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in

Muir J. (ed.), Basurco B. (ed.).
Mediterranean offshore mariculture

Zaragoza : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 30

2000
pages 57-64

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SUMMARY – During the early nineties the Cyprus government chose the technology of offshore cage culture to develop marine aquaculture, due to the already high exploitation of coastal land by tourism, concerns for environmental issues and the lack of sheltered inland sea sites. Currently there are 8 privately owned commercial sea cage farms, licensed for an average annual production of 150 t (mainly seabream and seabass). The farms are located 1-1.5 km offshore, spaced at 3 km intervals, in water depths ranging from 20-35 m. Of the main manufacturers (PolarCirkel, Dunlop, Bridgestone, FarmOcean, etc.) the most commonly used cage is the circular 16 m-diameter "PolarCirkel" type. The report provides information on the physicochemical environment, the supporting infrastructure (both private and governmental), and the regulations for the establishment/operation of cage farms. Information is also provided on aquaculture production and on main constraints/problems facing marine aquaculture development, i.e., the small size of the farms, the scarcity of available sites, the negative public perception of the environmental impact of aquaculture and the attitudes of the inshore fishermen towards cage farms. The potential for offshore mariculture development is discussed in relation to the application of the WTO philosophy on fish imports, and the harmonization of Cyprus to the "Aquis Communautaire".

Key words: Offshore mariculture, fish farming, cages, fisheries.

RESUME – *"L'expérience de l'aquaculture en mer ouverte à Chypre". Pendant les années quatre-vingt-dix, le gouvernement de Chypre a choisi la technologie de "offshore cage culture" pour développer l'aquaculture marine, dû à l'exploitation préexistante des terres côtières par le tourisme, aux préoccupations environnementales, et au manque de sites côtiers bien protégés. Actuellement il y a 8 entreprises privées d'aquaculture marine en cages flottantes qui sont autorisées pour une production moyenne annuelle de 150 t (la plupart dorade et loup). Les fermes sont situées à une distance de 1-1,5 km de la côte, séparées par une distance minimale de 3 km, à des profondeurs à partir de 20 à 35 m. Parmi les producteurs importants (PolarCirkel, Dunlop, Bridgestone, Farmocean), la cage le plus souvent utilisée est le type PolarCirkel, circulaire, de 16 m de diamètre. Cet article donne des renseignements sur l'environnement physico-chimique, l'infrastructure d'appui (privée et gouvernement), et les règlements pour l'établissement/opération. Des informations sont également apportées sur la production aquacole et sur les principales contraintes/problèmes que doit affronter le développement de l'aquaculture marine, c'est-à-dire la petite taille des exploitation, la rareté des sites disponibles, la perception négative du public concernant l'impact environnemental de l'aquaculture et les attitudes des pêcheurs du littoral face aux fermes aquacoles en cages. Le potentiel pour le développement de la mariculture en mer ouverte est examiné en liaison avec l'application de la philosophie de l'OMC sur les importation de poissons, et l'harmonisation selon "Aquis Communautaire" à Chypre.*

Mots-clés : *Mariculture, mer ouverte, cages, pêcheries.*

Introduction

The mass production of fry by privately owned marine fish hatcheries in Cyprus started as early as 1987. The ongrowing of fish was first undertaken during 1988 using a privately owned land-based installation located in the Liopetri area. During the summer months of 1990-1991 the farm was implicated by the neighbouring tourist industry as the root cause for the mass growth of the green filamentous alga *Cladophora patentiramea* which caused excessive nuisance along the tourist beaches. Despite a subsequent survey showing that domestic and agricultural runoff was in fact the greatly dominant source for elevated nitrates (Baird and Muir, 1990), the government was obliged to reconsider its policy for land-based marine aquaculture. According to the new policy only fish hatcheries were to be allowed onshore, while ongrowing would be located offshore in cages. As a consequence, Cyprus became one of the first Mediterranean countries to carry out the commercial culture of seabream and seabass in offshore cages.

The first commercial marine cage farm began operation in 1990-1991, in the only semi-protected area of the island, near the port of Limassol (Stephanou, 1993). This was followed by 7 additional

cage farms, which were established between 1992-1994 and operated under open sea offshore conditions.

The present state of marine aquaculture

Private commercial marine farms

The private sector played a decisive role in development, investing private funds in a new high-risk operation. Currently, there are 8 privately owned commercial marine cage farms licensed, for an average production of 150 t p.a. (Table 1).

