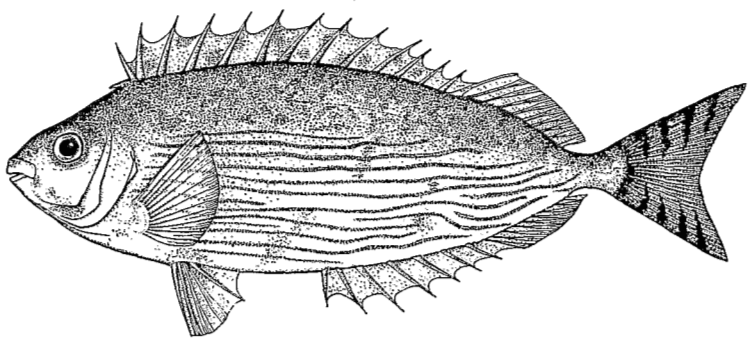
Species: *Poliprion americanus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	20				1							C, T	WJ	-	19	ES		

FAMILY SIGANIDAE

Siganus rivulatus (Forsskål, 1775); *Teuthis sigan*

English name(s)	Marbled spine-foot
French name(s)	Germanos; poisson-lapin
Italian name(s)	Sigano
Portuguese name(s)	Macua
Spanish name(s)	Siguro



It belongs to the Siganid family and is characterized by its compressed oval body and generally brown or olive-green colour on the back, vertically in a lighter shade with two gilt horizontal strips, slightly wavy, on the two lower tiers of the body. Its maximum size is 40 cm, average sizes being around 20 cm. It lives on large shoals in coastal waters, close to the sea bottom down to 60 m depth. It reaches sexual maturation at two years of age and reproduces from June to August. It feeds on algae (brown, red and green) and is fished in Egypt, Israel, Cyprus and Turkey (West Mediterranean).

Although no market studies have been conducted, perspectives seem to be good at a local level in Cyprus where it is regularly found, marketed fresh at 15 USD/kg. It is occasionally found in Egypt and Turkey.

Current situation of the culture: There are only culture trials in Cyprus (Dept. Fisheries) and Egypt (NIOF).

- Reproduction: Breeders are born from wild juveniles coming from reproduction in captivity. They are kept in tanks. It is necessary to gain knowledge regarding nutritional requirements, sexual maturation, control of spawning and broodstock management in general. Some problems of broodstock supply have appeared.

- Larval culture: It is carried out in small volumes in closed systems. It is essential to develop adequate culture techniques, determine nutritional requirements and live food demand. It is also important to improve survival rates.

- Weaning: The situation is identical to that of larval culture. It is necessary to determine nutritional requirements, type of diet and develop weaning technology.

- Ongrowing: It is conducted in tanks from fry born in captivity. Research should be channelled towards the elaboration of ongrowing techniques, establishment of nutritional requirements and the design of a proper diet.

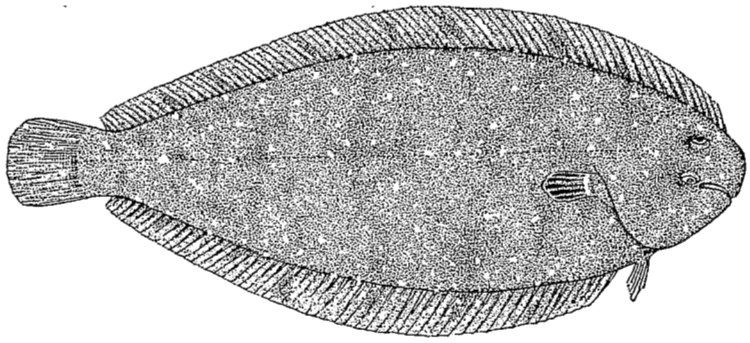
Species: *Siganus rivulatus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	U	22	T	RE, WJ	+/-	1,2,4, 6	SV	+/-	5, 6, 8	LV	+/-	5, 6, 8	T	RE	+/-	5,6,8	ES		NP
Respondent 2	Y	G	U	25	T	WJ, RE	+	3,6,7	SV	+/-	7, 13	SVO	+/-	7, 13, 16	-	-	-	--	ES	-	NP

FAMILY SOLEIDAE

Solea senegalensis (Kaup); *Solea Melanochira* (Moreau)

English name(s) Senegal sole
Spanish name(s) Lenguado senegalés



Belonging to the Soleidae family, it is found in the Atlantic, from Senegal as far as the Bay of Biscay, where it is rare and the Mediterranean. Characterized by its compressed, oval, elongated body, its colour is brownish-grey, often quite dark, with small blue spots which disappear after death. The average size is 45 cm with maximum sizes up to 60 cm. This demersal fish lives on sandy or clayey bottoms in coastal waters as deep as 100 m. First sexual maturation is reached at 25 cm. It breeds in spring and summer and feeds on benthic invertebrates, mainly polychaeta, bivalves and small crustaceans.

It is found regularly in Northern African markets and is rare in Spain. It is marketed fresh at prices ranging from 8 USD/kg (Tunisia) to 20 USD/kg (Spain and Portugal). No market studies have been conducted and the perspectives in all the countries where it is under culture are good, both locally and regionally.

Current situation of the culture: This species has been more or less successfully cultured in the following countries: Greece (Nireus), Portugal (Univ. of Algarve, IPIMAR Olhao), Spain (Cupimar, Univ. of Cádiz, CICEM Cadiz) and Tunisia (INSTM Salambó). Its reproduction and larval rearing have been managed successfully. Its growout, however, presents problems mainly relating to nutrition and husbandry techniques.

- Reproduction: Breeders are kept in tanks and ponds (Tunisia) and originate from juveniles or adults captured at sea. There are differences regarding management and control of reproduction in the different countries, achieving very good results in Tunisia and Spain; in Portugal it is necessary to improve techniques and solve problems related to nutritional requirements, control of maturation and spawning.

- Larval culture: Basically it is carried out in small volumes in open or closed systems. It also takes place in large volumes (Univ. of Algarve). The results obtained are good in Spain and acceptable in Portugal. It is necessary to design an appropriate inert food, establish the feeding sequence and optimize culture techniques.

- Weaning: It takes place in the same larval culture tanks but always in open systems. The level of knowledge acquired is very restricted and it is considered necessary to determine nutritional requirements, formulate an adequate type of diet, establish the feeding sequence and solve slow growth problems.

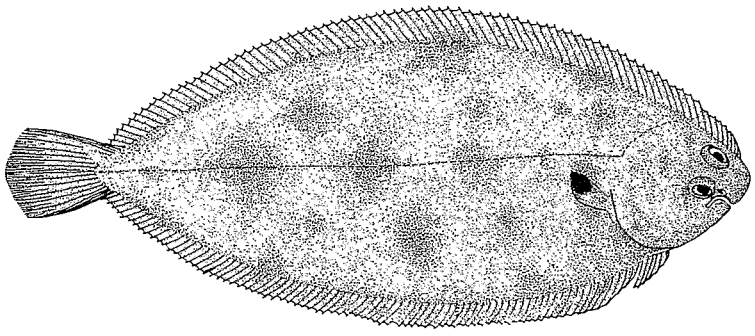
- Ongrowing: For the ongrowing stage, ponds are normally used, but it also takes place in tanks. Individuals used always come from controlled reproduction. The best results, although not optimal, are achieved in Cadiz (Spain). Good results are also obtained in polyculture systems. The main problem is nutrition where it is necessary to investigate and determine nutritional requirements. It is also important to improve the culture system.

Species: *Solea senegalensis*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	C	C	17																	
Respondent 2	N	G	G	20	T	WA	+/-	6	LV	+	9	LV	-	12, 13	P	RE	+/-	6	PS		NP
Respondent 3	N	G	G	+15	T	WJ, WA	+/-	2-4	SVO	+	9-5	SVO	-	6, 7, 8	P	RE	+/-	5, 6	PS, SC	50?	NP
Respondent 4	N	G	G	20	T	WJ	++		SVO	++	6,9	SVO	+/-	6, 7, 8	T	RE	+	8, 6	ES, PS		NP
Respondent 5	N	G	G	8	P	WA	++	-	SV	+/-	G	SVO	-	6, 13	P	RE	-	6, 13	PS	-	NP

Solea vulgaris; (Quensel, 1806); *Solea solea*

English name(s)	Sole; common sole
French name(s)	Sole commune; sole
Italian name(s)	Sogliola
Portuguese name(s)	Linguado legítimo; linguado
Spanish name(s)	Lenguado común



Its area of distribution comprises the Atlantic Ocean from Senegal to Scandinavia and the Mediterranean, where it is common. It is characterized by its oval body and bluish grey or darkish green colour, often with very fine spots or marked by a lengthwise series of round spots. It bears a blackish spot on the post-upper part of the pectoral fin, often white-rimmed at the back. The caudal fin has a round border. Its maximum size is 70 cm and average sizes range from 15 to 45 cm. This demersal fish lives on sandy and clayey bottoms up to 200 m deep. They reach sexual maturation at the age of 3-5 years (25 cm) and they reproduce from January to August, feeding on polychaeta, molluscs and small crustaceans.

This is a species with very good market prospects in Spain and other Mediterranean countries; Greece, Italy and Tunisia (high prices are fetched in Spain, up to 20 USD/kg). It is marketed fresh or frozen in fillets and its flesh is well appreciated.

Current situation of the culture: Although there are references of this species cultured successfully in semi-intensive conditions in some firms (e.g. Spain), we can only have reference of five Mediterranean centres engaged in its culture development: Egypt (NIOF), Greece (Nireus), Spain (Univ. of Cadiz, Univ. of Barcelona) and Tunisia (INSTM Salambó). The sole, *Solea solea*, with difficulties under intensive conditions presents a good growth performance in lagoon zones.

- Reproduction: The breeders, originating from wild juveniles or wild adults, are kept in tanks or ponds. The knowledge acquired in this stage of culture can be regarded as good, but it is necessary to investigate on feeding and control of maturation and spawning.

- Larval culture: Small volume tanks in open or closed systems are used. The existing data is scarce and it is considered necessary to determine nutritional requirements and to solve pathological problems.

- Weaning: It is conducted in small volume tanks in open systems. The problems encountered are the same as in larval culture.

- Ongrowing: It is carried out in tanks and also in ponds. In the first case, they start from fry born in captivity and in the other wild juveniles are used. Problems are encountered with low survival rates. It is necessary to investigate in order to define nutritional requirements, feeding regime, and establish adequate ongrowing techniques.

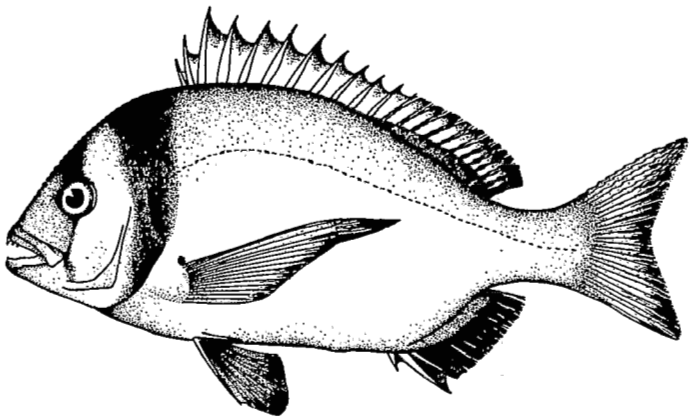
Species: *Solea vulgaris*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	Y	G	G	4.5	P	WJ	+	6, 7	SV	+/-	6, 7, 13	SVR	+/-	5,6,7	P	WJ	+	7, 8, 16	SC	81	NP
Respondent 2	N	G	G		T	WA	0	3, 4													
Respondent 3	N	G	G	20	T	WJ	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Respondent 4															P	WJ	+	5 / 6	ES		
Respondent 5	N	G	G	4.5	P	WA	+	4	SVO	+/-	6,10	SVO	+/-	6,10	T	RE	-	13, 19	PS	-	NP

FAMILY SPARIDAE

Acanthopagrus bifasciatus (Forsskål, 1755); *Sparus bifasciatus; Mylio bifasciatus*

English name(s)	Twobar seabream; two-stripes bream
French name(s)	Pagre double bande
Spanish name(s)	Sargo de dos bandas



Belonging to the Sparidae family, this fish is characterised by two vertical black bars across head, the first ending below angle of jaw, the second larger from nap across opercle to its interior edge. The body is fairly deep, compressed, yellowish on the top, silvery below, and with a silvery head. The upper profile of the head is nearly straight in young adults, abruptly bent at eye level in juveniles. In front of each jaw, 4 to 6 larger, more or less compressed teeth, followed behind and inside 4 to 6 rows of molars. Its maximum size is 50 cm, common between 20 and 35 cm.

It is considered omnivorous. It is found in shallow water, enters estuaries and bays, mainly around coral reefs. It spawns naturally throughout the spring-summer season in the gulf of Aqaba/Eilat (Red Sea).

It is found in the Pacific Sea, including Madagascar, water of Mauritania, eastwest extending into Indo-Malayan water. This is a local species in the gulf of Aqaba/Eilat.

Although no market studies have been carried out, on the local market (Eilat, Israel) it is highly appreciated, and commands good prices (about 6 USD/kg), and has a good taste. It is marketed fresh or dried.

Current situation of the culture: Experiments on the culture of this species have been conducted in Israel (NCM). A semi-commercial experiment was also carried out with fingerlings provided and produced by the NCM, in a cage farm in Eilat, giving poor growth-rate (using bream and bass feed).

- Reproduction: The breeders obtained from juveniles or adults from the sea are kept in tanks or cages. Further knowledge is required, and the main problems are related with nutritional requirements and feeding.

- Larval culture and weaning experiences: They have taken place in small open volume tanks. The present situation demands work on nutritional requirements and feeding regime.

