Introduction to Mediterranean aquaculture

Basurco B.

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B. Basurco
International Centre for Advanced Mediterranean Agronomic Studies
Mediterranean Agronomic Institute of Zaragoza
Apartado 202, 50080 Zaragoza, Spain

This short chapter is intended to complement the information obtained by the "TECAM Survey on Mediterranean Aquaculture Diagnostic Laboratories" by describing the main characteristics and the evolution in aquaculture production in the Mediterranean. The statistics here presented are those from the Food and Agriculture Organization of the United Nations (FAO FishStat databases: http://www.fao.org/fi/statist/statist.asp) covering aquaculture production in all GFCM (General Fisheries Commission for the Mediterranean) member countries. The production figures include freshwater aquaculture production, French and Spanish production from the Atlantic coast, as well as that of the Red Sea in Egypt. For the purpose of this work the aquaculture statistics of Japan (a GFCM member country) have not been considered. These production statistics, together with figures for the number of production units, even though they may be incomplete for certain countries, should help the reader to better understand the incidence and distribution of the diseases reported hereafter.

Mediterranean aquaculture: Current production status

As in many parts of the world, aquaculture production in the Mediterranean has been expanding rapidly over recent years. Total aquaculture production in the region reached 1,349,777 tonnes in 2001, which represented approximately 3% of the world aquaculture production (48,413,635 tonnes). Although Mediterranean aquaculture used to focus more on mollusc production (62% in 1992), the share of fish production is constantly increasing (from 37% in 1992 to 53% in 2001), following the world aquaculture trend. Looking closely at the annual growth rate it can be observed that total aquaculture production in the region has grown at an annual rate of 7.1% during this period (Table 1), which represented a total increase of 81.8%.

Table 1. Aquaculture production in the main species groups in the Mediterranean (tonnes)

	1992	1995	1998	2001	Growth ('92-'01)	Annual growth rate
Molluscs	461,828	566,595	633,560	626,080	35.6	3.7
Freshwater fishes	122,700	104,406	156,297	293,449	139.2	12.0
Marine fishes	33,701	68,408	136,835	253,137	651.1	25.7
Diadromous fishes	119,045	146,746	171,306	173,812	46.0	4.4
Aquatic plants	5,052	5100	3060	3013	–40.4	–4.5
Crustaceans	240	273	560	286	19.2	8.9
Total	742,566	891,528	1,101,618	1,349,777	81.8	7.1

The species group that has shown the fastest growth rate has been the marine finfish (seabream, seabass, mullets, etc.) increasing from 33,701 tonnes in 1992 to 253,137 tonnes in 2001, corresponding to an annual growth rate of 25.7% over this period. Freshwater fish (mainly tilapias and carps) also experienced a significant growth rate over this same period (from 122,700 tonnes to 293,449 tonnes, corresponding to a 12% annual growth). Diadromous fish species (trouts at the top of the list), however, showed an annual increase of only 4.4% during the same period (from 119,045 tonnes in 1992 to 173,812 tonnes in 2001).

Besides finfish, the overall mollusc production has developed less significantly, with an annual

growth of 3.7% shifting from 461,828 tonnes in 1992 to 626,080 tonnes in 2001. Mussels, oysters and clams represent the main productions. The output of crustaceans and seaweeds is still limited, *Gracilaria* being the main species of seaweed cultured in the region with over 3000 tonnes harvested in 2001. With regards to crustaceans, the 2001 production of various shrimp species and the red swamp crawfish (*Procambarus clarkii*), amounted only to 260 and 26 tonnes, respectively.

In the Mediterranean, aquaculture production is dominated by six countries: Egypt, Spain, France, Italy, Greece and Turkey (Table 2), which jointly supply 96% of the total production in the region. Whilst in Spain, France and Italy the production is mainly based on molluscs (mussels, oysters, and clams), in Egypt production is based on the semi-intensive production of freshwater (mainly tilapia and carp) and marine finfish species (mullet). Greece and Turkey, among others, concentrate mainly on the intensive production of selected finfish (seabream, seabass and trout). The average growth rate in these countries over the last decade has been impressive, with 24.6% in Egypt, 26.4% in Turkey and 20% in Greece.

Table 2. Aquaculture production growth of the main species groups in the Mediterranean countries (tonnes)