Table 1. Evolution of seabream, seabass offshore cage farms, by size class

Annual production	Number of licensed fish farms								
	1990	1991	1992	1993	1994	1995	1996	1997	1998
5-30 t		1		2	1	2	2	1	
30-100 t	1	1	2	1	4	4	3	4	2
100-200 t							3	3	6

Of these farms, one has its own hatchery. Two further commercial marine fish hatcheries are also established on coastal land. A shrimp farm and hatchery also operates in a land based installation (see map).

Ownership

All farms and hatcheries belong to Cypriot companies with Greek Cypriots being the majority shareholders. According to Government regulations foreign participation in aquaculture companies can be, under certain conditions, up to 49%. Foreign investors are shareholders in some of the farms.

Technology employed

The cage farms utilize the most successful offshore structures, tested in exposed areas in other parts of the world, such as Japan, Scandinavia, Ireland, etc. Development work by these companies continues to test new designs in the Mediterranean. A wide variety of offshore cages is in use, produced by manufacturers such as Bridgestone, FarmOcean, Dunlop, PolarCirkel, Aqualine, Aquazur, Stamatiou, etc. Also the new submersible cage Sea Station is being under experimental use (1998-1999).

Initially, most farms used the relatively expensive cages specifically designed for exposed areas, produced by Bridgestone, Dunlop and FarmOcean (Stephanou, 1993). Later, as more experience was accumulated on technological issues and site characteristics, farms found they could use lighter and cheaper cage types such as those manufactured by PolarCirkel.

The most commonly used cages are now the circular PolarCirkel types, with collars comprising 2 or 3 x 16 m HDPE pipes, with or without security steel chains, kept empty or filled with buoyancy material (mainly polystyrene). Support stanchions are usually made of steel. Cages of 8 m and 12 m diameter are also used, many farms using a combination of cage sizes and types. In addition to PolarCirkel type cages two farms use modular square rubber hose Dunlop cages, either 15 m x 15 m or 20 m x 20 m, and the similar Bridgestone type of 15 m x 15 m. In these farms the Dunlop and Bridgestone cages are used in effect as offshore breakwaters, providing shelter inshore for the PolarCirkel cage types. In semi-protected areas and offshore sites, FarmOcean "Flexfloat" interlocking plastic cube systems are also being used, forming cage areas of 12 m x 12 m or 6.5 m x 6.5 m. These are usually arranged to form multiple unit modules; one such cage platform module covers an area of 4500 m^3.

The cage net depth ranges between 6 m-15 m, with mesh sizes from 5 mm-13 mm. Net materials contain UV inhibitor. The rearing of 2 g fish is undertaken in the same offshore cages employed for ongrowing. Usually the farms use cages of different dimensions, i.e., smaller units for fry, harvest stocks, auxiliary and experimental use, and larger units for fattening. Recently there has been a trend to use antifouling-treated nets, which are claimed to extend the net lifespan and be more resistant to seabream net biting. Nets are usually changed only once during the production cycle, when the fry are large enough to be moved into larger mesh nets in ongrowing cages.

Species produced

The main species produced in 1998 were gilthead seabream (*Sparus aurata*) and seabass (*Dicentrarchus labrax*), at a ratio of about 4:1 bream:bass (Fig. 1).

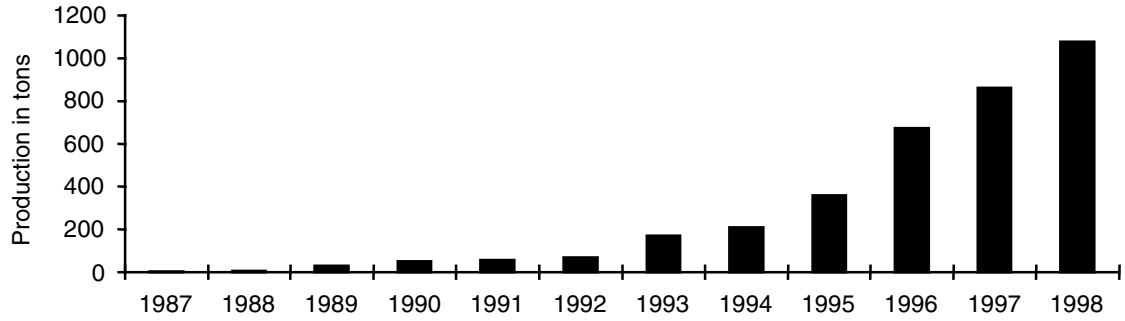

Fig. 1. Production of table fish for the years 1988-1998.