- Ongrowing experiments: They have been conducted in cages and ponds from fry born in captivity, being the low growth rate the main observed problem

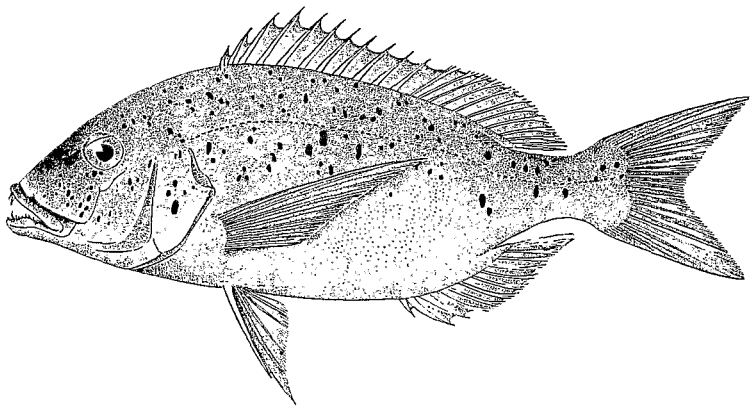
In general, it is necessary to work more on the control of reproduction, nutrition and feeding and diseases. It is to point out that this fish being an omnivore species, it will need a lower-protein diet than other sparids.

Species: *Acanthpagrus bifasciatus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	U	U	6	T, C	WJ, WA	+/-	6,7	SVO	+/-	6, 12	SVO	+/-	6, 8, 12	C,P	RE	+/-	12	ES		NP

Dentex dentex (Linnaeus, 1758); *Dentex vulgaris*

English name(s)	Dentex; sea bream; dog's tooth bream; common dentex
French name(s)	Denté commun; denté
Italian name(s)	Dentice; dentice mediterraneo; dentale
Portuguese name(s)	Capatâo legítimo; dentâo
Spanish name(s)	Dentón; dentón común, sama dorada; pargo testudo; capitón



It is a fish belonging to the Sparidae family, characterized by its 4-6 front teeth, well developed in each jaw. Its greyish and black-spotted back when young, turns into a pinkish shade on reaching maturity and develops into a blueish grey in more aged individuals. This fish can reach 100 cm long, although its average size ranges from 20 to 50 cm, and its maximum weight is 12 kg.

This demersal fish lives on firm sea-bottoms as deep as 150 m. They are gonochoric (both sexes are well separated) and reproduction in the wild takes place from April to June. They feed on fish and cephalopod mollusks and its range of distribution comprises the Mediterranean and the Atlantic Ocean from the Bay of Biscay to Senegal.

It is marketed fresh in Spain, Italy, Greece, Turkey, Cyprus, Tunisia and Morocco at prices ranging from 11 to 20 USD/kg. Although only few market studies have been carried out, perspectives seem to be good at local and regional levels, thus making it one of the few new sparids with good perspectives.

Current situation of the culture: Research on the culture of this species is being carried out by several public and private institutions of Cyprus (Dept. of Fisheries, Aquaculture Technologies), France (SCORSA Alerie), Greece (IMBC, NCMR, Nireus, Selonda), Italy (Itiomar II, Ittica Mediterranea), and Spain (IEO Murcia, Est. Acuicultura Mallorca, IRTA Tarragona).

Its culture, initiated very recently, has reached a similar level of development in certain Mediterranean countries. The culture knowledge of this species, together with *D. puntazzo* and *P. pagrus*, is one of the most developed. Although it has a higher growth rate than *Sparus aurata* and other sparids species, its culture still has high mortality rates, probably caused by pathological disorders and nutritional deficiencies. The broodstock maturation and spawning is feasible. Larval rearing, especially during the weaning stage, is problematic. Its growout to commercial size still presents considerable problems mainly due to poor survival from cannibalism and inadequate nutrition. For some companies the main problems are mainly found at the commercial production scale rather than at the Research and Development stage. The present situation of the different stages of culture is the following:

- Reproduction: The breeders which are kept in tanks or cages come from juveniles or adults captured in their natural environment. Except where the biological cycle has been closed, fry used are born in the rearing systems. The main problems are associated with management of broodstock as they are difficult to handle. The maturation may be erratic from year to year, and the eggs of poor quality. Research should be focused on maturation control and spawning (e.g. application of photoperiod control), knowledge of nutritional requirements and feeding regime, as well as different pathologies.

- Larval culture: Larval rearing takes place in small volume tanks in open or closed systems, or in large volumes using the mesocosm system. This stage of culture, especially in intensive systems, implies a series of problems, such as different growth rates and high mortality due to cannibalism, inadequate feeding and probably inadequate abiotic conditions. This problems are reduced when working with a mesocosm system. The establishment of the "metabolical" and nutritional requirements of the larvae and an adequate feeding sequence would lead to an improvement of survival rates and better larval quality. Research should be also aimed at the establishment of an intensivelarval culture technology specific for this species.

- Weaning: it is carried out in the same sort of tanks as for larval culture. During this stage there are some problems of deformities, cannibalism and heterogeneous growth among groups of the same origin. There are frequent pathological problems, for example protozoan or bacterial infections, but these can be easily treated. Although no industrial feed exists for this size and species, on a small scale, this problem can be solved by using moist pellets. It is necessary to devise adequate diets to cover nutritional requirements, establish an adequate feeding sequence and finally, a weaning procedure.

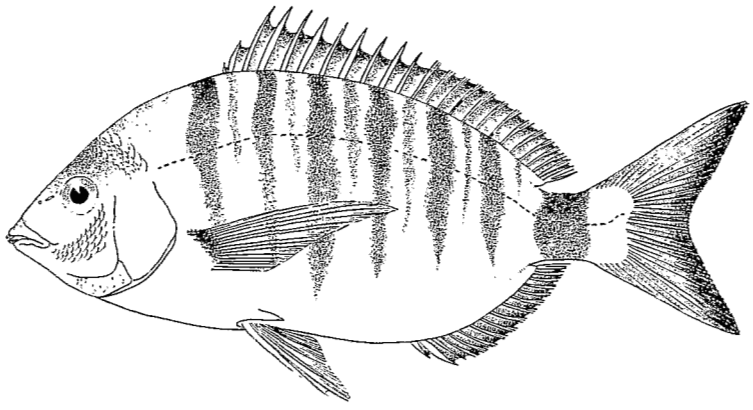
- Ongrowing: It takes place in tanks or cages, starting with juveniles or fry born in captivity. The results of the experiments carried out at laboratory scale or at small commercial scale indicate that appropriate ongrowing techniques should be developed and necessary knowledge is required. Problems similar to those encountered with weaning also arise during this stage Artificial diets designed for other species have probably caused mortalities in the rearing of this species, as their composition was not adequate to their nutritional requirements. Thus, research on nutrition (i.e. nutritional requirements) will lead to the adequate type of diet and feeding regime for a homogeneous growth and improvement of the feed conversion indexes.

Species:*Dentex dentex*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	16	T	RE	+/-	6,4,7	SVO	+/-	5, 6, 9	SVO	-	5, 6, 8, 11	T	RE	-	5, 6, 8, 11	ES		NP
Respondent 2	N	G	G		T	WJ	-	4	SVO	+/-	11	SVO	+/-	16	T	RE	-	16	PS		NP
Respondent 3	N	G	G	11	T	WJ, RE	+	4	LV, SV	+/-	6, 11	SVO	-	11	T	RE	-	6, 17	ES	5	IP
Respondent 4	Y	G	M		C	RE	+/-	2	SVO	+/-	6, 5	SVO	+/-	6, 5	C	RE	+/-	6, 12	PS	0, 5	
Respondent 5	N	G	G	15	T	WA	+	-	SVO	+/-	5, 15	LV	+/-	8, 11	C	RE	+	10, 19	PS	2	IP, NP
Respondent 6	Y	G	G	20	T	WA	+/-		SVO	+/-	5	SVO	+/-	11	C/T	RE	+/-	10	SC		
Respondent 7	N	G	G	18	T	WA	+	6, 7	SVO	+/-	11, 13	SVO	+/-	11, 16	P	RE	-	11, 13	PS		
Respondent 8	N	G	G	20	P, C	RE	++		SV	+/-	6, 11, 13	SVO	+/-	6, 11	C	RE	+/-	6, 8	PS	2	NP
Respondent 9	N	G	G	15-30	T	WJ, WA	+	1, 6	SV, SVO	+/-	6, 7, 13, 15	SVO	+/-	6, 13, 16	T	RE	+/-	6, 10	ES		NP

Diplodus puntazzo (Cetti, 1777); *Puntazzo puntazzo*

English name(s)	Sharp-snout sea bream
French name(s)	Sar à museau pointu; charax bec fin
Italian name(s)	Sarago pizzuto; sargo pizzuto
Portuguese name(s)	Sargo bicudo
Spanish name(s)	Sargo picudo



It is a sparid characterized by 8 incisives bent forward and a sharp snout. It is a silver-grey colour with 6-8 vertical dark strips alternating with 5-7 lighter ones, which disappear after death. A large spot appears on the caudal peduncle, which is more or less ring-shaped, and more clearly defined in young individuals. The caudal fin has a black rim. The largest size is 60 cm, but the average ranges from 15 to 30 cm. It is abundant in coastal waters on rocky bottoms as deep as 150 m. It is omnivorous and feeds on algae, mussels, crustaceans. It is hermaphrodite and in the wild reproduces from October onwards. Its area of distribution comprises the tropical Atlantic as far as the Bay of Biscay, where it is rare, and the Mediterranean where it is relatively common.

Regularly or occasionally, this fish is found in most Mediterranean markets and, normally, it is marketed fresh at prices ranging from 10 to 18 USD/kg. Although there are no market studies, its perspectives, both at regional or local levels, are considered to be good. As for aquaculture fish, this species is already produced at small commercial scale by some Mediterranean enterprises. At the initial stage of commercialization, some market problems have already been encountered, mainly due to a decrease in prices. This caused some companies to stop their production (i.e. MAROST). The situation is demanding enterprise and marketing strategies as well as more research in order to plan sales and improve production costs to become more competitive.

Current situation of the culture: It has been cultured since recently in different Mediterranean countries. There are culture trials reported in Cyprus (Dept. of Fisheries, Aquaculture Technologies, Sagro Aquaculture, Sagro Deep Sea Fish, Kimagro Fish Farming), France (Ste. GAEC), Greece (IMBC, NCMR, Selonda, Nireus), Italy (ENEA Rome, Ittiomar II, NCR Messina, Univ. of Palermo, Ittica Mediterranea), Malta (NAC), Spain (IEO Murcia, Est. Acuicultura Mallorca) and Tunisia (CAN Monastir). Production occurs at experimental, pilot and small commercial scales. During the year 1995 some companies already produced significant quantities (from 50 to 150 t), either in ponds or cages. Other companies have cultured this species in smaller quantities.

For some companies the main problems are found on the commercial production scale rather than the Research and Development stage. This species has been cultured on a commercial scale for the last couple of years in several Mediterranean countries like Greece, Morocco, Cyprus and Italy. The knowledge on its culture has advanced rapidly. Aspects such as larval rearing and growout have been studied thoroughly; however, more work remains to be done on the maturation and spawning as well as on the nutritional requirements and diet formulations. The current situation of the culture is the following:

- Reproduction: The breeders which, in principle, were obtained from wild adult juveniles originate now, in most cases, from fry born in captivity. They are kept in cages, tanks and ponds. The knowledge status on broodstock management can be considered as acceptable in most centres where this species is under culture. The main problem arising is maturation and spawning control, although it is essential to go further into research related to nutrition and feeding. Other aspects are cryopreservation of spermatozoa.

- Larval culture: Generally, it is carried out in small volumes, in open as well as in closed systems. It is necessary to determine nutritional requirements, devise an adequate diet, and establish the conditions which allow to the survival rate to increase, prevent cannibalism and improve larval quality, investigate the role of green waters in larval culture and establish morphological and morphometric series and quality criteria.

- Weaning: It is carried out in small volumes in open systems. The technique applied is acceptable but should be optimized, defining nutritional requirements, type of diet and feeding regime.

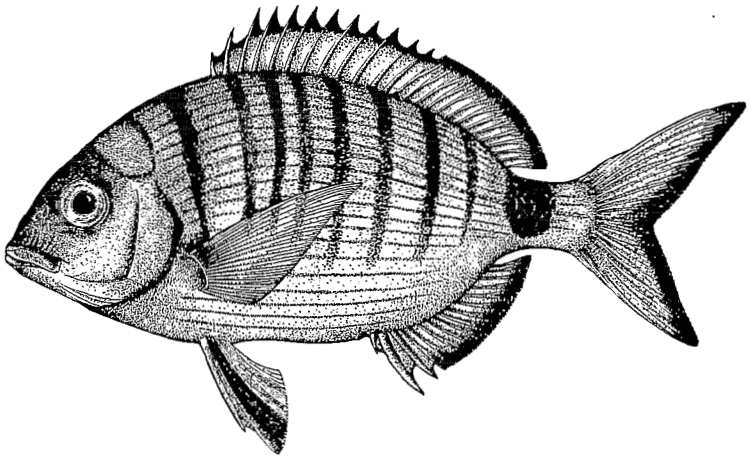
- Ongrowing: It is conducted in tanks, cages and ponds (Tunisia), using in most cases, fry born in captivity. Sometimes wild juveniles are used. Although satisfactory results have been achieved, there are nutritional and pathological problems. It is necessary to determine the nutritional requirements and feeding sequence, as well as the optimization of rearing techniques.