Country	Molluscs	Diadromous fishes	Marine fishes	Freshwater fishes	Crustacean	Aquatic plants	Total	Increase ('92-'01)	Annual growth rate (%)
Egypt	–	1	98,890	243,964	9	–	342,864	436.6	24.6
Spain	256,403	36,186	19,929	13	116	–	312,647	85.3	8.8
France	191,330	44,866	5,111	10,692	53	10	252,062	0.7	0.2
Italy	149,000	47,200	20,700	1,350	19	3,000	221,269	29.9	3.3
Greece	25,970	3,252	68,082	498	–	–	97,802	381.6	20.5
Turkey	5	38,064	28,485	687	–	–	67,241	640.1	26.4
Israel	–	940	4,530	14,630	–	–	20,100	64.6	5.8
Romania	–	600	–	10,218	–	–	10,818	–56.1	–7.9
Croatia	3,000	1,261	2,500	3,405	–	–	10,166	49.5	9.3
Syria	–	–	–	5,880	–	–	5,880	14.9	2.9
Cyprus		83	1,725	–	75	–	1,883	1114.8	34.1
Tunisia	46	11	1,304	507	–	–	1,868	117.5	13.3
Bulgaria	–	893	–	717	–	3	1,613	–80.2	–8.9
Morocco	156	120	506	580	–	–	1,362	83.8	11.0
Malta	–	–	1,235	–	–	–	1,235	147.0	14.0
Lebanon	–	300	–	–	–	–	300	130.8	13.2
Albania	150	15	100	7	14	–	286	–28.0	9.0
Algeria	20	20	40	201	–	–	281	91.2	11.6
Libya	–	–	–	100	–	–	100	25.0	2.6
Total	626,080	173,812	253,137	293,449	286	3,013	1,349,777	81.8	7.1

The increasing production from countries such as Malta, Cyprus and Israel (mainly finfish) should also be pointed out. On the other hand the statistics show that there are countries where aquaculture output has decreased (Algeria and Romania), and others that have contributed minimum quantities such as Albania, Algeria, Lebanon and Libya.

Aquaculture production not only accounts for an increasing share of the total supply in volume, but also in the supply of farmed species. The increasing diversification may certainly facilitate the growth of the sector. There has been a clear trend towards diversification in the evolution of the number of cultured species in the last two decades in the Mediterranean aquaculture sector. In 2001, FAO statistics showed production data for 85 species, of which 51 (40 finfish species and 11 mollusc species) produced over 100 tonnes (Table 3). In the same year, FAO statistics recorded 427 different captured species for the Mediterranean and Black Sea (253 species with captures over 1000 tonnes).

With regard to molluscan shellfish the production is represented mainly by four species (*Mytilus edulis*, *Mytilus galloprovincialis*, *Crassostrea gigas* and *Ruditapes philippinarum*) concentrated in three EU countries: mussels in Spain (over 250,000 tonnes), oysters in France (over 135,000 tonnes) and clams in Italy (over 50,000 tonnes). The contribution of other Mediterranean countries is still very low.

Whilst mussel production relies on two autochthonous species (*M. edulis* and *M. galloprovincialis*), oyster and clam culture are sustained by two recently introduced allochthonous species (*C. gigas* and *R. philippinarum*). Other mollusc species have a less significant production, e.g. common edible cockle (*Cerastoderma edule*) with 2968 tonnes and the Great Atlantic scallop (*Pecten maximus*) with 140 tonnes.

Table 3. Mediterranean aquaculture species diversification

Production (tonnes)	No. of cultured species				
	1981	1986	1991	1996	2001
Fish					
>50,000	2	2	2	1	5
50,000 – 10,000	–	2	2	6	5
10,000 – 1000	9	8	14	13	11
1000 – 100	7	11	12	11	19
Total fish > 100	18	23	30	31	40
Mollusc					
>50,000	3	3	3	3	4
50,000 – 10,000	1	1	1	1	–
10,000 – 1000	–	2	4	4	4
1000 – 100	–	1	1	3	3
Total mollusc >100	4	7	9	11	11
Total species >100	22	30	39	42	51

Fish production (above 10,000 tonnes) is mainly represented by about ten species (tilapias, carps, trout, seabream, seabass and mullets). Other important species are the European eel, turbot, bluefin tuna, and other freshwater species, such as European perch, pike-perch, sturgeon and tench.

In the finfish group, it should be noted that although marine finfish species is the group with the highest growth rate, the top-two ranking species in terms of production are freshwater fish, i.e. the Nile tilapia (*Oreochromis niloticus*) with over 150,000 tonnes, and the rainbow trout (*Oncorhynchus mykiss*), with over 120,000 tonnes. The production of the flathead grey mullet (*Mugil cephalus*) is noteworthy with 102,470 tonnes mainly from Egypt.

The rapid increase in the production of marine carnivorous fish, particularly the especially gilthead seabream (*Sparus aurata*) and the European seabass (*Dicentrarchus labrax*) is most evident, with over 80,000 tonnes in 2001 in the case of the first species and almost 60,000 tonnes for seabass.

The European turbot (*Psetta maxima*), although produced on the Atlantic coast of Spain and France, is another important, high-value cultured species. Production in 2001 was recorded at 4338 tonnes.

For certain other species, production is limited as the farming activity is based on stocking of young fish from the wild (capture-based aquaculture). This is the case of the European eels (3591 tonnes) and the bluefin tuna, *Thunnus thynnus*. Spain and Croatia are the leading countries in these new tuna farming activities, where most of the Mediterranean catch quota is used for farming (fattening) purposes. In spite of the existing difficulties in collecting statistics for this practice, FAO statistics accounted the production of this fish at 4446 tonnes. For the region, it is estimated that about 70% or more of the Mediterranean recommended ICCAT (International Commission for the Conservation of Atlantic Tunas) catch quota is already being used for this production, which is mainly exported to the Japanese market.