Other species farmed to a lesser extent are the sharpsnout bream *Puntazzo puntazzo,* and the Japanese red seabream *Pagrus major,* although by 1997 production of this species has practically ceased due to marketing problems, associated with its dark colour. The first table size red porgy *Pagrus pagrus* was produced by one cage farm recently, while another farm undertook the experimental culture of shi drum *Umbrina cirrosa* (Table 2).

Table 2. Evolution of marine aquaculture table fish production (t)

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sparus aurata	37	45	52	133	187	223	527	769	827
Dicentrarchus labrax	15	15	19	34	20	99	100	57	205
Puntazzo puntazzo						15	32	15	21
Pagrus major					1	11	4	–	–

Physicochemical environment

Currents-waves

Cyprus lacks any protected areas or bays along the 296 km of coastal land controlled by the government. The nearest lands to Cyprus are the Greek Island of Rhodes 380 km to the west, Egypt 380 km south, Syria 105 km east and Turkey 75 km to the north, and so aquaculture sites are exposed to long wind fetch distances.

The cages are found in open sea conditions, exposed mainly to south, southeast winds. The existing prevailing coastal currents were found to have an average speed of 0.2 m/sec at midwater depths, in areas where cage farms are located. The maximum significant waves range between 3 m (semi-protected area) and 5.5 m (exposed areas), while the mean significant waves are about 0.5 m.

In winter, waves of 3 m-4 m height are not uncommon. In exceptional cases, during storms, in the areas of some farms (Zygi, Paphos) waves of 8-9 m have been experienced and have caused damage (Govt. of Cyprus, 1994).

Water quality

The waters are oligotrophic, with background levels of P around 1 µg/l. Salinity is around 39‰ and surface water temperature ranges between 15°C-30°C during the year. A thermocline is established during summer months at about 25 m-30 m below the water surface.

The water is clean, without serious pollution problems. No serious fouling problems exist on the cage nets.

Supporting infrastructure

Technical

Each farm employs personnel of high academic and technical ability. During 1998, the farms employed 177 people on a full-time basis, with an additional 83 part-time for production, management and marketing of fish.

Cyprus is self-sufficient as regards fry production (Table 3 and Fig. 2), the majority of which has been exported since 1987.

Table 3. Evolution of marine fish fry production; (no of fry x10^3)

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sparus aurata	6095	7867	5593	4530	5194	7834	5575	9981	9906
Dicentrarchus labrax	500	110	287	517	818	1240	857	1429	1342
Puntazzo puntazzo					303	144	146	100	429
Pagrus pagrus							81	–	–
Pagrus major			20	80				–	–
Dentex dentex				12				–	–
Umbrina cirrosa								56	–

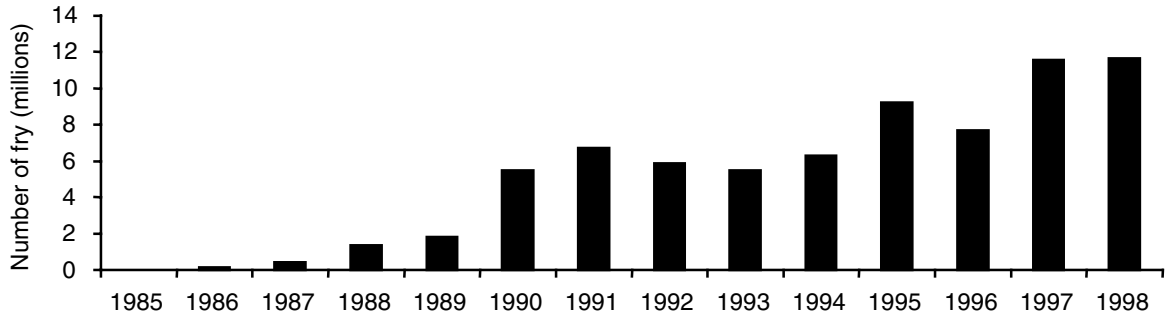

Fig. 2. Production of fry for the years 1986-1998.

