Specific diversification in Greek finfish mariculture

Kentouri M., Papandroulakis N., Divanach P.

Aspects économiques de la production aquacole

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 14

1995
pages 129-136

Specific diversification in Greek finfish mariculture

M. KENTOURI[1,2]
N. PAPANDROULAKIS[1,2]
P. DIVANACH[1]

[1] INSTITUTE OF MARINE BIOLOGY OF CRETE
IRAKLIO, CRETE
GREECE

[2] DEPARTMENT OF BIOLOGY
UNIVERSITY OF CRETE
IRAKLIO, CRETE
GREECE

SUMMARY - Specific diversification is one of the Greek Research & Development approaches for minimization of production problems related with exponential development of marine aquaculture, because it allows the farmers to open new markets. Among all the alternatives of diversification, those related to high growth, medium priced fish (*Thunnus tynnus, Coryphaena hippurus, Polyprion americanum, Seriola dumerilli*) and to lower growth, better priced fish (*Pagrus pagrus, Dentex dentex, Puntazzo puntazzo, Spondyliosoma cantharus Diplodus sargus, Epinephelus* sp.), are more discussed.
Some of these species are actually grown, but the majority of the biological basis for their reliable culture is yet unknown.

Key words : Aquaculture, Greece, new species.

RESUME - La diversification spécifique est l'une des approches de Recherche - Développement choisies par la Grèce pour minimiser les problémes de production liés au développement exponentiel de l'aquaculture marine dans le pays et doter la profession d'un outil d'avenir permettant d'ouvrir de nouveaux marchés.
Parmi toutes les alternatives de diversification envisagées, celles relatives aux poissons à croissance rapide et prix commercial moyen et celles relatives aux poissons à croissance plus lente mais prix commercial momentanément plus élevé sont plus spécialement discutées.
Certaines de ces espèces sont actuellement produites à l'échelle pilote mais l'état des connaissances sur leur biologie et leurs besoins reste limité sinon précaire.

Mots-clefs : Aquaculture, Grèce, espèces nouvelles.

INTRODUCTION

As in every other European country, the development of aquaculture in Greece followed a classical scheme with i) a research difficult phase with high demand and low offer, ii) an euphoric phase with high benefit and iii) a recent (1990) more difficult phase with increasing of offer and stabilization of demand (Stefanis J., Divanach P. 1993).

The production cost and the market are the key words for the future of mariculture. The biological and technological parameters of this industry should be analysed in relation with economical variables like the direct and indirect cost of the production process.

Like any market economy, the benefit, i.e. the reliability of an enterprise and the induced socio economical and labour relations are governed by the following equation:

$$(P) = [(MP) - (PC)] * (Pr)$$

Where P the profit, MP the market price, PC the production cost and Pr the production.

The strategies thus for maximising the profit are simple:

First the increase of the production (under constant market price and production cost) Solution impossible for the specific limited market which will lead to a further decrease of the market prices.

Second the increase of the market prices (under constant production and production cost) solution which need sophisticated methods of marketing and commercialization of the product.

And last, decrease of the production cost and / or increase of the market needs.

In the case of the last several implementation methods exist. One of the most important is the diversification of the production.

SPECIFIC DIVERSIFICATION AND RELATED NEW CRITERIA

NEW SPECIES.

The diversification of the production with new species which by definition increase the market size is an interesting solution. The species introduced, have to be selected under both limitations economical and biological. The general economical relation which should be analysed in these case is the price per size / fish / kilo taking into consideration also the cost of fry production and also the needs of the market. The biological limitations concern the rearing of the species (easy adaptation, endemic species, etc.). Following the analysis of several categories are presented showing also the possible candidates species for short and long term introduction in aquaculture.