Species: *Diplodus puntazzo*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	M	14	T	RE	+/-	4, 19	SVO	+	6	SVO	++	6	T	RE	+	10	ES		NP
Respondent 2	N	M	M	10	T	RE	+	4	SV0	+	13	SV0	+	6	T	RE	+	6	SC		NP
Respondent 3	N	G	G	8	T	CO	-	3, 4	LV	+	19	SVO	+	6	C/T	RE	+	6	SC	3	NP
Respondent 4	N	G	M	9	T	WJ	+/-	4	SVO	+	6,1	SVO	+	6	T	WJ, RE	+/-	12	ES	O	NP
Respondent 5	N	M	M	9	T	WA	+	4	SVO	++	-	LV	++	-	C	RE	+		SC	3	
Respondent 6	Y	G	M		C	RE	+	6	SVO	+/-	6	SVO	+	6	C	RE	+	6.10	SC	150	NP
Respondent 7	N	G	G	12	C/T /P	RE, WA	+	4	SV, SVO	+/-	5, 10, 15	SV, SVO	+/-	16	C/T	RE, WJ	+	5	SC	-	NP
Respondent 8	N	G	G	15	T	WA	+	-	SVO	+	-	SVO	+	-	C/T	RE	+	-	PS		
Respondent 9	N	G	G	15	T	WA, RE	+	4	SVO	+/-	5	SVO	-	7	T	RE	+	12	ES		
Respondent 10	N	G	G	10	T	WA	+	6	SVO	+	6	SVO	+	6	P	RE	+/-	6	SC	140	
Respondent 11	Y	G	G	18	C	RE	+	6, 7	SVO	+	6, 9, 11	SVO	+	8	C	RE	+	8	PS	20	NP
Respondent 12	N	M	M	9	C/T	WJ	+	4							C/T	WJ	+/-	6, 10	ES	0.3	NP
Respondent 13	N	M	M	5	C	WJ	+	4	SVO	+		SVO	+	STRESS	C	RE	+	10	SC	50	-
Respondent 14	N	M	G	11	T	WJ, RE	+	4	SV, SVO	+/-	14	SVO	+	6	T	RE	+/-	6,10	ES		NP
Respondent 15	N	M	U	9	P, C	RE	++		SV	+	10	SVO	+/-	6	C	RE	+/-	6, 10	ES		
Respondent 16	N	M	M	5	P	WJ	+			O	19		O		P	WJ	+		PS	-	NP

Diplodus sargus (Linnaeus, 1758)

English name(s)	White sea bream
French name(s)	Sar commun; sargue commun
Italian name(s)	Sarago maggiore; sarago; sargo
Portuguese name(s)	Sargo legítimo
Spanish name(s)	Sargo marroquí



Fish belonging to the Sparidae family. It has 8 incisives on each jaw and, in exceptional cases 10 on the upper jaw, 3 or 4 rows of molars on the upper jaw and 2 or 3 rows on the lower jaw. It is light grey colour with silver reflexions. It has 8 or 9 transversal dark grey strips alternating with light ones which diffuse and finally disappear with age. The caudal fin is black-rimmed and the caudal peduncle is dark-spotted. Maximum sizes reach 45 cm but average size is normally between 15 and 30 cm.

It lives in coastal waters on rocky or sandy bottoms as deep as 50 m. Sexes are separated or can be proterandrous hermaphrodites, reaching sexual maturation at the age of two years and reproducing in January-March (Eastern Mediterranean) and in March-June (Western Mediterranean). The young are omnivores and the adults carnivores (worms, mollusks, crustacea, etc.). It is common in the Mediterranean and rare in the Bay of Biscay.

In general, no market studies have been carried out (only at Palermo University). Market perspectives are average (Spain) and good (Italy and Greece). It is marketed fresh at prices which range from 4 to 10 USD/kg in markets of Spain, Italy, Greece, Cyprus, Turkey and Morocco.

Current situation of the culture: Culture trials are done in Egypt (NIOF), Greece (IMBC, Nireus, Selonda), Italy (NCR Messina, Univ. of Palermo) and Spain (IEO Murcia, IEO Tenerife, Univ. of Cadiz, Est. Acuicultura Mallorca). The current situation of the culture is the following:

- Reproduction: The breeders are generally obtained from juveniles or adults captured in the sea, and are kept in ponds and cages. In the cases in which the biological cycle has been closed (IMBC and Univ. Palermo), the broodstock come from fry born in captivity. The knowledge about this stage of culture seems to be good, nevertheless it is necessary to study in greater depth aspects such as nutritional requirements, feeding regime and control of maturity and spawning.

- Larval culture: Small volume tanks are used in open and closed systems, and large volumes in Crete and Italy (Palermo). Although better technological knowledge is required in general, the yield of the larval culture is acceptable. The level of development achieved seems to be higher in Cadiz and Palermo. As for research, the present situation requires the development of proper culture techniques and work on nutritional requirements, feeding regime and solving the problem of yield in growth. It is also necessary to establish morphometric and morphological series as well as quality criteria.

- Weaning: It is carried out in the same sort of tanks of larval culture. The situation, related to the level of technological development achieved, is the same as that of larval culture, the main problems being in the current lack of knowledge on nutritional requirements and feeding regime.

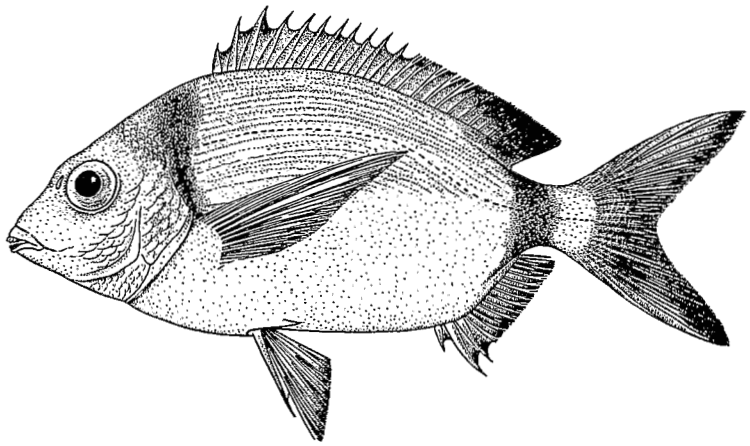
- Ongrowing: Cages are used (Palermo, Mallorca) as well as tanks and ponds. The fish come from fry born in captivity and also from juveniles coming from the sea (Messina). As regards the level of growth reached in this stage, there is a high diversity of opinions and the applied techniques give very good results in Cádiz, good results in Palermo and Messina and not so good results in other centres. There are problems of slow growth and a need to establish nutritional requirements. It is necessary to work on growth problems, especially in winter.

Species: *Diplodus sargus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	7	T	WJ, RE	+/-	4	LV, SV	+/-	6	SVO	+/-	6	T	RE	+/-	6	ES	2	
Respondent 2	Y	G	M		C	RE	+/-	2	SVO	+/-	6, 5	SVO	+/-	6, 5	C	RE	+/-	6, 12	PS	0.5	
Respondent 3	N	G	G	14	T	WA, RE	+		SVO	-		SVO	+		C	RE	++	12	PS		
Respondent 4	Y	G	M	4.5	P	WJ	+/-	6, 7	SVO	+/-	7, 13	SVO	+/-	7, 13, 16	P	WJ	+/-	7, 16	SC	35	
Respondent 5	N	G	G	15	T	WA, WJ	+	4	SVO	+/-	5	SVO	+/-	12	T	WJ	+	12	ES		IP propo
Respondent 6	Y	M	M	18	C	RE	+	6, 7	LV	+	6, 7, 12	LV	+	12	C	RE	+	12	PS	12	NP
Respondent 7	N	G	G	10	T	WA	+	6	SVO	+	6	SVO	+	6	P	RE	+/-	5, 12, 17	PS	2	
Respondent 8	N	M	M		T	WA	++		SVO	++		SVO	++		T	RE	++		ES/ PS		NP
Respondent 9	N	U	U	4	T	WJ	+	4	SV, SVO	+/-	14, 15	SVO	+/-	6	T	RE	+/-	12	ES		NP
Respondent 10	N	M	U	10	P/C	WA	++		SV	+/-	12	SVO	+/-	12	C	RE	+/-	12	ES		
Respondent 11	N	M	M	5	T	WA	+/-	1, 4, 6	SVO	+/-	7	SVO	+/-	6, 8, 12	T	WJ, RE	+/-	6, 8, 12	ES		NP

Diplodus vulgaris (Geoffroy St. Hilaire, 1817)

English name(s)	Common two-banded sea bream
French name(s)	Sar à tête noire
Italian name(s)	Sargo testa nera; sarago fasciato; sarago
Portuguese name(s)	Sargo-safia; choupa
Spanish name(s)	Sargo mojarra; mojarra; moixarra



This is as sparid fish, with an oval, high, compressed body. Generally silver-grey in colour, lighter on the ventral part with 14-16 longitudinal golden lines which are more or less visible. It has a large stain at the back of the neck spreading from the beginning of the dorsal to the insertion of the pectoral fins and behind the operculum. The ring on the caudal peduncle runs over the base of the last rays of the dorsal and the anal fins. Reaching a maximum size of 45 cm, the most common size of this species varies between 18 and 25 cm.

The *Diplodus vulgaris* lives in coastal waters on rocky or sandy bottoms as deep as 130 m. The individual young fish live on the meadows of Posidonia. They are carnivores and feed on crustaceans, molluscs and maggots. Being potentially hermaphrodite, they mature at two years of age (17 cm) and breed in October-November in the western Mediterranean and in December-January in the eastern Mediterranean. There are two breeding seasons off the coasts of Algeria: December-January for the youngest and May-June for individuals greater than 25 cm.

Its area of distribution includes the Mediterranean, where it is common and the tropical Atlantic as far as the Bay of Biscay.

As regards markets, this species' perspectives are unknown. In Spain this species has average-low prices (4 USD/kg).

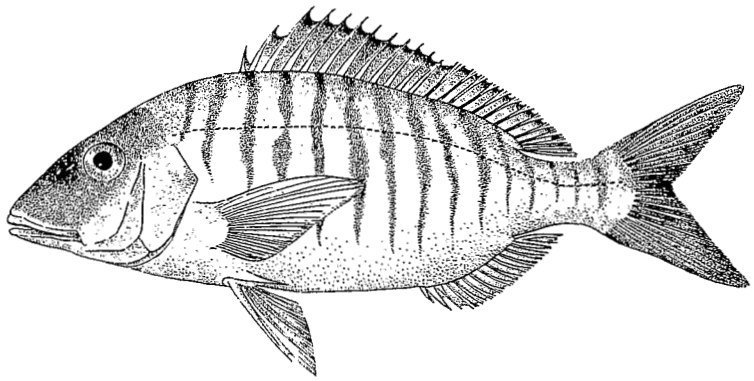
Current situation of the culture: Ongrowing has been attempted (IEO Murcia, Spain), from wild juveniles. Although there is very little data, in principle its culture is not advisable due to its low growth.

Species: *Diplodus vulgaris*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	U	U	4	T	WJ	+/-	4		O			0		T	WJ	+/-	12	ES		NP

Lithognathus mormyrus (Linnaeus, 1758); *Pagellus mormyrus*

English name(s)	Striped sea bream sand steenbras
French name(s)	Marbré
Italian name(s)	Marmora; mormora
Portuguese name(s)	Ferreira
Spanish name(s)	Herrera



This sparid has quite an elongated, compressed body. Grey in colour with silver reflexions which become darker in the dorsal section. It has 14 or 15 narrow, vertical grey or dull stripes. It reaches a maximum size of 55 cm but common sizes range from 15 to 30 cm.

Its lives near sandy or sandy-silty bottoms and above meadows as deep as 80 m, occasionally swimming into brackish waters. It is gregarious and sometimes forms large shoals. Breeding takes place in spring and summer, reaching sexual maturity at two years of age (approx. 14 cm). It is carnivorous and feeds on worms, molluscs, small crustaceans and sea urchins.

Its area of distribution includes the eastern Atlantic, from Morocco to the Bay of Biscay, where is it rare and the Mediterranean, where it is quite common.

No market studies have been conducted and therefore the perspectives are unknown. Average prices are fetched in Spain (about 4 USD/kg). It is found in most Mediterranean countries, where is sold fresh or chilled.

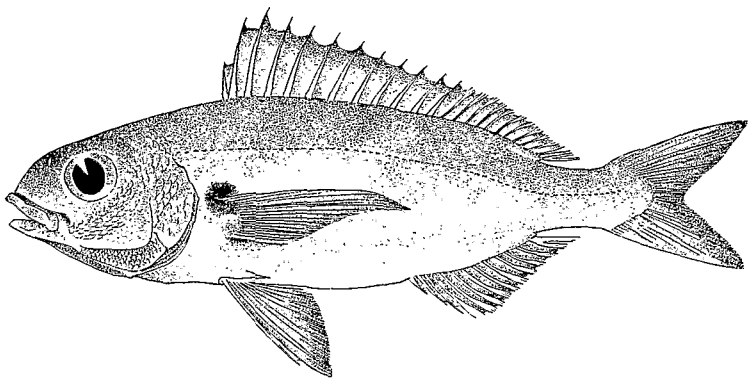
Current situation of the culture: A broodstock has been maintained in Spain (IEO Murcia) and spontaneous spawning has been achieved but without success at the time of feeding larvae.

Species: *Lithognathus mormyrus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	U	U	4	T	WJ	+/-	4		0			0		T	WJ	+/-	12	ES		NP

Pagellus acarne (Risso, 1826)

English name(s)	Axillary sea bream
French name(s)	Pageot acarné; pageot blanc; bogaravelle; pageot bâtard
Italian name(s)	Pagello mafrone; pagello bastardo; pagello
Portuguese name(s)	Besugo
Spanish name(s)	Aligote; besugo blanco; pancho; besugo chato



It is a sparid with pointed teeth at the front of the jaw and molar-shaped teeth at the back. It is pinkish grey in colour, darker on the back. Its maximum size is 36 cm although the average ranges from 10 to 25 cm. They are demersal fish which live on diverse bottoms at depths from 40 to 180 m. They are proterandric hermaphrodites and reproduce intermittently from June to September. They feed on worms, molluscs, small crustaceans and fish larvae. It is common in the Mediterranean and tropical Atlantic but rare at the north of the Bay of Biscay.

Currently present in markets of Spain, Morocco, France, Italy, Turkey and Cyprus and occasionally in Tunisia, Greece, Israel and Egypt, this species is marketed at prices that range from 4 to 10 USD/kg. No market studies have been conducted and therefore the perspectives are unknown.

Current situation of the culture: Culture experiments are taking place in Italy (NCR Messina), Spain (IEO Murcia) and Cyprus (Dept. Fisheries). Research on the culture of the species is at an initial stage. The maturation and spawning of broodstock is currently under study.

- Reproduction: The breeders, which come from wild juveniles, are kept in tanks and there is very little existing data on management. Problems of management, nutritional requirements, maturation in captivity and control of spawning must be solved.

- Larval culture: In Italy and Cyprus, it is carried out in small volumes in open systems. There is hardly any data and it is necessary to establish culture techniques, nutritional requirements and feeding sequences.

- Weaning: It takes place in open systems and in small volumes. It is necessary to develop weaning techniques.