The food used is basically of an extruded type and the majority is imported. Efforts are currently under way to produce feed locally. The majority of farms feed by hand, supplemented in some cases with the use of an air feed cannon or using the built-in computerized system of the FarmOcean platform. One farm is using a fully computerized system, with food being distributed from a central unit via pipes.

Farms are usually located up to 10 km from the nearest port, fishing shelter or marina. The locations of all farm sites are marked on Admiralty maps. Locations of farms are also identified by radar reflectors and by solar powered beacon lights.

Governmental

According to the government "Strategic Plan on Development for the period 1994-1998", "emphasis will be given to strike a balance between aquaculture development and the environment, and the diversification of aquaculture sector. These targets will be pursued through the promotion of marine aquaculture in offshore cage culture units, the culture of trout (in reservoirs) and of ornamental fish and recreational fishing in reservoirs for tourist purposes".

The Department of Fisheries of the Ministry of Agriculture, Natural Resources in the competent authority for aquaculture development. A special Aquaculture Division is included in its establishment, which operates from its central Nicosia Offices as well as at the Meneou Marine Aquaculture Research Station, which has some cage culture facilities in addition to land-based ones. The Department has established an Aquaculture Data Bank for assisting and monitoring the aquaculture industry, related government departments, and prospective investors, etc. It is also an active member of the Mediterranean aquaculture thematic networks TECAM, SIPAM, SELAM and EAM (Stephanou, 1995, 1999).

Up to now government financial assistance to marine fish farms has been very limited. Since 1996 however, a government scheme was introduced subsidizing aquaculture loan interests. The scheme aims at inducing and accelerating investments on topics which are considered crucial for the consolidation and further development of, mainly, marine aquaculture: for the expansion of farms, the installation or improvement of packing facilities in order to conform to relevant EU regulations, technological improvements and the amelioration of the quality of the effluents from land-based farms.

Research on marine aquaculture

Research is focused mainly on the diversification of species and technology of marine aquaculture. The main species presently under experimental culture are: *Pagrus pagrus, Puntazzo puntazzo*, *Siganus rivulatus, Dentex dentex* and *Umbrina cirrosa.* Research work is centred on reproduction and larval rearing aspects, but work on aspects like the intensive rearing up to the commercial level, broodstock management, etc. is also undertaken. The experiments are undertaken at the Meneou Experimental Marine Aquaculture Station of the Department of Fisheries and by some of the private farms, in parallel and/or in cooperation with the Department of Fisheries (Stephanou, 1996).

Research on the diversification of technology refers mainly to open sea cage culture technology, like submersible cage, etc.

Inspection-quality control of aquaculture products

Fish inspection and quality control aspects are under the jurisdiction of the Veterinary Services Department, which is in the process of strengthening and upgrading its infrastructure (personnel, laboratories, legislation), in cooperation with the Department of Fisheries. This work has been catalyzed by assistance provided within the framework of the special FAO-Cyprus government Technical Cooperation Project-"Supporting Services to Aquaculture Development".

Regulations for the establishment and operation of cage farms

The government is responsible for the management and environmental monitoring of farms. The obligation to provide statistics is included in the terms and conditions under which the farms operate. According to government policy, cage farms should not be anchored over *Posidonia* beds and should be at least 1 km offshore and in a minimum water depth of 20 m. Existing farms conform to these regulations and are found in distances ranging from 1 km to 1.5 km offshore and in depths of 20 m to about 35 m. The setting up of cage farms is not allowed in certain locations. These include site

opposite residential zones, areas of natural beauty, nature reserves, marine parks, etc. Although avoided up to now, fish farms could be set up in tourist zones under certain assumptions. According to the existing government practice the reason for the rather arbitrary distance between the farms (approx. 3 km) is to minimize their interaction and their synergism as regards their environment impact (Stephanou, 1999).

No recreational fishing is allowed within a distance 300 m from the floating structures of the cage farms. In the case of professional fishermen the distance is 150 m.

Presently the government is at the stage of revising its policy for the further development of marine aquaculture. Expectations are that existing farms will be allowed to increase their production level, and new farms may be allowed to establish.

Licensing

Any prospective fish farmer requires an Environmental Impact Assessment study. This is assessed by the Department of Fisheries, the Environment Service, and finally the Technical Advisory Environment Committee, which may impose binding terms and conditions on the relevant investor. The EIA then becomes part of the terms and conditions of the license for the operation of the fish farm.