a. Small fishes

Species for consumption, such as Atherina boyeri, Mullus barbatus and Mullus surmuletus are marketed at a size of 10 - 20 gr per fish with a price of about 2,000 drch per kilo. Considering classical production conditions (hatchery and weaning phase) the production cost per individual is about 25 to 50 drch, leading to a production cost of more than 3,000 drch per kilo i.e. higher than the market price. Only decoration or bate fishes with high prices per individual are economically interesting. Aspects like environmental risk should be considered in this case (exotic species introduced).

b. Species with valued products

Another interesting case are the fishes which are cultured due to their high valued products like the botargo. In some areas of Greece (Messologgi) the botargo produced by gray mullets is marketed at prices around 20,000 drch per kilo. The mullets production from the local lagoon is about 3,000 MT yearly. The mullets are reared uptoday under extensive conditions with a partial enrichment of the local lagoon with juveniles. Considering a sex ratio of about 2 and a gonadosomatic index of 30%, the price of this species per kilo is about 4,000 making it a good candidate for intensive culture. Further research on the improvement of the sex ratio and on sex differentiation i.e. female selection is needed.

c. Flatfish

Flatfishes constitute one more potential category of fishes. The sole (Solea solea) with difficulties under intensive conditions presents a good growth performance in lagoon zones (BAYNES S.M., et al, 1993; DEVAUCHELLE N., et al., 1987; FUCHS J., 1981). The existence of such areas in Greece gives possibilities for the increase of such a culture.

The turbot (Scophthalmus maximus) is an other candidate. (DANIELSSEN D.S. & GULBRANDSEN K.E., 1989; FAUVEL C., et al., 1993; GUILLAUME J., et al, 1991; IGLESIAS J., 1993). The requirement of medium temperature water (15 - 20 °C) make the adaptation difficult in Greece due to the high water temperature during summer. However marine well water with a normal temperature of 17 - 19 °C can be utilised for the rearing.

d. Fresh water species

One more category consists of members of the fresh water families: acipenserides (stugeron) and anguillidae (eel), during their marine phase. The existence in Greece of areas with carst resorsion give possibilities for an exploitation of the culture of these species but further research is needed.

e. High priced marine species

For the increase of the market size until now, and due to the high prices of sea bream and sea bass, the choice of new species was limited to the ones of similar price, like common dentex (Dentex dentex), common porgy (Pagrus pagrus) and white head sea bream (Diplodus sargus) which were the first species introduced in small scale in the production (GLAMUZINA B., et al., 1989; MINICONI R., 1980; DIVANACH, P., et al. 1992; EFTHIMIOU, S., et al, 1994; KENTOURI, et al., 1992; DIVANACH P., 1985; KENTOURI M.,et al., 1979; KENTOURI M., et al., 1992; RAIS C., 1987).

With the decrease of the prices new species have also appeared as potential candidates for introduction in the industry, mainly due to other advantages.

One category includes some partially herbivorous species with satisfactory prices like the sharpsnout sea bream (Puntazzo puntazzo) or the black sea bream (Spondyliosoma cantharus), which clean the tanks and the nets from fouling, in mixed cultures with seabass, resulting in a decrease of required man power. Others like Pagellus acarne or P bogaraveo, which enter by themselves into the cages, are interesting due to the elimination of the fry cost. This group of species present comparative growth and production cost with the seabass (Fig 1).

However the present state for the species discussed above must still to be consider far from satisfactory. Limiting or no control of the reproduction cycle, together with difficulties in the larvae rearing, are the main inhibiting factors for a well established production, even though small numbers are already produced.