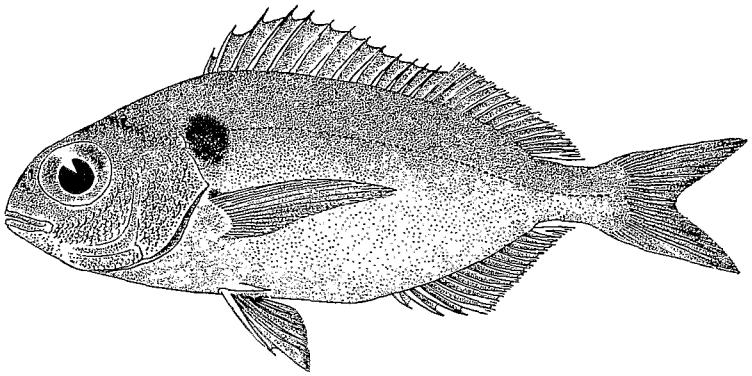
- Ongrowing: It is carried out in tanks and from wild juveniles. In some cases, fry born from reproduction in captivity have been used. There does not seem to be many problems although it is necessary to develop and optimize adequate techniques, establish nutritional requirements and design a type of diet apt to improve the low growth rates.

Species: *Pagellus acarne*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	M	U	9	T	WJ	+/-	2, 4, 6	SVO	+/-	5, 6, 7	SVO	+/-	5, 6, 8	T	RE	+/-	5, 6, 8	ES		NP
Respondent 2	N	M	M	10	T	WJ	+	3		0					T	WJ	+		ES		
Respondenr 3	N	U	U	4	T	WJ	0			0			0		T	WJ	+	12	ES		NP

Pagellus bogaraveo (Brünnich, 1768); *Pagellus cetrodontus*

English name(s)	Red sea bream; red bream; common sea bream; dorade; chad; blackspot sea bream
French name(s)	Dorade commune; dorade rose; brème de mer; bogaravelle; dorade; pironneau; rousseau
Italian name(s)	Occhialone; rovello; pagello
Portuguese name(s)	Goraz
Spanish name(s)	Besugo; besugo de Laredo; goraz; pancho; besugo del Norte; bagaravel; aligote bogaraveo



A sparid fish, it has an oblong reddish-grey body with a dark spot at the origin of the lateral line. Maximum size is 70 cm and the common size ranges from 15 to 50 cm. This demersal species lives on various sea-bottoms (rocky, sandy, silty) as deep as 400 m in the Mediterranean and 700 m in the Atlantic. It is a gregarious fish during the spawning period when adults approach the coast. It is a proterandrous hermaphrodite breeding in summer and autumn. The first sexual maturity is reached at 4-5 years of age (22-25 cm). It is predominantly carnivorous and feeds on pelagic invertebrates, eggs, larvae and juvenile fish.

Its area of distribution includes the tropical Atlantic from Norway, where it is common, and the Mediterranean where it is not so common.

No market studies have been carried out. Local perspectives are good and regional perspectives are unknown. They are regularly found in markets in Spain, Morocco and Italy, occasionally in Tunisia and Greece and are sold fresh.

Current situation of the culture: Culture experiments are being carried out in Greece (Nireus), Italy (NCR Messina) and Spain (IEO Vigo, IEO Santander, Centro Invest. Marinas Vilanova de Arosa).

- Reproduction: Breeders come from the sea (juveniles or adults) and are kept in tanks. In Italy, the main problem lies in the difficulty of obtaining maturation in captivity. In Spain there are problems in the obtention of adults from the sea and it is necessary to improve husbandry techniques.

- Larval culture: Both small and large volumes are cultured in closed and open systems. No serious problems seem to exist but it is necessary to improve culture techniques.

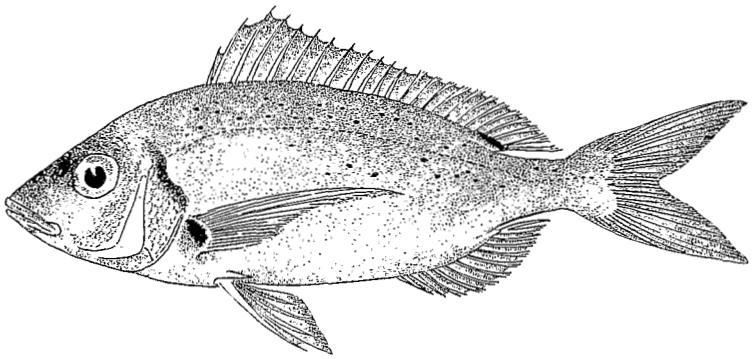
- Ongrowing: This will be carried out in cages and tanks of fry obtained in captivity. It is necessary to determine the nutritional requirements and establish the diet-type, as well as to develop the adequate on-growing techniques.

Species: *Pagellus bogaraveo*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	U	15	T	WJ	-	3		0					T	WJ	+		ES		NP
Respondent 2	N	M	M	9											C	WJ	+		SC	4	
Respondent 3	N	G	G	18	T	WJ, WA	+/-	2, 6	SV, SVO	+/-	5, 6, 9	SVO	0	10	T	RE	+/-	6, 10, 8, 17	PS		NP
Respondent 4	N	G	G	18	C	WA	+/-	2, 4, 6				C			C	RE	+/-	6, 10, 5	PS		NP

Pagellus erythrinus (Linnaeus, 1758); *Pagellus canariensis*

English name(s)	Pandora; Spanish sea bream; common pandora
French name(s)	Pageot rouge; pageot commun
Italian name(s)	Pagello fragolino; fragolino; pagallo; luvaro
Portuguese name(s)	Bica
Spanish name(s)	Breca; pajel; garapello; pagel



It is a sparid characterized by its compressed oval body and rectilinear head profile. It is bright pink in colour with blue spots on the upper part of the flanks. The post-upper fringe of the operculum is red crimson and bears a reddish spot at the bottom of the pectoral fins. The maximum size is 60 cm, the average ranging from 10 to 30 cm.

It can be found in the tropical Atlantic ocean as far as Norway (rare at the north of the Bay of Biscay) and it is common in the Mediterranean. This demersal fish lives on diverse bottoms (rocks, sand, gravel) as deep as 320 m; but is commonly found at depths from 20 to 100 m. A protogenic hermaphrodite, the individuals which are first females, turn into males as from the beginning of the 3rd year (17-18 cm). They reproduce from spring to autumn. They are omnivorous and predominantly carnivorous.

This sparid is marketed fresh, chilled or frozen. It is commonly found in markets in Algeria, Spain, France, Morocco and Cyprus, and the selling price ranges from 12 to 16 USD/kg. There are no market studies (except at the University of Palermo). The perspectives, in principle, seem to be good both at local and regional levels.

Current situation of the culture: There is some data on its culture, coming from Italy (COISPA Bari, Univ. of Palermo). In Spain experiences have also been made at the IEO Tenerife.

- Reproduction: The breeders are captured in the sea as juveniles or adults and are kept in tanks or cages. According to the existing data, the level of knowledge about management of breeders can be considered to be acceptable. Nevertheless, it is necessary to investigate into aspects related to feeding, maturation and spawning control and spawning quality.

- Larval culture: It takes place in small volume tanks in open or closed systems. The situation of the culture in the different centres can be characterized by a lack of data (COISPA) but a good knowledge status (Mariculture), the main problems being low egg quality (Reproduction) and larvae, which grow slowly. It is considered necessary to advance in the development of culture techniques and define nutritional requirements and a feeding sequence.

- Weaning: It is carried out in the larval culture tanks and the situation is similar to that existing in the previous stage, it being essential to gain knowledge and further study the design and elaboration of adequate diets and feeding regime.

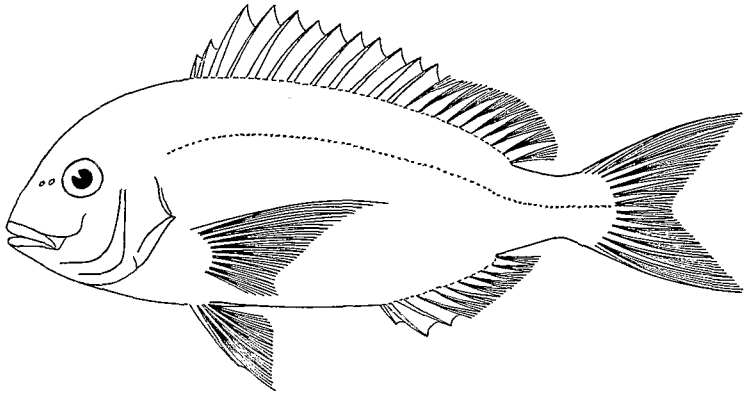
- Ongrowing: Tanks and cages are used, starting from fry born in captivity and also wild juveniles. The development of adequate ongrowing techniques is still pending.

Species: *Pagellus erythrinus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	15	T	WA, RE	+	2	SVO	+		SVO	+		C	RE	++	12	PS		
Respondent 2	N	G	G	15	T	WA	+	-	SVO	+	-	SVO	+	-	C/T	RE	+/-	-	PS		
Respondent 3	N	G	G	16	T	WJ	+/-	4		O			O		T	WJ	+/-		PS		NP
Respondent 4	Y	U	U	12	C	WJ	+	4, 7	SV	+/-	14, 15	SV	+/-	7	C	RE	+/-	5	ES		NP
Respondent 5	N	G	G		T	RE, WA		4													
Respondent 6	N	G	G	16	T	WJ, WA	+/-	4							T	WJ	+	ES			NP, IP
Respondent 7	N	M	M	5	T	WA	+/-	1, 2, 4	SVO	+/-	7, 8, 13	SV0	+/-	6, 13	T	WJ, RE	+/-	8, 13	ES		NP

Pagrus major (Temmick and Schlegel, 1843); *Chrysophrys major; Sparus major*

English name(s)	Madai; Japanese sea bream
French name(s)	Daurade japonaise; daurade géante
Italian name(s)	Orata del Giappone
Portuguese name(s)	Dourada do Japâo
Spanish name(s)	Dorada gigante



It is a sparid which is featured by having two pairs of canines in the upper jaw and three pairs in the lower. On the flanks of both jaws it has two rows of molars. It has a bright pink-coloured back and white shade in the abdomen.

It is abundant in the North Pacific, being non-autochthonous in the Mediterranean. It is a demersal fish which lives on rocky bottoms at 80-90 m deep. It is a proterandric hermaphrodite and the spawning season goes from March to May in Japanese waters at temperatures of 15-22°C. It feeds on invertebrates and small fish.

The market possibilities for the Japanese sea bream in the Mediterranean are uncertain. Reported selling price in Italy and Cyprus ranges between 9 and 11 USD/kg. Only one market study has been implemented in Italy (Mariculture). It should be pointed out that because of marketing problems, mainly due to the dark colouring of the fish, work on this species has been discontinued on this species by Cyprus government and the private sector in 1997.

Current situation of the culture: Experiments on the culture of this species (already commercially cultured in Japan), some of them already discontinued, have been made in Cyprus (Dept. of Fisheries, Sagro Aquaculture Ltd, Sagro Deep Sea Fish Ltd) and Italy (ENEA Rome, Ittiomar II). The situation is the following:

- Reproduction: Once the biological cycle is closed, the breeders which are kept in tanks, come from the fry born in captivity. There does not seem to be any problem on broodstock management and yield of spawning (very good level).

- Larval culture: It takes place in small volume tanks and in open systems (sometimes the system is closed). The knowledge status gained in this stage of the culture is good although it is considered necessary to optimize culture techniques, establish a feeding sequence and solve mortalities due to cannibalism.

- Weaning: It is done in small volume tanks and open systems. The technique used can be regarded as acceptable and it is also necessary to achieve homogeneous growth and determine nutritional requirements and to avoid cannibalism.

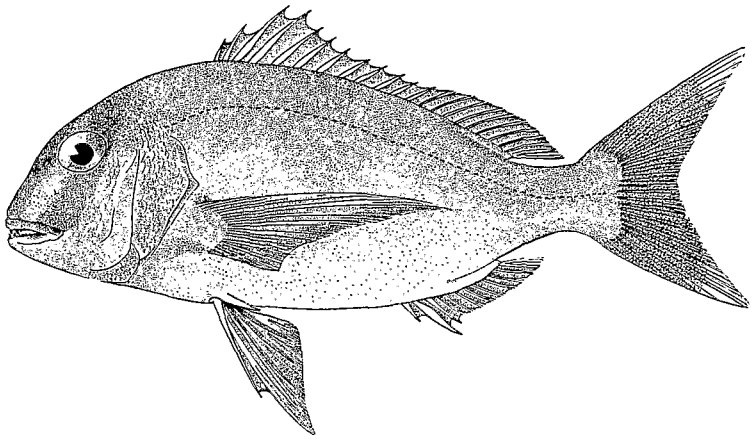
- Ongrowing: For the ongrowing, tanks and cages are most often used. The individuals selected for this stage of the culture come from spawnings in captivity. It is necessary research further into nutrition (nutritional requirements) and pathology, and do away with cannibalism problems.

Species: *Pagrus major*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	U	U	11	T	RE	+		SVO	+	7	SVO	+	6, 11, 16	T	RE	+	19 ,6	ES	0.2	NP
Respondent 2	N	M	M	9	T	RE	+	5	SVSVO	+	5	SVSVO	+	11, 16	T	RE	+	6, 10, 15	SC	-	NP
Respondent 3	Y	U	U	-	T	RE	++	-	SVO	+	11	SVO	+	11	C/T	RE	+/-	11	SC		

Pagrus pagrus (Linnaeus, 1758); *Pagrus vulgaris; Sparus pagrus*

English name(s)	Couch's sea bream; common sea bream; red porgy
French name(s)	*Pagre commun*
Italian name(s)	Pagro mediterraneo; pagro
Portuguese name(s)	Pargo legítimo; pargo; pargo verdadeiro
Spanish name(s)	Pargo



It is a sparid characterized featured by having large canines in the central part of each jaw (4 upper canines and 6 lower canines), followed by smaller obtuse canines which turn into molar-shaped teeth at the back. It is pink and silver in colour and lighter in the central part. Both ends of the caudal fin are white with a dark spot on the axila of the pectoral fins. Its maximum size is 82 cm. although it the size of 20-60 cm is more common. It can weigh more than 10 kg.