Licenses for the setting up and operation of marine farms are issued by the Department of Fisheries according to the provisions of the Fisheries Law Cap. 135, Regulation 20 of the Fisheries Regulations of 1990. Certain terms and conditions are included in the license which aim at safeguarding good management practices, collection of data on production, responsible use of chemicals, protection of the environment, etc. according to Article 9 – Aquaculture Development of the FAO "Code of Conduct for Responsible Fisheries".

A special Law of Aquaculture and related regulations has been drafted with assistance from FAO. The legislation, after lengthy discussions with the interested parties, is expected to be approved soon by the House of Representatives.

Constraints and problems of offshore mariculture

To date the development of marine aquaculture in Cyprus has on the whole proved to be a success, despite some "teething problems" and difficulties.

The farms do no face any serious technological problems and are at the stage of expansion and consolidation. The acquired experience for the management in the maintenance of stocks and structures under the prevailing conditions filled an existing knowledge gap, since offshore mariculture is still a rather new activity in the Mediterranean.

The small size of farms results in high production costs and, to a lesser extent, low productivity: the average production/person ranges is 20 t and average production/cage volume is 8 kg/m^3. Applications for an annual production increase of existing farms up to 300 t and the establishment of new ones of the same production magnitude may help overcome these constraints. These are under consideration by the Department of Fisheries in anticipation of the new government policy being approved by the Council of Ministers.

The scarcity of sites for new farms is another constraint, because of the intensive use of the coastal zone for other activities, particularly tourism. Tourism is the main industry on the island, with a sector of US $660 million value added, that employs 10-5% of active population and in 1996, contributes 8% to the GDP. Aquaculture does not figure in coastal zone management projects as a significant activity, despite its growing economic importance.

The lack of port facilities further limits the areas suitable for cage farming, although the setting up of new marinas now under way will allow the further exploitation of new areas for aquaculture currently lacking boat refuge facilities.

The negative public image towards aquaculture, considered by many as being an enemy to the environment, has been due mainly to the *"Cladophora case"* when a privately owned land-based installation located in the Liopetri area was implicated by the neighbouring tourist industry as the root cause for the mass growth of the green filamentous alga *Cladophora patentiramea*. This was alleged to have caused excessive nuisance along the tourist beaches. Regardless of the extremely dubious scientific validity of these assertions, this image poses obstacles, usually in the hands of local authorities, to the establishment and expansion of fish farms. Their present geographical positions are also at stake because of the continuous demands for their movement to other sea areas. This is due mainly to the lack of any coastal zone management plan.

Conflict also exists between inshore fishermen and fish farms, due partly to the locating of farms within inshore fishing areas but mainly due to fears of reduced market value brought about by the greater availability of farmed produce.

Thefts, and to a lesser extent vandalism, are becoming more of a problem to cage fish farmers. Bird predation, mostly during the migration of cormorants, is alarming. Oil pollution from an oil spill was successfully handled in one case.

Until now the local market has regulated, to a degree, the rate and level of farm expansion, which has proceeded gradually in parallel with the expansion of local markets. However, these are not expected to be able to absorb the anticipated production increase. This will require Cyprus farms to become locally and internationally competitive and capable of surviving the foreseen liberalization of fish imports. Seabream and seabass, which until recently were not sold in local markets, are now becoming very popular (Stephanou, 1995). Their demand is expected to increase with the anticipated decrease of their price as a result of potential import competition, and local economies of scale. New outlets, such as supermarkets, and better organization of the distribution-marketing system, combined with successful publicity undertaken by the government as well as the producers, provide further opportunities for the industry. However, the securing of export markets is of crucial importance to its continued development. The setting up or upgrading of packing facilities to conform to relevant EU regulations is now taking place to overcome any foreseen quality control problem for future exports. Exports of aquaculture table fish by October, 1999 reached 125 t.