A second category includes species with rapid growth and satisfactory market price. The production cost is influenced by time-dependent parameters directly (labour cost, paying off, and other financial obligations) or indirectly (security or other problems increasing analogous with the rearing duration). Species that are adapted to such a strategy are the Thunnus tynnus and the Coryphaena hippurus reaching about five kilos from egg in a year, (BENETTI D.D., et al. 1993; OSTROWSKI A.C., et al., 1989; OSTROWSKI A.C., et al., 1993; SZYPER J.P., 1985) and also species like the Polyprion americanum, Seriola dumerilli and some Epinephelus sp. which reach weight of 1.5 Kg in a year (Fig. 2). (BARNABE G., 1976 CAVALIERE A., et al., 1989; GARCIA GARCIA B., et al., 1992; GÖKOGLU M. & ORAY I.K., 1992; GRECO S., et al., 1992; GRECO S., et al., 1993; LAZZARI A. & BARBERA G., 1989; MICALE V., et al., 1993; PORELLO S., et al., 1992; BARNABE G., 1974; BOUAIN A., 1980; BOUAIN A. & SIAU Y., 1983; CASTELLO-ORVAY F. & FERNADEZ VILAR A., 1992; LAVETT SMITH C., 1961)

The results to date for this second category are even more limited than the first one. Most of them are well adapted to captivity but there is no control of their reproductive cycle and there exist serious difficulties in the larval rearing. These

species are available in aquaculture mainly due to capture of juveniles or adults individuals.

STATE OF KNOWLEDGE AS BOTTLE-NECK FOR THE DEVELOPMENT

The scientific knowledge constitutes the limiting factor for the development of any of the above described strategies. Like seabass and sea bream during the seventies and eighties, the limiting factor for the successful introduction of new aquaculture species is the lack of knowledge for the control of the whole production cycle specially in the field of reproduction control and the larvae rearing. In Fig. 2 and 3 the succesion of the references number for sea bass and sea bream found in the data base ASFA are presented, giving an indication of the relation between the level of knowledge and the successful production.

Searching for bibliographic references relating to the above mentioned species, in the data base ASFA (from 1975 to 1994) the total number of references and the percentage of the ones relating to aquaculture has been noted. If this data is considered as a level of knowledge, it shows that for all the species which are important for the aquaculture (Sparus aurata, Dicentrarchus labrax, Seriola quinqueradiata, Pagrus major, Epinephelus sp.) a total number of references higher than 100 exist, of which more than 50 % are related to their culture (Table 1). On the contrary the new species under consideration for aquaculture, present both these figures lower than the mean of the already cultured. This fact proves an important lack of knowledge and at the same time the need of research.

Table 1

SPECIES	NUMBER OF ASFA REFERENCES		
	TOTAL	AQUACULTURE RELATED	%
Dicentrarchus labrax	980	625	63.8
Sparus aurata	1050	610	58.1
Seriola dumerilii	2	1	50
Seriola quinqueradiata	320	162	50.6
Dentex dentex	8	1	12.5
other *Dentex*	67	7	10.4
Pagrus pagrus	24	2	8.3
Pagrus major	286	144	50.3
Puntazzo puntazzo	14	7	50
Diplodus sargus	60	20	33.3
Diplodus vulgaris	21	9	42.9
Polyprion americanum	21	-	0
Epinephelus aeneus	19	-	0
Epinephelus guaza	15	4	26.7
other *Epinephelus*	278	97	34.9
Coryphaena hippurus	73	39	53.4
Thunnus sp.	3.311	109	3.3

RESEARCH STRATEGY

The research priorities today have two different orientations i.e. genetic improvement vs. new species. However, the particular characteristics of the seabass and sea bream market (small and almost saturated) should be considered, before methodologies however successful in other cases are applied. The experience gained from other sectors like the salmonidae will help in the avoidance of similar mistakes.

For definition of the research priorities, the present state in the production level and the trials for diversification focuses on the problems and drive to research sectors which will allow the total control of the production cycle.

REFERENCE (Selected)

BARNABE G., 1974 - La reproduction du mérou Epinephelus gigas : observations préliminaires de terrain. Aquaculture, 4, 363-367.

BARNABE G., 1976 - Rapport d'activité pour 1976 (Contrat CNEXO - USTL n°76-1479) - Station de Biologie Marine et Lagunaire, Sète.