This demersal fish lives on firm or sandy bottoms up to 250 m deep (more common as far as 100 m deep). At sea they reproduce from April till June. They are carnivores and feed mainly on crustaceans, molluscs and fish. It is rare in the tropical Atlantic and can be found in the Mediterranean, although it is less common than the gilt-head sea bream.

This fish, which has a high price demand, is found regularly or occasionally in most Mediterranean markets: Spain, Italy, Greece, Turkey, Egypt, Cyprus. Market studies are non-existent, but its flesh is highly appreciated and perspectives are good in the countries where it is cultured. Its price ranges from 11 to 22 USD/kg.

Current situation of the culture: Culture experiments are carried out in Cyprus (Deprt. of. Fisheries, Aquaculture Technologies, Sagro Aquaculture Ltd), Greece (NCMR, IMBC, Selonda, Nireus), Italy (ICRAM Rome, Ittaca Mediterranea), Portugal (Univ. of Algarve) and Spain (IEO Tenerife, GIA Gran Canaria.

This sparid presents a high growth rate. It has a good adaptability to culture conditions and presents no serious disease problems. Data on reproductive biology, growth and larval rearing, as well as information related to the intensive farming problems is already available. However, technological and nutritional improvements must be made in larval rearing, in order to avoid problems, such as the discolouration of the *Pagrus pagrus* body, apparently due to its nutritional requirements.

- Reproduction: The breeders come from juveniles captured at sea, although they may also originate from juveniles born in captivity (IMBC, Crete). They are normally kept in tanks, and sometimes, in cages. Reproduction is adequately controlled through the photoperiod. There are problems concerning the availability of individuals and it is necessary to investigate into nutritional aspects, maturation control and spawning quality. It is also necessary to study the social factors which influence sexual inversion and also to define the necessary sex-ratio for reproduction.

- Larval culture: It takes place in small volumes in open or closed systems, and in large volumes in mesocosmos systems. It is necessary to develop the larval culture techniques, determine nutritional requirements and establish the feeding sequence which allows a higher rate of survival and better larval quality to be obtained. It is also necessary to study the role of green waters in larval culture and establish morphological and morphometrical series as well as quality criteria.

- Weaning: It is developed in the same sort of tank as the larval culture but in open systems. The results obtained are different in the different culture centres and therefore it is necessary to optimize the techniques fixing the nutritional requirements, the type of diet and feeding sequence in order to achieve higher survival rates.

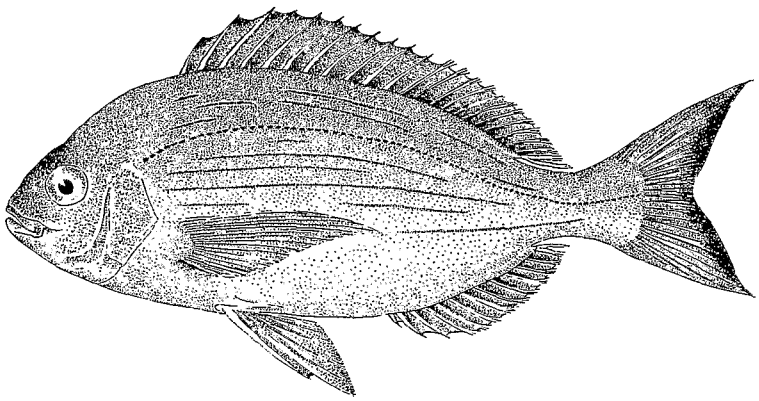
- Ongrowing: It takes place, with good results, in tanks and cages, most often from wild juveniles and in some exceptional cases, from fry produced in captivity. There are feeding, nutritional and pathological problems. The problem of pigmentation, although ameliorated, has not been completely solved (the natural pink colour has not yet been achieved). It is necessary to improve the ongrowing techniques and devise appropriate diets in order to get a better feed conversion and a homogeneous growth of individuals.

Species: *Pagrus pagrus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	22	T	WJ	+/-		SVO	+/-	5, 6, 7, 14	SVO	+/-	5, 6, 7, 13	T	RE	+/-	5, 6, 19	ES		IP / NP
Respondent 2	N	G	G		T	WJ	-	4											ES		NP
Respondent 3	N	G	G	13	T	WJ	+/-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
Respondent 4	N	G	G	11	T	WJ, RE	+	4	LV, SV	+/-	5, 6, 7, 8 ,11	LV	+	6	T	WJ, RE	+/-	6, 8, 17	ES	5	IP
Respondent 5	Y	G	G		C	RE	+	2	SVO	+	5	SVO	+	8, 6	C	RE	+	5	SC	50	
Respondent 6	N	G	G	14	T	WA	+	-	SVO	++	-	LV	++	-	C	RE	+	19	SC	2	
Respondent 7	N	G	M	15, 18	T	WJ	-	1, 6		+/-			+/-		C/T	WJ	+/-	5, 6, 10	ES	1-2	NP
Respondent 8	N	M	M		T	WA	+/-	3, 4													
Respondent 9	N	G	G	20	T	WA	+/-	4	SVO	-	13	SVO	0						ES		IP
Respondent 10	Y	G	G	11	C+T	WA	+/-	19	SVO	+/-	19	SVO	+/-	19	C/T	WJ	+/-	19	ES		NP
Respondent 11	N	G	G	11	T	WJ	+/-	4	SVO	+/-	6,7	SOV	+/-	5,6,8	T		+/-	6	ES		NP

Spondyliosoma cantharus (Linnaeus, 1758); *Cantharus cantharus; Cantharus griseus; Cantharus lineatus*

English name(s)	Black sea bream; sea bream; old wife
French name(s)	Dorade grise; griset; canthare gris
Italian name(s)	Tanuta; cantaro
Portuguese name(s)	Choupa
Spanish name(s)	Chopa; jargueta; pañoso



This sparid has an oval, compressed body. It is silver-grey in colour with blue-green or pink reflexions. The head is darker, especially between the eyes and over the mouth. There are longitudinal, golden-yellow, more or less dotted lines on the flanks.

Maximum size is 60 cm and common sizes range between 20 and 30 cm.

This demersal species lives above the continental shelf on meadows and rocky or sandy bottoms. Adults go down as deep as 150 m and young fish down to 50 m. This is a proterogynous hermaphrodite species which breeds between February and March. It is omnivorous and feeds on algae and small invertebrates, especially crustaceans.

Although no market studies have been carried out, the perspectives for this species are considered to be good at local level (Greece).

Current situation of the culture: Up to now, broodstocks are only maintained, in tanks, in Greece (IMBC, NCMR, Nireus) and Italy (Ittica Mediterranea). Successful reproduction has not yet been achieved in captivity. When spawning is achieved there are problems with eggs that stick to bottom objects. Thus, research priorities for this species must concentrate on spawning control, egg collection and hatching systems.

Species: *Spondyliosoma cantharus*

Institution/Company	Market knowledge				Broodstock management				Larvae culture			Weaning			Ongrowing				Production scale		Res
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Respondent 1	N	G	G	8	T	RE	-	3		0			0				0				
Respondent 2	N	G	M	12	T	WA	+/-	4											ES		
Respondent 3	N	M	M		T	WA	+/-	3, 4													

Annexe I

Survey questionnaire

TECAM. NETWORK ON TECHNOLOGY OF AQUACULTURE IN THE MEDITERRANEAN

SURVEY ON MEDITERRANEAN MARINE AQUACULTURE FINFISH SPECIES DIVERSIFICATION

FIRST NAME: SECOND NAME:
COUNTRY:
UNIVERSITY / INSTITUTION /COMPANY:
FACULTY / CENTRE / DELEGATION:
DEPARTMENT / SECTION:
ADDRESS:

TELEPHONE: FAX: E.MAIL:

Please, indicate the present knowledge status you have in your Laboratory, Institution or Company for the different culture aspects of new marine aquaculture finfish species, other than gilthead sea-bream and sea-bass. Read the instructions (pages 2 & 3) before answering the survey. See the example given in page 6.

[1]SPECIES	[2]Market knowledge				[3]Broodstock management				[4]Larvae culture			[5]Weaning			[6]Ongrowing				[7]Scale of Production		[8]Research
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	

Intructions to answer the survey

Column

1. Species:

Write the ***latin name*** of the marine new finfish species your are working on. New marine Mediterranean aquaculture finfish species, among others, are: *Solea sp.*, other Flatfish, Siganids, *Puntazzo puntazzo, Pagrus pagrus, Dentex dentex, Diplodus sp., Pagelulus bogaraveo, P. erythrinus, P. acarne, Corypahena hyppurus, Seriola dumerilii, Epinephelus marginatus, Epinephelus sp. and Sciaenops ocellatus*. Be advised that *Sparus aurata, Dicentrarchus labrax*, eels and sturgeons are not considered new species.

2. Market Knowledge:

Indicate here if you have done a market study for the species you are working on, and indicate the perspectives for the commercialization of the species at local or regional market (Mediterranean countries).

Market study (S):
- N = Market Study Not Done
- Y = Market Study Done

Local Market perspectives (L):
- U = Unknown Perspectives
- M = Medium Perspectives
- G = Good Perspectives

Regional Market perspectives (R):
- U = Unknown Perspectives
- M = Medium Perspectives
- G = Good Perspectives

Price (P)
- XXX = 1995 local market price in USD/Kg

3. Broodstock management:

Rearing System (RS):
- C = Cage
- T = Tank
- P = Pond

Fish Origin (FO):
- WJ =Wild Juveniles
- WA = Wild Adult
- RE = Controlled Reproduction

Knowledge Status (KS):
- 0 = No data
- - = Constraints
- +/- = Further Knowledge Required
- + = Good
- ++ = Very Good

Main problems (MP):
- 1 = Breeders availability
- 2 = Broodstock management
- 3 = Sexual maturation in captivity
- 4 = Control of spawning
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 19 = Others: indicate any other problem in page 4.

4. Larvae culture:

Rearing System (RS):
- SV = Small Volume tot/par. Closed system
- SVO = Small Volume Open System
- LV = Large Volume: mesocosm

Knowledge Status (KS):
- 0 = No data
- - = Constrainst
- +/- = Further Knowledge Required
- + = Good
- ++ = Very Good

Main Problems (MP):
- 5 = Appropiate larval rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Live food
- 9 = Inert food
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 14 = Egg quality
- 15 = Larval quality (morphological anomalies)
- 19 = Others: indicate any other problem in page 4.

5. Weaning:

Rearing System (RS):
- SVR = Small Volume tot/par recircul.
- SVO = Small Volume Open System
- LV = Large Volume

Knowledge Status (KS):

0 = No data
- = Constraints
+/- = Further Knowledge required
+ = Good
++ = Very Good

Main problems (MP):

5 = Appropriate rearing techniques
6 = Nutritional requirements
7 = Feeding sequence / Regime
8 = Type of diet
10 = Diseases
11 = Cannibalism
12 = Low growth
13 = Low survival
16 = Different growth rate within group of same origin
19 = Others: indicate any other problem in page 4.

6. Ongrowing:

Rearing System (RS):

C = Cage
T = Tank
P = Pond

Fish Origin (FO):

WJ = Wild Juveniles
RE = Controlled Reproduction

Knowledge Status (KS):

0 = No data
- = Constraints
+/- = Further Knowledge required
+ = Good
++ = Very Good

Main problems (MP):

5 = Appropiate rearing techniques
6 = Nutritional requirements
7 = Feeding sequence / Regime
8 = Type of diet
10 = Diseases
11 = Cannibalism
12 = Low growth
13 = Low survival
16 = Different growth rate within group of same origin
17 = Poor feed conversion
18 = Precocious sexual maturation
19 = Others: indicate any other problem in page 4.

7. Scale of production:

Type: ES = Experimental or laboratory scale
PS = Pilot scale
SC = Small commercial scale

Tons: XXX = Please, indicate the 1995 / 6 production (tons) at your facilities.

8. Research: Indicate if you have research projects on this species.

NP = National Projects
IP = International Project

For more explanations (topics, etc) use survey comments page (page 4).

Survey comments

Please use one sheet per species

1. Species:

2. Market Knowledge:

3. Broodstock management:

4. Larvae culture:

5. Weaning:

6. Ongrowing:

7. Scale of production:

8. Research:

8.1. Indicate on what area/research topics your group is at present working on a given species:

8.2. Indicate on what area/research topics you will like to work on a given species:

5

8.3. Please, give the name of the experts that integrate your group, indicating their work topic

Other comments: Indicate here any problem or aspect not previously mentioned you may want to point out concerning the culture of a given species. For instance, exotic species, restocking, ranching, etc.

