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Experiences of integrated mariculture in a southern Tyrrhenian area (Mediterranean Sea)

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Abstract

To ascertain the potential for exploiting marine areas for mariculture, data on the cultivation of molluscs and fish in the open sea of the southern Tyrrhenian were collected from May 1994 to June 1995. The aims of this integrated study were to test simple breeding methods for molluscs and fish, to apply these to the practices employed by local fishermen and to experiment with the use of a cage system requiring a low level of investment. *Crassostrea gigas* (Thunberg) and *Mytilus galloprovincialis* (Lamarck) were cultivated on submerged long lines around cages used for cultivating *Seriola dumerili* (Risso) and *Diplodus puntazzo* (Cetti). *S. dumerili* specimens were placed in two cages and fed with either fish scraps or pellets, while in a third cage, *D. puntazzo* were fed with pellets only. After a period of 12 months, the following results were obtained: the oysters measured 47.50 ± 12.30 mm and weighed 0.13 ± 0.09 g; the mussels placed in culture as juveniles reached a length of ≈ 40 mm, while the mussels placed in culture as subadults reached the commercial size of about 60 mm. The mean length and weight measurements of the two fish species were as follows: *Diplodus* 228 ± 14.4 mm and 228 ± 40.48 g; *Seriola* (lot A) 438.1 ± 25.28 mm and 1149 ± 172.2 g; *Seriola* (lot B) 347 ± 25.6 mm and 576 ± 139 g.

Introduction

In recent years, in Mediterranean aquaculture, there has been an attempt to select new species to bring about diversification (Cahiers options méditerranéennes 1995). The success of a particular species is based on its growth performance, the availability of juveniles and the results obtained on the market. Along the coasts of the Tyrrhenian Sea, the greatest limit to the expansion of mariculture is the low frequency of sheltered marine areas and the lack of a tradition among the coastal communities of marine species cultivation.

In an attempt to overcome these limits, a new integrated model of cultivation was tested in the Gulf of Castellammare. The main goals were to exploit the professional skills of small-scale fishermen and to suggest an economic tool for integration into small-scale fisheries through the cultivation of species common to the area, such as *Seriola dumerili* (Risso 1810), *Diplodus puntazzo* (Cetti 1777) and the newly introduced edible bivalve molluscs *Crassostrea gigas* (Thunberg) and *Mytilus galloprovincialis* (Lamarck 1819). *Seriola dumerili* is a species that adapts itself readily to culture in both tanks (Cavaliere, Crisafi, Faranda, Greco, Lo Paro, Manganaro & Mazzola 1989; Lazzari & Barbera 1989; Garcia-Gomez 1993; Greco, Caridi, Cammaroto & Genovese 1993) and cages (Giovanardi, Mattioli, Piccinetti & Sambucci 1984; Navarro, Belmonte & Culmarex 1987; Boix, Fernandez & Macia 1993; Mazzola, Sarà, Favaloro & Mirto 1996). Its controlled reproduction has, however, not yet been achieved, and the necessary juvenile recruitment takes place in the wild.

Great interest has also been shown recently in the sharpsnout seabream (*Diplodus puntazzo*), and excellent results have been achieved from culture in tanks (Faranda, Cavaliere, Lo Paro & Manganaro 1983; Divanach & Kentouri 1984) with controlled reproduction as well as in cages (Quero & Gueguen 1978; Faranda, Cavaliere, Lo Paro, Manganaro & Mazzola 1985; Porcile, Repetto & Wurtz 1987;

Santulli, Cusenza, Modica, Curatolo & D'Amelio 1991; Georgiou & Stephanou 1995; Marangos 1995).

In the southern Mediterranean, bivalve molluscs (especially *C. gigas*) are cultured in a few sheltered and highly productive areas (Sarà, Manganaro, Cortese, Pusceddu & Mazzola 1998). Only a small number of studies have looked at the growth performance of bivalve molluscs, especially of *C. gigas* and *M. galloprovincialis* in the southern Mediterranean (Genovese 1970; Sarà, Cortese, Manganaro & Pulicanò 1992; Sarà 1994; Sarà & Mazzola 1997; Sarà *et al.* 1998). Data regarding the cultivation of bivalve molluscs integrated with other fish species are also limited.

The aims of this study were (i) to test a submerged model of integrated culture in an area of artificial reefs – a model that is simple to install, involves low technology and is low cost; (ii) to measure the growth rate and feeding parameters of *S. dumerili* and *D. puntazzo*; and (iii) to study the potential of growing *C. gigas* and *M. galloprovincialis* in the same culture system.

Materials and methods

The experimental trials were conducted from 1994 to 1995 in an area of the Gulf of Castellammare (latitude 38° 02′ 31″ N, longitude 12° 55′ 28″ E) containing artificial reefs, at a distance of ≈ 1000 m from the coast. The average water temperature during the trials was 19.6 ± 2.03 °C (16.7 °C in autumn and winter, 22 °C in summer), and the salinity was 37.88 ± 0.19 p.s.u. (37.5 p.s.u. in autumn and winter, 38.1 p.s.u. in summer). A thermocline was observed from June to September between depths of 10 and 12 m (Sarà *et al.* 1998).