BAYNES S.M., HOWELL B.R. & BEARD T.W., 1993 - A review of egg production by captive sole, Solea solea (L.). Aquaculture and Fisheries Management, 24, 171-180.

BENETTI D.D., IVERSEN S.E., OSTROWSKI A.C. & LUTZ P.L., 1993 - Growth and bioenergetics of captive Dolphin, Coryphaena hippurus. World Aquaculture'93, E.A.S. Special Publication N° 19, p.313 (résumé).

BOUAIN A., 1980 - Sexualité et cycle sexuel des mérous (Poissons, Téléostéens, Serranidés) des côtes du Sud tunisien. Bull. Off. natn. Pêch., Tunisie, 4(2), 215-229.

BOUAIN A. & SIAU Y., 1983 - Observations on the female reproductive cycle and fecundity of three species of groupers (Epinephelus) from the southeast tunisian seashores. Marine Biology, 73, 211-220.

CASTELLO-ORVAY F. & FERNADEZ VILAR A., 1992 - Effets de différents types d'alimentation sur la croissance du mérou (Epinephelus guaza L.) en captivité. Aquaculture Europe, 16(3), p. 7.

CAVALIERE A., CRISAFI E., FARANDA F., GRECO S., LO PARO G., MANGANARO A. & MAZZOLA A., 1989 - Collection of finberlings and rearing of Seriola dumerili in tanks. Aquaculture - A Biotechnology in progress.

DANIELSSEN D.S. & GULBRANDSEN K.E., 1989 - Growth rate of Turbot (Scophthalmus maximus L.) and Sole (Solea solea L.) based on dry pellets. Aquaculture - A biotechnology in progress. N. De Pauw, E. Jaspers, H. Ackefors, N. Wilkins (Eds), EAS, 632-637.

DEVAUCHELLE N., ALEXANDRE J.C., LE CORRE N. & LETTY Y., 1987 - Spawning of sole (Solea solea) in captivity. Aquaculture, 66, 125-147.

DIVANACH P., 1985 - Contribution à la connaissance de la biologie et de l'élevage de 6 sparides mediterranéens : Sparus aurata, Diplodus sargus, Diplodus vulgaris, Diplodus annularis, Lithognathus mormyrus, Puntazzo puntazzo (poissons téléostéens).USTL Montpellier, p.

DIVANACH, P., KOUMOUNDOUROS, G., KENTOURI, M. AND STERIOTI, A. 1992. Développement prélarvaire du Pagre Pagrus pagrus et du Denté Dentex dentex en Crete. Rapp. Comm. int. Médit., 33: 384.

EFTHIMIOU, S., DIVANACH, P. AND ROSENTHAL, H., 1994. Growth, food conversion and agonistic behaviour in common dentex (Dentex dentex) juveniles fed on pelleted moist and dry diets. Aquat. Liv. Resour., 7(4): in press.

FUCHS J., 1981-1982(b) - Production de juveniles de sole (Solea solea) en conditions intensives. I. Le premier mois d'élevage. Aquaculture, 26, 321-337.

FUCHS J., 1981-1982(b) - Production de juvéniles de sole (Solea solea) en conditions intensives - II. Techniques de sevrage entre 1 et 3 mois. Aquaculture, 26, 339-358.

FAUVEL C., OMNES M.H., MUGNIER C., NORMANT Y., DORANGE G. & SUQUET M., 1993 - La reproduction du turbot : aspects biologiques et gestion des reproducteurs. La pisciculture française, 112, 23-39.

GARCIA GARCIA B., MORENO J. & ROSIQUE M.J., 1992 - Rate of feeding, growth and gross efficiency in youngs of yellowtail Seriola dumerilii. Aquaculture Europe, 16(3), p. 10.(résumé)

GASSET E., 1985 - Résultats préliminaires des élevages larvaires de la dorade coryphaene C. hippurus, et du seabass L. calcarifer a partir de larves importées, et maturation et élevages larvaires du mérou E. microdon au C.O.P. en 1985. Ifremer Aquacop Tahiti.