TECAM. NETWORK ON TECHNOLOGY OF AQUACULTURE IN THE MEDITERRANEAN

SURVEY ON MEDITERRANEAN MARINE AQUACULTURE FINFISH SPECIES DIVERSIFICATION

October 1995

FIRST NAME: SECOND NAME:

SURVEY EXAMPLE

COUNTRY:
UNIVERSITY / INSTITUTION /COMPANY:
FACULTY / CENTRE / DELEGATION:
DEPARTMENT / SECTION:
ADDRESS:

TELEPHONE: FAX: E.MAIL:

[1]SPECIES	[2]Market knowledge				[3]Broodstock management				[4]Larvae culture			[5]Weaning			[6]Ongrowing				[7]Scale of Production		[8]Research
	S	L	R	P	RS	FO	KS	MP	RS	KS	MP	RS	KS	MP	RS	FO	KS	MP	Type	Tons	
Solea senegalensis	N	G	U	25	P	WJ	++		LV	++	9	LV	-	5, 6, 10	P	WJ	-/0	6, 11	SC	50	NP
Puntazzo puntazzo	N	U	M	15	C	WA	-/0	4, 19	SVO	+		SVO	+	6	C	RE	+/-	6, 12	PS	2	
Diplodus sargus	Y	G	M		C	WJ	-/0	4	SV	-/0		SVO	++		C	WJ	-	8	PS		
Dentex dentex	Y	G	G	20	C	RE	++	19	SVO	++	6, 7	SVO	+/-	10	C	RE	+/-	6, 8	SC	100	IP
Pagellus acarne	Y	M	M		T	WA	0		LV	0	19	SVR	0		C	WJ	-		ES		
Epinephelus marginatas	N	G	G	27	T	WJ	-/0	1	SV	0		LV	0		T	WJ	+		ES		NP
Seriola dumerilii	N	M	G	15	C	WJ	-/0	3	SV	0		LV	0		C	WJ	++		ES		NP
Coryphaena hippurus	N	M	U		T	RE	-	2	LV	-	5, 6, 7	LV	0		P	WJ	++		ES		

Annexe II

Mediterranean institutions, firms, experts and their related working topics

CROATIA

Experts	Species	Topics working on	Topics to work on
Institute of Oceanography and Fisheries (IOF), Dubrovnik			
SKARAMUCA, Bosko (team coordinator: experimental design, broodstock management, sample data analysis) GLAMUZINA, Branko (hormonal treatement, eggs and larval quality, broostock condition) KOZUL, Valter (live food production, egg and larval rearing, sample processing, statistical analysis) ONOFRI, Vladimir	*Epinephelus marginatus* *Seriola dumerili* *Scorpaena scrofa* *Labrus merula*	*E. marginatus:* reproduction and larval rearing *S. scrofa:* rearing and spawning	

CYPRUS

Experts	Species	Topics working on	Topics to work on
Ministry of Agriculture, Natural Resources and Environment, Dept. of Fisheries, Nicosia			
STEPHANOU, Daphne (reprod. larval rearing, ongrowing) GEORGIOU, Georgios (reprod. larval rearing, ongrowing) ANASTASIADES, G. (fish nutrition) LOIZIDES, L. (water quality) HADJICHRISTOPHOROU, M. (environ. impact) SAVVIDES, A. (fish pathology) ANASTASIADES, S. (fish pathology)	*Dentex dentex* *Pagellus acarne* *Pagrus major* (discontinued in 1997) *Pagrus pagrus* *Diplodus puntazzo* *Siganus rivulatus*	*D. puntazzo*: Reproduction *D. dentex*: Reproduction, larval rearing, weaning, ongrowing *P. pagrus*: Reproduction, larval rearing parameters, ongrowing *S. rivulatus*: Reproduction, larval rearing, ongrowing *P. acarne*: Reproduction, larval rearing, ongrowing	Problems encountered with the reproduction of *D. puntazzo*, the change of the colour (darkenning) of *P. pagrus* table size fish and the mass production of larvae of Siganids using mesocosm rearing system. Reproduction, larval rearing and ongrowing of *Pagellus erythrinus, Seriola dumerilii*, and groupers (in the future).
Aquaculture Technologies Ltd., Limassol			
Hatchery Manager	*Dentex dentex* *Epinephelus marginatus* *Pagrus pagrus* *Diplodus puntazzo* *Umbrina cirrosa*	*E. marginatus*: Control of maturation /reproduction. Development of suitable sized live feeds. Development of suitable on-growing diets. *D. dentex*: Research scaled down in favour of other more promising species. Maturation and reproduction	*D. dentex*: Nutrition and diet development
Kimagro Fish Farming Ltd., Limassol			
KIMONIDES, Antonis	*Diplodus puntazzo*	Fattening, marketing	
Sagro Aquaculture Ltd., Paphos, Limassol			
MARANGOS, Christos	*Diplodus puntazzo* *Pagrus major* (discontinued in 1997) *Pagrus pagrus*	*D. puntazzo*: Reproduction, fry production *P. major*: Reproduction, fry production *P. pagrus*: Larval rearing, fry rearing	Reproduction problems of *P. puntazzo* Groupers Seriola
Sagro Deep Sea Fish Ltd., Paphos, Limassol			
AGROTIS, Savvas	*Diplodus puntazzo* *Pagrus major* (discontinued in 1997)	*D. puntazzo*: Fattening, marketing *P. major*: Fattening, marketing	Fattening of *Pagrus pagrus*. Darkening problem of this species.
Telia Aqua Marine Ltd., Liopetri, Nicosia			
Hatchery manager	*Pagrus pagrus*	Larval, fry rearing	Fattening of *Pagrus pagrus* Siganids

EGYPT

Experts	Species	Topics working on	Topics to work on
National Institute of Oceanography & Fisheries (NIOF), Alexandria			
ZAKI, Magda I. (Head of Lab. / Fish spawning) ESSA, Mohamed A. (Head of El-Mex Research Station / Fish breeding and production) El-WAFA, Mona A. Abo (Fish rearing) RAHMAN, Soliman H. A. (Fish nutrition)	*Siganus rivulatus* *Diplodus sargus* *Solea vulgaris*		Artificial production of larvae

FRANCE

Experts	Species	Topics working on	Topics to work on
Université de Montpellier II, Sète			
BARNABE, Gilbert (Researcher)	*Thunnus thynnus* *Seriola dumerili* *Sparus* sp.	Some research already conducted	
Cyclope -- Productions Aquacoles, Sète			
BONFILS, Jerôme (Manager)	*Epinephelus marginatus*	Building up of broodstock lost at the beginning of 1995, some hormone injection trials - no spawning	
SCORSA, Aleria			
BRONZINI (Director)	*Seriola dumerili* *Charax charax* *Dentex dentex* *Diplodus puntazzo*	Some ongrowing trials in cages	
Sté GAEC "Les Poissons du Soleil", Balaruc les Bains			
BALMA, Georges (Director)	*Diplodus puntazzo*	Broodstock, larval rearing, fry production (400,000 fry produced in 1994), pre-ongrowing	
Société 3A SARL, La Brague, Antibes			
DAMIANO (Director)	*Sciaena umbra*	Broodstock built up, beginning of larval rearing	

GREECE

Experts	Species	Topics working on	Topics to work on
Institute of Marine Biology of Crete (IMBC), Iraklio			
Dr. KENTOURI, Maria Dr. DIVANACH, Pascal (biodigestion, mesocosms) Dr. PAVLIDIS, Michaelis (physiology, reproduction) Dr. PASPATIS, Michaelis (behavior, feeding rhytms) Dr. PAPANDROULAKIS, Nikos (intensive larval cultures Mr. KOUMOUNDOUROS, Georgios (MSc) (morphology, morphometry)	*Diplodus puntazzo* *Pagrus pagrus* *Dentex dentex* *Diplodus sargus* *Seriola dumerili* *Epinephelus aeneus* *Cantharus cantharus*	*D. puntazzo*: Extensive larval rearing, wearing, ongrowing and preliminary studies on reproduction *P. pagrus, D. dentex*: Reproduction (broodstock management, sexual maturation in captivity, control of spawning)	*D. puntazzo*: Intensive larval rearing *P. pagrus, Dentex dentex*: Intensive larval rearing, nutritional requirements
National Centre for Marine Research (NCMR), Institute of Marine Biological Resources, Aquaculture Department, Athens			
Dr. KLAOUDATOS, Spyros (Broodstock management, eggs and larval rearing) Dr. CONIDES, Alexis (larval rearing, fry management, ongrowing, sample processing and analysis) Dr. ALEXIS, Maria (Fish nutritionist, biochemistry) Dr. NENGAS, Ioannis (Fish nutrition, aquaculture biologist) Mr. CHRISTOFILOGIANNIS, Panos, Msc. (Fish pathology) Ms. FOUNDOULAKI, Eleni, Msc. (Fish nutrition) Mr. GIALAMAS, Ioannis, Msc. (Chemical engineering, biochemestry) Ms. ZANNOU, Barbara, Msc. (Marketing, socioeconomic analysis) Ms. PAPOUTSI, Eleni (Aquaculture technician) Mr CHATZIEFSTATHIOU, Michalis (Aquaculture technician) Mr. KYRIAKAKOS, Lysandros (Aquaculture technician)	*Pagrus pagrus* *Diplodus puntazzo* *Dentex dentex* *Spondyliosoma cantharus*	*P. pagrus*: Broodstock management. Intensive larval rearing and nutritional requirements *D. puntazzo*: Reproduction, larval rearing and nutritional requirements *Dentex dentex:* Nutrition	*Pagellus erythrinus*: Reproduction, larval rearing and ongrowing of fish *D. puntazzo*: Development of suitable diets for stimulation and control of reproduction of captivity

GREECE (cont.)

Experts	Species	Topics working on	Topics to work on
Nireus. Fisheries and Aquaculture Consultants S.A.			
BAKELA, Zoe (Manager) TZOUMAS, Apostolos-Spiridon N. (Production and R&D Director) DATSOPOULOS, Andreas D. (Manager)	*Diplodus puntazzo* *Pagrus pagrus* *Dentex dentex* *Diplodus sargus* *Pagellus erythrinus* *Pagellus bogaraveo* *Seriola dumerili* *Epinephelus alexandrinus* *Spondyliosoma cantharus* *Solea* spp.	*D. puntazzo*: Photoperiod spwaning *P. pagrus*: Ongrowing, pigmentation *D. dentex*: Spawinig control (e.g. by photoperiod), nutritional requirements during ongrowing *P. erythrinus*: Broodstock management and spawning *E. alexandrinus*: Spawning, broodstock management *Solea* spp.: Comparative growth of *S. solea* and *S. senegalensis* under extensive and intensive conditions	*P. pagrus*: Nutritional requirements *D. dentex*: Larval quality, nutriotional requirements at larvae and weaning stages, pathology *D. sargus*: Nutritional requirements, genetic improvement *P. erythrinus*: Nutritional requirements, genetic improvement *P. bogaraveo*: Spawning control *S. cantharus*: Eggs collection and hatching
Selonda Aquaculture S.A. & Rio Pesca			
SELONDA AQUACULTURE: GATLAND, P. (chairman of R&D committe) KELSEY, P. (hatchery techniques; larval rearing and weaning) PAVLIDOU, P. (broodstock; nutrition) LYTRA, K. (diseases; nutrition) RIO PESCA: KOLLIOS, P. (hatchery techniques; larval rearing and weaning) KYRITSIS, S. (diseases; nutrition) KATRIBUZIZIS (nutrition and R&D work)	*Diplodus puntazzo* *Pagrus pagrus* *Dentex dentex* *Diplodus sargus* *Seriola dumerili*	Nutritional and disease problems on all the afore mentioned species are the main area of research at Selonda. R&D effort on new species is in applied form using small production tonnage for trials	We would like fundamental nutritional work to be undertaken in collaboration with research institute/university

ISRAEL

Experts	Species	Topics working on	Topics to work on
Israel Oceanographic and Limnological Research (IOLR), National Center for Mariculture (NCM), Eilat			
GORDIN, Hillel Dr. ELIZUR, Abigail (reproduction control) Dr. TANDLER, Amos (larval rearing, since end of 1996 director of NCM) Drs. KISSIL, George, KOVEN, Bill and LUPATCH, Ingrid (nutrition) Dr. ANGEL, Dror (integrating the mullets as sanitation fish under fish cages) Drs. DIAMANT, Arik and COLORNI, Angelo (disease control) Dr. RON, Benny (nursing stage, physiology and behavior) Mr. Odi ZMORA (live food chain, head of department)	*Ephinephelus aeneus* *Acanthpagrus bifasciatus* *Mugil cephalus*	*E. aeneus:* Broodstock buiding, reproduction, larval rearing and diseases *A. bifasciatus:* Reproduction, larval rearing, nutrition, weaning, feeding and diseases	*E. aeneus*: Broodstock buiding, reproduction, larval rearing and diseases *A. bifasciatus*: Reproduction, larval rearing, nutrition, weaning, feeding and diseases

ITALY

Experts	Species	Topics working on	Topics to work on
Consiglio Nationale delle Ricerche (CNR), Istituto di Biologia delle Mare, Venezia			
BARBARO, Alvise Collaborations with: - NATURAE: larva culture, weaning, ongrowing	*Umbrina cirrosa*	Sexual maturation in captivity control of spawning of *U. cirrosa*	
Consiglio Nationale delle Ricerche (CNR), Istituto Sperimentale Talassografico, Messina			
GRECO, Silvestro MICALE, Valeria (reproductive biology) GENOVESE, Lucrezia (ongrowing & diseases)	*Diplodus puntazzo* *Diplodus sargus* *Pagellus acarne* *Seriola dumerili* *Pagellus bogaraveo*	Ongrowing and reproduction of *P. bogaraveo* Artificial diets for juvenile *S. Dumerili* Hormonal induction of spawning in *S. dumerili*	Control of spawning and optimization of rearing techniques for *D. puntazzo* Ongrowing and reproduction of *P. erythrinus*
Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA), Dipartimento Innovazione, Rome			
BARBATO, Fabio CANESE, Stefano (reproduction, genetics, rearing, fish, mollusk) CECCARELLI, Riccardo (environment, rearing, fish, mollusk) LAZARRI, Andrea (rearing, fish) MORETTI, Filippo (reproduction, genetics., fish)	*Pagrus major* *Diplodus puntazzo* *Seriola dumerili*	*D. puntazzo*: Cryopreservation of spermatozoa *P. major*: Cryopreservation of spermatozoa *S. dumerili*: Submerse cage rearing and reproduction	*D. puntazzo*: Reproduction, genetics *P. major*: Reproduction, genetics *S. dumerili*: Reproduction
Istituto Centrale per la Ricerca Scientifica e Tecnologia Applicata al Mare (ICRAM), Aquaculture Department, Rome			
MARINO, Giovanna Collaborations with: - Univ. of Genova (Dr. A. MANDRICH): endocrinology of reproduction - Univ. of Rome "Tor Vergata" (Prof. S. CATAUDELLA): genetics of gry mullets; *S. dumerili* and *E. marginatus* - Univ. of Rome "3 Univ." (Dr. G. VENTURINI): fish physiology	*Epinephelusa marginatus* *Pagrus pagrus* *Seriola dumerili* *Chelon labrosus* *Mugil cephalus*	*E. marginatus*: Physiology of reproduction, ermaphroditism, gamete quality, biochemical and haematological reference values *P. pagrus*: Physiology of reproduction, ermaphroditism, control of maturation and spawning, gamete quality, biochemical and haematological reference values, nutritional requirements (lipids) *S. dumerili*: Physiology of reproduction, control of maturation and spawning, gamete quality, biochemical and haematological reference values	For the aforementioned species work to be done on: Physiology of reproduction, endrocrinology of reproduction, artificial propagation, and larval rearing in mesocosm systems In addition for Seriola and *P. pagrus:* Sex inversion studies

ITALY (cont.)