Offshore aquaculture in the context of Cyprus fisheries

In Cyprus there is a shortage of fresh marine fish. Local production from domestic fishing activities in 1998 met about 40% of the total demands for fish and fish products. Fisheries depend on inshore boats (av. annual catch per boat: 3.2 t) and trawlers which fish in the narrow continental shelf of the island and in international waters. The role of offshore mariculture is complementary to that of capture fisheries. In 1998 the production from aquaculture gave an additional quantity of 1180 t table fish (including trout) and about 11.8 million fry (including 6.3 million exports) valued at C£6.4 million (C£ 1 = US$1.93). The production from aquaculture represented about 33% of the total quantity of fish produced in Cyprus, 47% of their value and more than 60% of the good quality fresh fish in the local market. However, in addition to domestic production, 5500 tons of fish and fish products valued at about C£10.5 million had to be imported to cover the demand. The per capita consumption of fish and fish products in 1998 was 13.5 kg out of which 1.7 kg came from aquaculture (mainly marine) and about 3.6 kg from domestic fisheries.

The prospects for increasing local production of fish through fisheries is limited, since the East Mediterranean is generally poorly productive, the fishing grounds almost fully exploited and overfishing of certain species exists. Production from fisheries has therefore been almost stable during the last 5 years, in contrast with that of aquaculture, particularly the marine sector.

Fishery products are not included in the Customs Union Agreement of Cyprus with the EU, which provides a series of preferential trade concessions. For this reason 15% and 16% duty is imposed on table size marine fish and fish fry respectively when exported to EU countries.

In 1996, applying the philosophy of GATT/WTO to fish trade, imports of fresh fish into Cyprus were liberalized, while at the same time imposing an import duty to protect local production until marine fish farms become competitive at the national and international level. As a result of this measure, production from marine aquaculture replaced, to a great extent, the imports of fresh fish, which were

derived mainly from the Gulf countries. Fish prices continued to be profitable to the producers, despite the decreasing trends, due to decreased production costs.

Requirements for development of offshore mariculture

A relevant government policy and infrastructure, to safeguard the sustainable future development of aquaculture in an environment of free competition and in harmony with the environment is considered to be of utmost importance. The introduction of a legal framework covering all aspects of aquaculture is essential as well as the preparation/implementation of a coastal zone management plan where aquaculture activities will be included.

The need is now emerging for the adoption of more advanced technology for the exploitation of deeper waters, further away from the coast, in exposed area, including new cage designs, self-contained units, remote sensing/control equipment, new management practices, higher levels of mechanization and more sophisticated mooring systems.

More research is also needed on environmental aspects and on the interactions of offshore aquaculture and the environment, to overcome the existing reservations on their perceived impact.

A limited number of new farms could be set up in "new" areas. A lot depends on the technology to be employed, since the siting of farms further offshore is expected to be less favourable than for the existing units. Their establishment is expected to be scrutinized according to a set of criteria (technological, financial, managerial, etc.). The marketing prospects of aquaculture products will play a substantial role in every development, because a decisive factor for the achievement of the targets will be the conditions prevailing both in the local as well the international market.

The potential for further increase of local market of aquaculture products, the replacement of imports and the development of exports will dictate the rate of production increase, as well as the levels of production.

The further growth of offshore mariculture will safeguard the potential for production of good quality fish, in sufficient quantities, at reasonable prices.

References

Baird, D.J. and Muir, J. (1990). *The impact of Telia Aqua Marine Fish Farm* on the coastal environment at Liopetri at Cyprus. UNDP/Cyprus Government (unpublished report), p. 50.

Govt. of Cyprus (1994). *Nearshore wave climate analysis.* Prepared by X. Loizidou. Project on coastal zone management for Cyprus, Public Works Department (internal report), p. 300.

Stephanou, D. (1993). Open sea cage culture development in Cyprus. In: *MEDRAP II TECAM Workshop on Aquaculture Engineering and Offshore Culture,* Toulon (France), 23-25 June 1993, p. 6.

Stephanou, D. (1995). On the supply and consumption of fish in Cyprus. In: Marketing of Aquaculture Products, CIHEAM (IAMZ), Zaragoza (Spain), 1996. *Options Méditerranéennes, Séries Cahiers,* 17: 45-54.

Stephanou, D. (1996). Marine aquaculture development in Cyprus. In: *First Regional Symposium on Enhancement of Coastal Productivity in the Middle East through Mariculture Development,* Elat (Israel), 14-16 October 1996 (abstracts).

Stephanou, D. (1999). Marine aquaculture development and tourism: The case of Cyprus. In: Aquaculture Planning in Mediterranean Countries, Proceedings of the Workshop of the SELAM Network, CIHEAM/FAO/INRH, Tangier (Morocco), 12-14 March 1998. *Options Méditerranéennes, Séries Cahiers,* 43: 35-40.