GLAMUZINA B., JUG-DUJAKOVIC J. & KATAVIC I., 1989 - Preliminary studies on reproduction and larval rearing of common dentex, Dentex dentex (Linnaeus 1758). Aquaculture, 77, 75-84.

GÖKOGLU M. & ORAY I.K., 1992 - Investigations on the catch of the yellowtail Seriola dumerilii (Risso 1810) in the gulf of Antalya in Turkey. Aquaculture Europe, 16(3), p. 11.(résumé)

GRECO S., CARIDI D., CAMMAROTO S., MONDELLO C. & GENOVESE L., 1992 - Nutritional trials on amberjack fingerlings. Aquaculture Europe, 16(3), p.12 (résumé).

GRECO S., CARIDI D., CAMMAROTO S. & GENOVESE L., 1993 - Preliminary studies on artificial feeding of amberjack fingerlings. Production, Environment and quality. Bordeaux Aquaculture'92. G. Barnabé and P. Kestemont (Eds). E.A.S. Special Publication n° 18.

GUILLAUME J., COUSTANS M.F., METAILLER R., PERSON-LE RUYET J. & ROBIN J., 1991 - Flatfish, Turbot, Sole and Plaice in : Handbook of nutrient requirements of finfish, R.P. Wilson (Ed.), CRC Press, 77-82.

HASSLER W.W. & HOGARTH W.T., 1977 - The growth and culture of dolphin, Coryphaena hippurus in North Carolina. Aquaculture, 12, 115-122.

IGLESIAS J., 1993 - Research activities on turbot industrial procedures in Spain. World Aquaculture'93 - EAS Special Publication n° 19, p.615 (résumé).

KENTOURI M., DIVANACH P., CHARALAMBAKIS G., POUGET F. & STERIOTI A., 1992 - Comparison of growth performance of six mediterranean fish species, reared under intensive farming conditions in Crete (Greece), in raceways with the use of self feeders. Aquaculture Europe, 16(3), p. 14 (résumé).

KENTOURI, M., KOUMOUNDOUROS, G., DIVANACH, P. AND STERIOTI A., 1992. Développement embryonnaire du Pagre Pagrus pagrus et du Denté Dentex dentex en Crete. Rapp. Comm. int. Médit., 33: 385.
KENTOURI M., DIVANACH P. & CANTOU M., 1979 - Données préliminaires sur le comportement, la croissance et la survie du sar (Diplodus sargus) en élevage. Etud. Rev. Cons. Gén. Pêches Méditerranée, 57, 33-51.
KRAUL S., 1989 - Review and current status of the aquaculture potential for the Mahimahi, Coryphaena hippurus. Advances in Tropical Aquaculture tahiti, Feb. 20 - March 4, 1989. Aquacop Ifremer Actes de Colloque 9, 445-459.
LAVETT SMITH C., 1961 - Synopsis of biological data on groupers (Epinephelus and allied genera) of the western north atlantic. FAO Fisheries Biology Synopsis, 23,
LAZZARI A. & BARBERA G., 1989 - Farming the mediterranean yellowtail, Seriola dumerilii (Risso 1810) in concrete ponds : results and perspectives. Aquaculture - A Biotechnology in progress.
MICALE V., GENOVESE L., GRECO S. & FERDICHIZZI F., 1993 - Aspects of the reproductive biology of the amberjack, Seriola dumerili (Risso 1810). World Aquaculture'93 - EAS Special Publication n° 19, p. 413 (résumé).
MINICONI R., 1980 - Poissons de Corse et de Méditerranée. Parc Naturel Regional de la Corse. Découverte de la nature, 21, 116 p.
OSTROWSKI A.C., SCHALEGER E. & DUERR E.O., 1993 - Practical diets for growout of Mahimahi (Coryphaena hippurus). World Aquaculture'93, EAS Special Publication N°19, p.426.
OSTROWSKI A.C., BROWNELL C. & DUERR E.O., 1989 - Growth and feeding rates of juvenil dolphins (Corypheana hippurus) fed a practical diet through growout. World Aquaculture, 20(4), 104-105.
PORELLO S., ANDALORO F., VIVONA P. & MARINO G., 1992 - Rearing trial of yellowtail (Seriola dumerilii) in floating cage. Aquaculture Europe, 16(3), p. 22 (résumé).
RAIS C., 1987 - Production artificielle d'alevins de sar (L. 1758) par la méthode extensive et sans culture de plancton. Bull. Inst. natn. scient. tech. Océanogr. Pêche Salammbô, 14, 5-14.
SZYPER J.P., 198 - Culture of Mahimahi : review of life stages. Handbook of maroculture, Volume II, Finfish Aquaculture, CRC Press, 228-240.
STEFANIS J. AND DIVANACH P., 1993. Farming of Mediterranean finfish species. Present status and potentials World Aquaculture'93, EAS Special Publication N°19, p.426.