Experts	Species	Topics working on	Topics to work on
Università di Palermo, Istituto di Zoologia			
MAZOLA, Antonio	*Seriola dumerili* *Diplodus puntazzo* *Diplodus sargus* *Pagellus erythrinus*		
COISPA Tecnología & Ricerca, Mola di Bari			
SPEDICATO, María Teresa LEMBO, Guiseppe CARBONARA, Pierluigi PLATI, Salvatore	*Epinephelus marginatus* *Pagellus erythrinus* *Paralichthys olivaceus*	*E. marginatus*: Induced spawning, sex reversal, ongrowing of wild juveniles, development of biotelemetry technique in order to control the restocking actions *P. erythrinus*: Broodstock formation, induced spawning, ongrowing of wild juveniles *P. olivaceus*: Nutritional and environmental requirements during larval stages	*E. marginatus*: Larval and post-larval rearing *P. erythrinus*: Larval and post-larval rearing
Ittica Mediterranea S.R.L., Petrosino			
LICARI, Vicenzo Collaborations with: - ICRAM - TECNOLOGIE EVOLUTE IN AQUACULTURA	*Diplodus puntazzo* *Diplodus sargus* *Dentex dentex* *Umbrina cirrosa* *Sciaena umbra* *Pagellus erythrinus* *Seriola dumerili* *Solea solea* *Epinephelus marginatus* *Pagrus pagrus* *Spondyiolosma cantharus*		
ITTIOMAR II, Monfalcone			
Hatchery Manager	*Dentex dentex* *Pagellus erithrinus* *Pagrus major* *Diplodus puntazzo* *Umbrina cirrosa*		

MALTA

Experts	Species	Topics working on	Topics to work on
Min. Agriculture and Fisheries, National Aquaculture Centre (NAC), Marsaxlokk			
MEILAK, Alex (Broodstock management)	*Diplodus puntazzo* *Seriola dumerili* *Coryphaena hippurus*		

MOROCCO

Experts	Species	Topics working on	Topics to work on
Institut National de la Recherche Halieutique (INRH), Projet Aquaculture Thon Rouge, Tetouan			
NHHALA, Hassan	Atlantic bluefin tuna	Reproduction	Larvae culture

PORTUGAL

Experts	Species	Topics working on	Topics to work on
Universidade do Algarve, Unidade de Ciencias e Tecnologias dos Recursos Aquáticos, Faro			
DINIS, Maria Teresa RIBEIRO, Maria Laura (histochem. formation of digestive tract) SOARES, Florbela (larval ontogeny, identification of abnormalities by histology and histochemistry) MAGALHAES, Nuno (quality of larvae using biochem. tools - DNA, RNA)	*Pagrus pagrus* *Solea senegalensis*	Larvae metabolism: Digestive tract, development and enzymes Larvae bioenergetics: Early weaning to inert, diets Essays on ongrowing in earthponds	Broodstock management Larval feed regime and larval quality
Instituto Português de Investigaçao Maritima (IPIMAR), Centro de Investigaçao Marítima do Sul (CIMSUL), Olhao			
POUSAO-FERREIRA, Pedro	*Solea senegalensis*		

SPAIN

Experts	Species	Topics working on	Topics to work on
Instituto Español de Oceanografia (IEO), Centro Oceanográfico de Canarias, Santa Cruz de Tenerife			
CEJAS PULIDO, Juana Rosa (*P. erythrinus, D. sargus, P. pagrus*) FORÉS SANJUÁN, Rafael (*S. dumerili*, and tuna fish)	*Seriola dumerilii* *Pagellus erythrinus* *Diplodus sargus* *Pagrus pagrus* *Thunnus thynnus* *Thunnus albacares* *Thunnus obesus*	*P. pagrus:* Broodstock management and larval cullture *D. sargus:* Broodstock management and larval cullture and ongrowing *P. erythrinus:* Broodstock management and larval cullture and ongrowing *S. dumerili:* Broodstock management Ongrowing of tuna fish in on-land facilities	Nutritional requirements and ongrowing of sparids
Instituto Español de Oceanografia (IEO), Centro Oceanográfico de Murcia, Mazarrón, Murcia			
GARCÍA-GÓMEZ, Antonio (new species diversification, rep., nut., growing) ABELLÁN MARTÍNEZ, Emilia (new species diversification, rep., nut., growing) GARCÍA-ALCÁZAR, Alicia (reproduction, nutrition, larvae cult)	*Dentex dentex* *Diplodus vulgaris* *Diplodus sargus* *Lithognathus mormyrus* *Mullus surmuletus* *Pagellus acarne* *Diplodus puntazzo* *Seriola dumerili*	*S. dumerili:* Phisiology of reproduction, nutrition and pathology *D. dentex:* Improvement of the survival rate and larval quality by developing better culture conditions and studying the factors which determine the feeding schedules	We would like to work on the larvae culture and weaning of *S. dumerili*, when the reproduction in captivity of this species will be possible. We would also like to work in other fast-growing species like tunids. In *D. dentex*, we would like to develop a basal diet which could cover its nutritional requirements in the pre-growth and growth stages and state their optimum feeding strategy.
Instituto Español de Oceanografia (IEO), Centro Oceanográfico de Santander, Cantabria			
FERNANDEZ, Carlos	*Pagellus bogaraveo*	*P. bogaraveo*: Reproduction, larval culture and nutrition	
Instituto Español de Oceanografia (IEO), Centro Oceanográfico de Vigo, Pontevedra			
OLMEDO HERRERO, Mercedes PELETEIRO ALONSO, José Benito	*Pagellus bogaraveo*	*P. bogaraveo*: Reproduction, larval culture and ongrowing in tanks	

SPAIN (cont.)

Experts	Species	Topics working on	Topics to work on
Universidad de Barcelona, Fac. de Biología, Dpto. Biología Animal			
CASTELLÓ I ORVAY, Francesc (Head of Group) PEREIRA, Ferran (Arrecifes artificiales) Alós, Carmen (Bentos) GUERAO, Guillermo (Crustáceos) CARDONA, Luis (Mugilidae) CALDERER, Ana (Sparidae) SÁNCHEZ, Angels (Spirulina) GRACIA, Vicente (Serranidae) GISBERT, Enric (Acipenseridae) MARTÍNEZ, David (Pleuronectiformes)	*Epinephelus marginatus* *Solea solea*	Growth under different culture conditions. Growth using different nutritional requirements. Wild and ecological studies.	Control reproduction Larval production to juvenile stage
Universidad de Cádiz, Centro Andaluz Superior de Estudios Marinos (CASEM), Puerto Real, Cádiz			
VÁZQUEZ GÓMEZ, Rosa	*Diplodus sargus* *Epinephelus marginatus* *Solea senegalensis* *Solea solea*	Reproduction and weaning of *S. senegalensis*. Aclimatization of sole spawners. Reproduction, histology of gonads, controlled reproduction.	Same as previous section
Generalitat de Catalunya, Institut de Recerca i Tecnologia Agroalimentaires (IRTA), Centre Nacional d'Aqüicultura, Sant Carles de la Rápita, Tarragona			
FURONES, Dolores (Director) CARBO, Ricar	*Dentex dentex*	Ongrowing and feeding studies Larvae culture techniques (mesocosm)	
Gobierno de Canarias, Instituto Canario de Ciencias Marinas (ICCM), Grupo de Investigación en Acuicultura (GIA), Gran Canaria			
FERNÁNDEZ-PALACIOS, Hipólito (Broods. man./ reprod.) IZQUIERDO LÓPEZ, Marisol (Lipids/EFA req.) VEGARA Martín, José Manuel (Nut./ongrowing) ROBAINA ROBAINA, Lidia (Altern.prot.sources /ongrowing) HERNÁNDEZ CRUZ, Carmen Mª (Nutrition /larvae) MONTERO VÍTORES, Daniel (Nutrition and Stress) GONZÁLEZ PÉREZ, Moisés, (Vit.req. /larv) SOCORRO CRUZ, Juan (Histopathology) MOLINA DOMÍNGUEZ, Lucía (Cage environ. Impact)	*Pagrus pagrus*	*P. pagrus*: Acclimatization of wild broodstock to captive conditions. Studies on optimum sex ratio, histology of maturation, spawning performance. Biochemical characterization of eggs/larvae for preliminary nutritional requirements. Larval culture techniques, including tanks design, live food sequence and quality, environmental parameters, survival, growth.	*P. pagrus*: Large volume larval culture systems (Mesocosm). Nutritional requirements at ongrowing stages. Technology transfer to commercial producers.

SPAIN (cont.)

Experts	Species	Topics working on	Topics to work on
Govern Balear, Dir. General de Pesca y Cultivos Marinos, Estación de Acuicultura, Mallorca			
PASTOR GRACIA, Elena RIERA MUNVERA, Francisco (Larvae culture, ongrowing) GRAU JOFRE, Amalia (Histopatholgy) GRAU JOFRE, Antonio (Larvae culture) POU FONT, Sebastian (ongrowing)	*Dentex dentex* *Diplodus puntazzo* *Seriola dumerilii* *Diplodus sargus* *Epinephelus marginatus* *Polyprion americanus* *Coryphaena hippurus* *Balistes caroliniensis*	Larvae culture: Fatty acids. Nutritional requierments, histopathology Ongrowing: Studies with different diets for *D. dentex*	
Junta de Andalucía, Centro de Investigación y Cultivo de Especies Marinas (CICEM) "El Toruño", El Puerto de Santa María, Cádiz			
CÁRDENAS, Salvador CAÑAVATE, José Pedro	*Solea senegalensis* *Diplodus sargus* *Thunnus thynnus* *Pagrus auriga* *Epinephelus marginatus*	Aclimatization of spawners Natural spawning Controlled reproduction Larval culture Weaning of sole	Same as previous section
Xunta de Galicia, Centro de Investigacións Mariñas (CIMA), Vilagarcía de Arousa, Pontevedra			
LINARES CUERPO, Fatima	*Pagellus bogaraveo*	*P. bogaraveo*: Reproduction and ongrowing	
Cultivos Piscicolas Marinos S.A. (CUPIMAR), San Fernando, Cádiz			
SANTAELLA SANCHEZ; Isaac (Technical Director)	*Solea senegalensis*	Weaning Reproduction	Albinism

TUNISIA

Experts	Species	Topics working on	Topics to work on
Institut National des Sciences et Technologies de la Mer (INSTM), Centre National d'Aquaculture de Monastir			
AYARI, Abdelaziz (fish rearing, *C. hyppurus & P. puntazzo*) GUERBEJ, Hamadi (fish rearing, *C. hyppurus & P. puntazzo*) BESBES Raouf (finfish rearing) ZAAFRAN, Sami (finfish pathology) MAATOUG, Kalthoum (finfish pathology) MEDHIOUB, Nejib (Genetics) MEDHIOUB, Amel (Genetics) BEN OUADA, Hatem (Genetics)	*Coryphaena hippurus* *Solea solea* *Solea senegalensis* *Diplodus puntazzo*	Now our research group is working on the larvae rearing, broodstock management and ongrowing of *D. puntazzo* and we will carry on research about *Coryphaena*	In future we would like to work on the broodstock management and ongrowing of *D. dentex* because of their juveniles availability in Tunisian coast. We will also try to do different hybridisation in Sparidae in aim to study their resistance to pathogens.
Institut National des Sciences et Technologies de la Mer (INSTM), Département d'Aquaculture, Tunis			
BEDOUI, Rafika (*Solea solea*)	*Solea solea* *Solea senegalensis*	At present, we have to control for breeders: 1 Sexual maturation 2 Spawning 3 Nutrition	Appropriate larval rearing Nutritional requirements Feeding sequence (mainly inert food) Feed conversion

Annexe III

Directory of Mediterranean institutions and companies working on finfish diversification identified during this survey

Directory of Mediterranean institutions and firms working on finfish diversification identified during this survey

INSTITUTIONS & COMPANIES	*CONTACT PERSON*
CROATIA	
INSTITUTE OF OCEANOGRAPHY AND FISHERIES (IOF) LABORATORY FOR ECOLOGY OF SHELLFISH AND FISH REARING DAMJANA JUDE, 12 P.O. BOX 39 20000 DUBROVNIK	Bosko SKARAMUCA Tel: 385 20 427937 Fax: 385 20 425775 E-mail: branko@labdu.izor.hr
CYPRUS	
MINISTRY OF AGRICULTURE, NATURAL RESOURCES AND ENVIRONMENT DEPT. OF FISHERIES DIVISION OF AQUACULTURE AND INLAND WATERS MANAGEMENT 13 AEOLOU ST. 1416 NICOSIA	Daphne STEPHANOU Tel: 357 2 807862 Fax: 357 2 775955 E-mail: D.Stefan@cytanet.com.cy
AQUACULTURE TECHNOLOGIES LTD. P.O. BOX 5097 3820 LIMASSOL	Hatchery Manager Tel: 357 5 336361 Fax: 357 5 336064
KIMAGRO FISH FARMING LTD. P.O. BOX 1761 LIMASSOL	Antonis KIMONIDES Tel: 357 5 369691 Fax: 357 5 369695
SAGRO AQUACULTURE LTD. P.O. BOX 1761 LIMASSOL	Christos MARANGOS Tel: 357 5 369691 Fax: 357 5 369695
SAGRO DEEP SEA FISH LTD. P.O. BOX 1761 LIMASSOL	Savvas AGROTIS Tel: 357 5 369691 Fax: 357 5 369695
TELIA AQUA MARINE LTD. P.O. BOX 1886 NICOSIA	Hatchery Manager Tel: 357 2 448538 Fax: 357 2 463945
EGYPT	
NATIONAL INSTITUTE OF OCEANOGRAPHY AND FISHERIES (NIOF) AQUACULTURE DIVISION KAYED BAY ALEXANDRIA	Magda I. ZAKI Tel: 20 3 4221959 or 807138 /140 Fax: 20 3 801174 / 5451388
FRANCE	
UNIVERSITÉ DE MONTPELLIER II STATION MEDITERRANEENE DE L'ENVIRONNEMEN LITT. LABORATOIRE D'ECOLOGIE MARINE 1 QUAI DE LA DAURADE 34730 SETE	Gilbert BARNABE Tel + Fax: 33 467 463373
CYCLOPE – PRODUCTIONS AQUACOLES QUAI DU MAS COULET 34200 SÈTE	Jerôme BONFILS Tel: 33 467 80 17 75 Fax: 33 467 80 00 52
SCORSA ETANG DE DIANE 20270 ALERIA	M. BRONZINI Tel: 33 495 57 01 49 Fax: 33 495 57 03 63
SOCIÉTÉ GAEC "LES POISSONS DU SOLEIL" B.P. 10 34540 BALARUC LES BAINS	Georges BALMA Tel: 33 467 48 56 77 Fax: 33 467 48 94 12