Fish farming production units

It is here highlighted that the diversified character of Mediterranean fish farming systems is based on the broad geographical differences of their inland water bodies (rivers, lakes, ponds, etc.) as well as that of their coastal areas (bays, lagoons, islands, etc.), together with a range of historical and socio-economic factors. Thus, in the Mediterranean there are examples of small or big companies for almost all the production systems (extensive, semi-intensive, intensive, monoculture, polyculture, etc.) and techniques (freshwater raceways or pond production, coastal lagoon management, marine land based installations, cage farming, etc.) described.

Although a large part of the farming is still based on extensive and semi-intensive farming systems, e.g. vallicultura in Italy, coastal lagoon production in Egypt or carp production in Egypt, Bulgaria, Romania, Croatia, etc., due to the lack of statistics about these systems, the figures presented in this section only compile information about industrial fish farms (intensive and semi-intensive) in Mediterranean countries, which on the other hand are the systems with more diseases and a closer follow up. The different types of farm unit, based on finfish species produced are summarised in Table 4.

Table 4. Fish farms (intensive and semi-intensive) in Mediterranean countries (developed in 2002 in collaboration with the SIPAM network and through personal contacts)

Country	Bass and bream hatcheries	Bass and bream ongrowing	Tuna	Turbot	Salmon	Marine trout	Freshwater trout	Eels	Carps	Tilapia	Mullets	Others
Croatia	4	37	9			1	16		27			
Cyprus	4	8					7					
Egypt	3	N.D.†							N.D.			
France	9	29		5	1	7	480		900††			
Greece	33	266			4		96	10	12			
Israel	2	6										
Italy	15	79	2	4	2		589	74	50	2	±500	193
Malta		5	2									
Morocco	1	3	1				1	1				
Portugal	5	61		3			30	1				13
Romania							50		250			
Spain	9	58	7	17	2		132	2	1			3†††
Tunisia	2	5										
Turkey	16	324		1		11	967		68			
Estimated total	103	881	21	30	9	19	2368	88				

†N.D. = not determined.
††Most are part time activity.
†††Tench units and 1 sturgeon unit.

As regards *freshwater fishes*, with more than 2000 units, trout farming is still the most important type of freshwater fish cultivation. Trout is mostly produced in freshwater and takes place in intensive systems using concrete raceways or ponds in Italy, France, Greece, Spain and Turkey.

Carp aquaculture is also an important type of freshwater fish cultivation. It is traditionally undertaken by large farms that cover several hundred or sometimes even more than a thousand hectares. Most farms were established at the end of the 19th century or first half of the 20th century. Carp aquaculture is still by far the most important type of freshwater fish cultivation in countries such as Bulgaria, Croatia and Romania. This type of production is based on using all the food available by polyculture. The species introduced with the common carp are tench (*Tinca tinca*), grasscarp (*Ctenopharingodon idella*), bighead (*Aristichthys nobilis*), silver carp (*Hypophtalmichthys molitrix*), European catfish (*Silurus glanis*), pike (*Esox lucius*) and perch-pike (*Stizostedion lucioperca*). Carp aquaculture in Egypt, as most tilapia cultivation, is based on extensive and semi-intensive farming systems in earth ponds.

As regards *marine fish farming*, for seabass and bream, production techniques are very diverse, ranging from extensive to highly intensive systems, involving vale systems, earth ponds, floating cages, or raceways or tanks. The technology applied has evolved rapidly, both in modifying existing facilities (e.g. water recirculation for land based installations) and in developing new projects (e.g. offshore cage technology). By far, cage units, used in lagoons, sheltered bays or semi-exposed and offshore conditions, are the predominant ongrowing system (about 900 units) in the regions. Seabream and seabass companies are very diverse, ranging from large companies with several ongrowing farms (Nireus, Cupimar, Maricultura, Pinar, Seafarm Ionian, Selonda, Tinamenor, etc.) to small family enterprises. Companies prefer to have several units of 500 to 1000 tonnes rather than one bigger farm and are increasingly equipped with one or several marine hatcheries and pre-ongrowing units.

Besides the ongrowing units, there are about 100 land-based marine hatcheries, with a production capacity ranging from 5 to 15 million fingerlings or more, and increasingly incorporating recirculating technologies.

Besides seabass and seabream, it is worth mentioning turbot, which accounts for about 30 units in Mediterranean countries. Turbot, which is mainly produced in Spain and France, is cultured only in land-based installations, both hatcheries and ongrowing. This species is cultured in intensive land-based systems. Eels, with over 80 units, are also produced in land-based installations, either in ponds or in highly intensive recirculation systems.

Besides mentioning the case of sea trout (18 units), which is mainly reared in Turkey (11 units) in cage farms, the case of bluefin tuna (*Thunnus thynnus*) fattening is here highlighted. During the last 3-5 years there has been a very important development of tuna farms in the Mediterranean, now over 20 farms. Although Spain (9 farms) and Croatia (9 farms) are the main producers, other countries (e.g. Malta, Italy and Turkey) have already initiated this production.