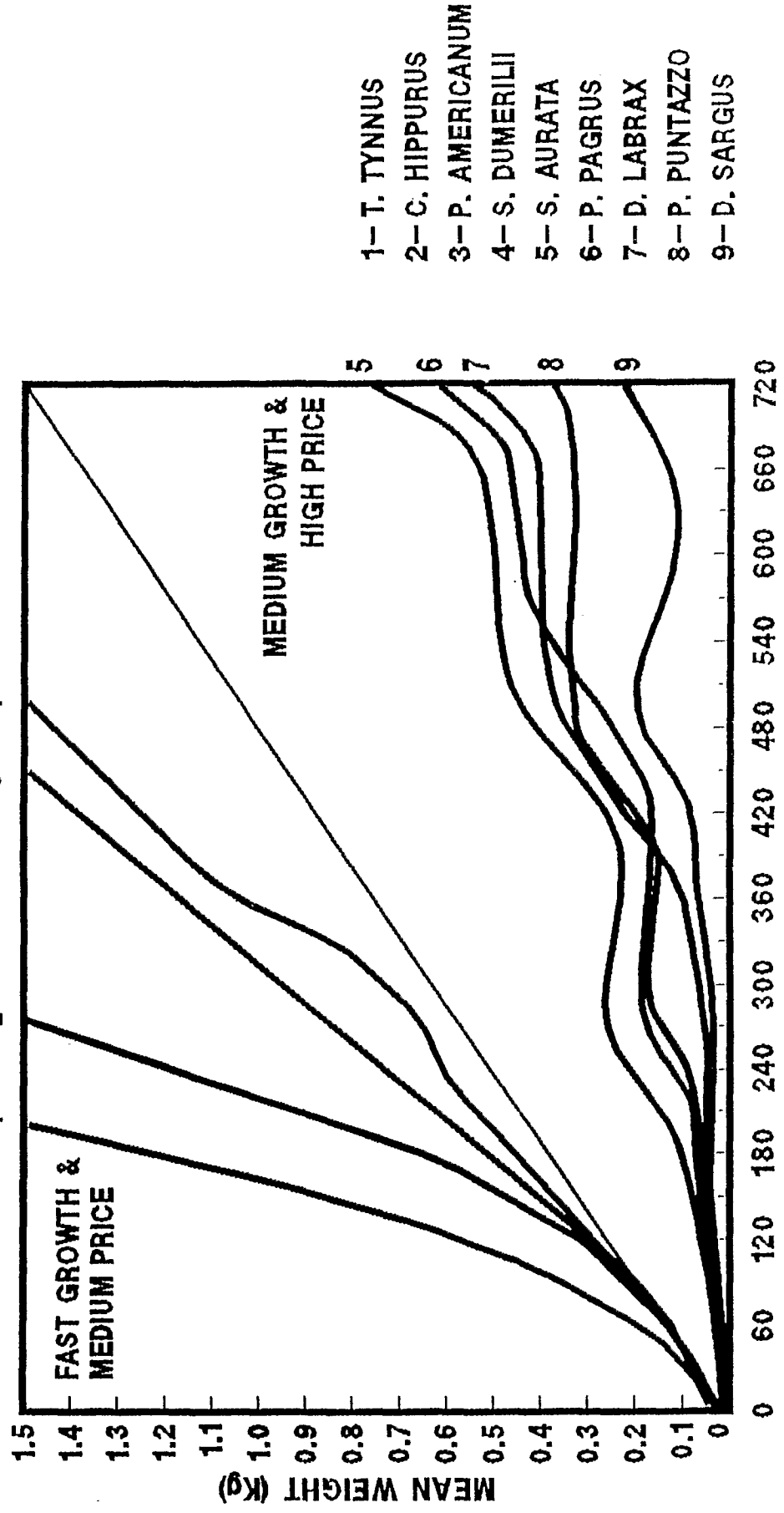

Figure 1. Growth rate of some Mediterranean species (Stefanis J. and Divanach P., 1993)

Figure 2. Evolution of the number of