INSTITUTIONS & COMPANIES	*CONTACT PERSON*
SOCIÉTÉ 3A SARL RUE MOZART – LA BRAGUE 06600 ANTIBES	M. DAMIANO Tel: 33 493 74 54 55 Fax: 33 493 95 90 38
GREECE	
INSTITUTE OF MARINE BIOLOGY OF CRETE (IMBC) P.O. BOX 2214 71003 IRAKLIO CRETE	Pascal DIVANACH & Maria KENTOURI Tel: 30 81 242022 Fax. 30 81 241882 E-mail: imbc@imbc.gr
NATIONAL CENTRE FOR MARINE RESEARCH (NCMR) INSTITUTE OF MARINE BIOLOGICAL RESOURCES AQUACULTURE DEPARTMENT AGIOS KOSMAS 16604 HELLINIKON ATHENS	Spyros KLAOUDATOS Tel: 30 1 9822557 Fax: 30 1 9833095 E-mail: klaoudat@posidon.ncmr.gr
NIREUS FISHERIES.AND AQUACULTURE CONSULTANTS S.A. 1ST KLM KOROPIOU-VARIS AVE 19400 KOROPI	Zoe BAKELA Tel: 30 1 6624280 -1 Fax: 30 1 6624282 / 6626998 E-mail: nireuscons@otenet.gr
SELONDA AQUACULTURE S.A. & RIO PESCA AG. PANTON 9, 17672 KALLITHEA ATHENS	Philip GATLAND Tel: 30 1 95778880 Fax: 30 1 9521767 E-mail: 100575.2124@compuserve.com
ISRAEL	
ISRAEL OCEANOGRAPHIC AND LIMNOLOGICAL RESEARCH (IOLR) NATIONAL CENTER FOR MARICULTURE (NCM) P.O. BOX 1212 88112 EILAT	Hillel GORDIN Tel: 972-(0)7-6361436 Fax: 972-(0)7-6375761 E-mail: gordin@agri.huji.ac.il
ITALY	
CONSIGLIO NAZIONALE DELLE RICERCHE (CNR) ISTITUTO DI BIOLOGIA DELLE MARE REPARTO ACQUACOLTURA RIVA 7 MARTIRI, 1364 30122 VENEZIA	Alvise BARBARO Tel: 39 041 5207622, E-mail barbaro@vecnr8.ibm.ve.cnr.it
CONSIGLIO NAZIONALE DELLE RICERCHE (CNR) ISTITUTO SPERIMENTALE TALASSOGRAFICO SPIANATA S. RAINERI 86 98122 MESSINA	Silvestro GRECO & Valeria MICALE Tel: 39 090 669003 Fax: 39 090 669007 E-mail: micale@talas.ist.me.cnr.it
ENTE PER LE NUOVE TECNOLOGIE, L'ENERGIA E L'AMBIENTE (ENEA) CASACCIA DIPARTIMENTO INNOVAZIONE SETTORE BIOTECNOLOGIE E AGRICOLTURA SP 028 VIA ANGUILLARESE 301, S.M. DIGALERIA 00060 ROME	Fabio BARBATO Tel: 39 06 30484717 Fax: 39 06 30484768 Email: barbatof@casaccia.enea.it
ISTITUTO CENTRALE PER LA RICERCA SCIENTIFICA E TECNOLOGIA APPLICATA AL MARE (ICRAM) AQUACULTURE DEPARTMENT VIA DI CASALOTTI 300 00166 ROMA	Giovanna MARINO Tel: 39 06 6170447 / 615701 Fax: 39 06 61561906 E-mail: g.marino@rdn.it

INSTITUTIONS & COMPANIES	*CONTACT PERSON*
UNIVERSITÀ DI PALERMO ISTITUTO DI ZOOLOGIA LABORATORIO DI BIOLOIA E RISORSE MARINO VIA ARCHIRAFI 18 90123 PALERMO	Antonio MAZOLA Tel: 39 091 6167497 Fax: 39 091 6172009 E-mail: upamblam@mbox.vol.it
COISPA TECNOLOGÍA & RICERCA STATALE 16, KM 818,8 CASELLA POSTALE 62 70042 MOLA DI BARI BARI	María Teresa SPEDICATO & Guiseppe LEMBO Tel: 39 080 4732077 Fax: 39 080 4733440 E-mail: coispa@eostel.it
ITTICA MEDITERRANEA S.R.L. C/DA TRIGLIA SCALETTA 91020 PETROSINO	Vicenzo LICARI Tel.: 39 0923 986 865
ITTIOMAR II VIA TIMAVO 76 34074 MONFALCONE (GO)	Hatchery Manager Tel: 39 481 410035 Fax: 39 481 791385
MALTA	
MIN. AGRICULTURE AND FISHERIES NATIONAL AQUACULTURE CENTRE (NAC) FORT SAN LUCJAN MARSAXLOKK BBG 06	Director Tel.: 356 658863 Fax: 356 688380
MOROCCO	
INSTITUT NATIONAL DE LA RECHERCHE HALIEUTIQUE (INRH) PROJET AQUACULTURE THON ROUGE B.P. 31 PORT DE M'DIQ, TETOUAN	Hassan NHHALA Tel: 212. 9. 975505 / 663235 Fax: 212.9.975506
PORTUGAL	
UNIVERSIDADE DO ALGARVE UNIDADE DE CIENCIAS E TECNOLOGIAS DOS RECURSOS AQUÁTICOS CAMPUS DE GAMBELAS 8000 FARO	María Teresa DINIS Tel: 351 89 800927 Fax: 351 89 818353 Email: mtdinis@unozart.si.ualg.let
INSTITUTO PORTUGUÊS DE INVESTIGAÇAO MARITIMA (IPIMAR) CENTRO DE INVESTIGAÇAO MARITIMA DO SUL (CIMSUL) AV. 5 DE OUTUBRO S/N 8700 OLHAO	Pedro POUSAO-FERREIRA Tel: 351 89 702779 Fax: 351 89 702514 / 704078 E-mail: ppousou@mail.telepac.pt
SPAIN	
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO) CENTRO OCEANOGRÁFICO DE CANARIAS CARRETERA DE SAN ANDRÉS S/N APDO. 1373 38120 SANTA CRUZ DE TENERIFE, TENERIFE	Juana Rosa CEJAS PULIDO Tel: 34 922 549578 Fax: 34 922 549554
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO) CENTRO OCEANOGRÁFICO DE MURCIA CTRA. DE LA AZOHÍA S/N 30860 PUERTO DE MAZARRÓN MURCIA	Emilia ABELLAN Tel: 34 968 153339 Fax: 34 968 153934 E-mail: emilia.ieomz@mx2.redestb.es
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO) CENTRO OCEANOGRÁFICO DE SANTANDER PROMONTORIO DE SAN MARTIN, S/N APDO. 240 39004 SANTANDER	Carlos FERNANDEZ Tel: 34 942 275033 Fax: 34 942 275072

INSTITUTIONS & COMPANIES	*CONTACT PERSON*
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO) CENTRO OCEANOGRÁFICO DE VIGO PUNTA DEL APIO SAN MIGUEL DE OYA. APDO. 1552 36280 - VIGO (PONTEVEDRA)	Mercedes OLMEDO and José Benito PELETEIRO Tel: 34 986 492111 Fax: 34 986 492351
UNIVERSIDAD DE BARCELONA FACULTAD DE BIOLOGIA DEPARTMENTO DE BIOLOGIA ANIMAL AVDA. DIAGONAL, 645 08028 BARCELONA	Francesc CASTELLO Tel: 34 93 402 1447 Fax: 34 93 411 0358 Email: Dorada@Porthos.bio.UB.ES
UNIVERSIDAD DE CADIZ CENTRO ANDALUZ SUPERIOR DE ESTUDIOS MARINOS (CASEM) LABORATORIOS DE CULTIVOS MARINOS POLIGONO RO SAN PEDRO S/N 11510 PUERTO REAL – CÁDIZ	Rosa VAZQUEZ GOMEZ Tel: 34 956 470870 Fax: 34 956 470818 E-mail: rosa.vazquez@uca.es
GENERALITAT DE CATALUNYA INSTITUT DE RECERCA I TECNOLOGIA AGROALIMENTAIRES (IRTA) CENTRE NACIONAL D'AQÜICULTURA 43540 SANT CARLES DE LA RÁPITA, TARRAGONA	Dolores FURONES Tel: 34 977 745427 Fax: 34 977 744138
GOBIERNO DE CANARIAS INSTITUTO CANARIO DE CIENCIAS MARINAS (ICCM) GRUPO DE INVESTIGACIÓN EN ACUICULTURA (GIA) APDO. CORREOS 56, TELDE 35200 GRAN CANARIA	Hipolito FERNANDEZ-PALACIOS Tel: 34 928 132900/04 Fax: 34 928 132908 Email: pipo@iccm.iccm.ulpgc.es
GOVERN BALEAR DIRECCIÓN GENERAL DE PESCA Y CULTIVOS MARINOS ESTACIÓN DE ACUICULTURA INGENIERO GABRIEL ROCA 69 07158 PUERTO DE ANDRATX, MALLORCA	Elena PASTOR Tel: 34 971 672335 Fax: 34 971 674240
JUNTA DE ANDALUCÍA CENTRO DE INVESTIGACIÓN Y CULTIVO DE ESPECIES MARINAS (CICEM) "EL TORUÑO" DEPARTAMENTO DE PRODUCCIÓN CAMINO TIRO DE PICHÓN, S/N APDO. 16 1500 EL PUERTO DE SANTA MARÍA - CÁDIZ	Salvador CÁRDENAS Tel: + 34 956 562340 Fax: + 34 956 562385 E-mail: salvador.cardenas@uca.es
XUNTA DE GALICIA CENTRO DE INVESTIGACIONS MARIÑAS (CIMA) PEDRAS DE CORON, S/N APDO. 208 36600 VILAGARCIA DE AROUSA, PONTEVEDRA	Fátima LINARES CUERPO Tel: 34 986 500155 / 500161 Fax: 34 986 506788
CULTIVOS PISCICOLAS MARINOS, S.A. (CUPIMAR) CARRETERA DE LA CARRACA S/N SALINAS DE SAN JUÁN BAUTISTA 11100 SAN FERNANDO - CADIZ	Isaac SANTAELLA SANCHEZ Tel: 34 956 883447 / 8 Fax: 34 956 880708 E-mail: cupimart@arrakis.es
TUNISIA	
INSTITUT NATIONAL DES SCIENCES ET TECHNOLOGIES DE LA MER (INSTM) CENTRE NATIONAL D'AQUACULTURE DE MONASTIR 5000 MONASTIR	Abdelaziz AYARI Tel: 216 54 62867 Fax: 216 54 62867

INSTITUTIONS & COMPANIES	*CONTACT PERSON*
INSTITUT NATIONAL DES SCIENCES ET TECHNOLOGIES DE LA MER (INSTM) DEPARTMENT AQUACULTURE 28, RUE DU 2 MARS 1934 2025 SALAMMBO	Rafika BEDOUI Tel: 216 1 730548 Fax. 216 1 732622

Table of keys for the interpretation of survey replies

Market knowledge:

Market study (S):
- N = Market study not done
- Y = Market study done

Local market perspectives (L):
- U = Unknown perspectives
- M = Medium perspectives
- G = Good perspectives

Regional market perspectives (R):
- U = Unknown perspectives
- M = Medium perspectives
- G = Good perspectives

Price (P): XXX = 1995 local market price in USD/kg

Broodstock management:

Rearing system (RS):
- C = Cage
- T = Tank
- P = Pond

Fish origin (FO):
- WJ = Wild juveniles
- WA = Wild adult
- RE = Controlled reproduction

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 1 = Breeders availability
- 2 = Broodstock management
- 3 = Sexual maturation in captivity
- 4 = Control of spawning
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 19 = Others

Larvae culture:

Rearing system (RS):
- SV = Small volume total/partial closed system
- SVO = Small volume open system
- LV = Large volume: mesocosm

Knowledge status (KS):
- 0 = No data
- - = Constrainst
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropiate larval rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Live food
- 9 = Inert food
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 14 = Egg quality
- 15 = Larval quality (morphological anomalies)
- 19 = Others

Weaning:

Rearing system (RS):
- SVR = Small volume total/partial recirculation
- SVO = Small volume open system
- LV = Large volume

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropriate rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Type of diet
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 16 = Different growth rate within group of same origin
- 19 = Others

Ongrowing:

Rearing system (RS):
- C = Cage
- T = Tank
- P = Pond

Fish origin (FO):
- WJ = Wild juveniles
- RE = Controlled reproduction

Knowledge status (KS):
- 0 = No data
- - = Constraints
- +/- = Further knowledge required
- + = Good
- ++ = Very good

Main problems (MP):
- 5 = Appropiate rearing techniques
- 6 = Nutritional requirements
- 7 = Feeding sequence / Regime
- 8 = Type of diet
- 10 = Diseases
- 11 = Cannibalism
- 12 = Low growth
- 13 = Low survival
- 16 = Different growth rate within group of same origin
- 17 = Poor feed conversion
- 18 = Precocious sexual maturation
- 19 = Others

Scale of production:

Type:
- ES = Experimental or laboratory scale
- PS = Pilot scale
- SC = Small commercial scale

Tons:
- XXX = Please, indicate the 1995 / 6 production (tons) at your facilities.

Research:
- NP = National projects
- IP = *International project*