references for seabass in the ASFA data base

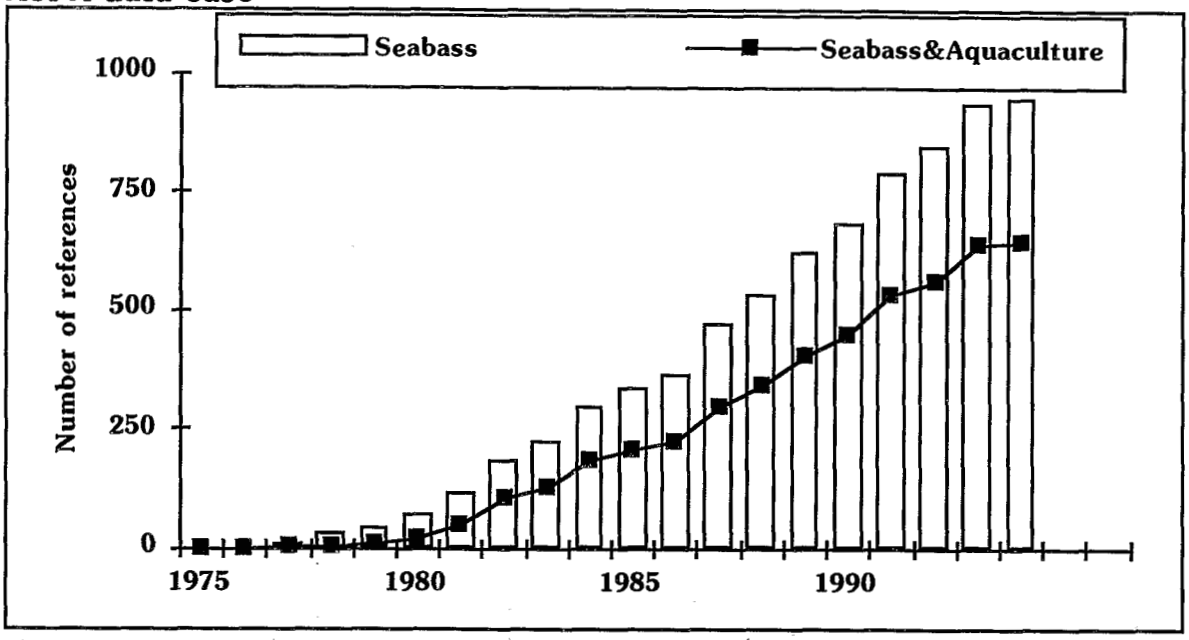

Figure 3. Evolution of the number of references for seabream in the ASFA data base