For fish cultivation a 'lantern' module of three cages (75 m^3, 4.5 m diameter × 5 m deep, 12-mm net mesh) was anchored ≈ 3 m from the sea bed to a system of artificial reefs at a depth of 20 m.

Juvenile specimens of *S. dumerili* ($n = 1600$) were caught during summer 1994 by a local co-operative of fishermen using a purse seine net (150 m × 40 m and 20-mm mesh). Specimens were placed in two cages ($n = 800$ per cage; lot A and lot B) at an initial density of 10 individuals m^{-3}, at an initial mean total length of 141.4 ± 34.2 mm and a mean total weight of 48 ± 28.05 g. During the period of cultivation (September–December 1994), 50 individuals of *S. dumerili* per cage were removed monthly, their total length and weight measured [total length TL (mm), total weight TW (g)] and returned to their respective cages. In the same area as that used for cultivation, wild specimens of *Seriola* were caught monthly by the same group of fishermen ($n = 50$ each month), weighed and measured in an identical manner to the former specimens and released again.

The two lots were fed twice a day with fish scraps (lot A) or food pellets (lot B). The diet of lot A was composed of *Scomber scomber* (46.4%), *Boops boops* (17.0%) and *Trachurus trachurus* (15.5%), with these species forming 78% of the total food administered. The diet of lot B consisted of commercial pellets (size 3, 4 and 8 mm; Trouvit-Hendrix). The chemical composition of pellet was 48% protein, 10.5% lipid, 1% cellulose and 11% ash.

In August 1994, juveniles of *D. puntazzo* (lot C) were introduced in the third cage ($n = 2500$). These specimens originated from a Sicilian fish farm and were stocked at an initial density of 33 individuals m^{-3}, an initial mean total length of 143.0 ± 9.4 mm and an initial mean total weight of 46.7 ± 9.4 g.

During the cultivation period (11 months, August 1994 to June 1995), specimens of *D. puntazzo* ($n = 50$) were removed monthly, and biometric measurements were taken. The *D. puntazzo* lot was fed with pellets (2, 3 and 4 mm) twice a day at a rate of 0.5–3% of body weight. The specific growth rates (Jobling 1983) and food conversion ratios (Stead, Houlihan, McLay & Johnston 1996) were calculated for the three lots of fish.

The cultivation of molluscs was carried out around the cages between May 1994 and April 1995. Juveniles of *C. gigas*, originating from an Adriatic nursery (initial mean length 11.50 ± 1.75 mm; mean dry weight 0.036 ± 0.009 g) were cultured in PVC bags. Juveniles (mean initial length 11.20 ± 1.60 mm; mean dry weight 0.01 ± 0.0001 g, J7 and J13) and subadult (mean initial length 43.16 ± 2.02 mm; mean dry weight 0.51 ± 0.04 g, A7 and A13) specimens of *M. galloprovincialis* (about 1000 kg), also originating from the northern Adriatic, were cultured in small-mesh nylon net bags (height 1.5 m; 4-cm mesh size). Both species of mollusc were secured to two suspended lines (at depths of 7 m and 13 m) attached to underwater artificial reefs at a depth of 20 m, and their growth ($n = 200$) and frequency of spawning were monitored monthly according to the methods detailed in the literature (Crisp 1984; Sarà 1994; Dame 1996; Sarà & Mazzola 1997; Sarà *et al.* 1998).

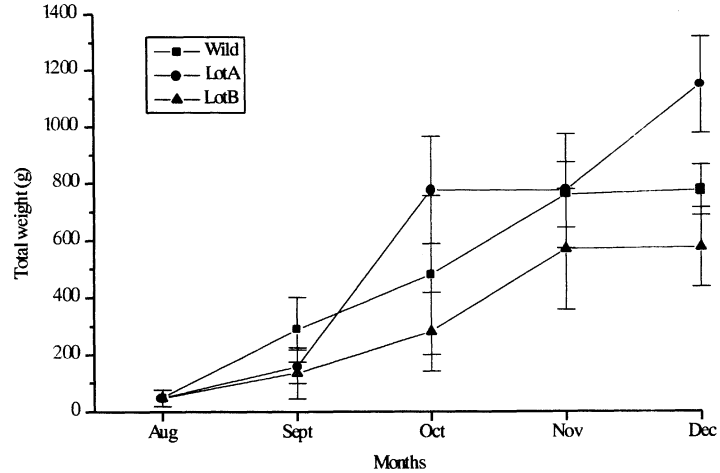

Figure 1 Monthly trend in total weight (g) for the three lots of *Seriola dumerili*.

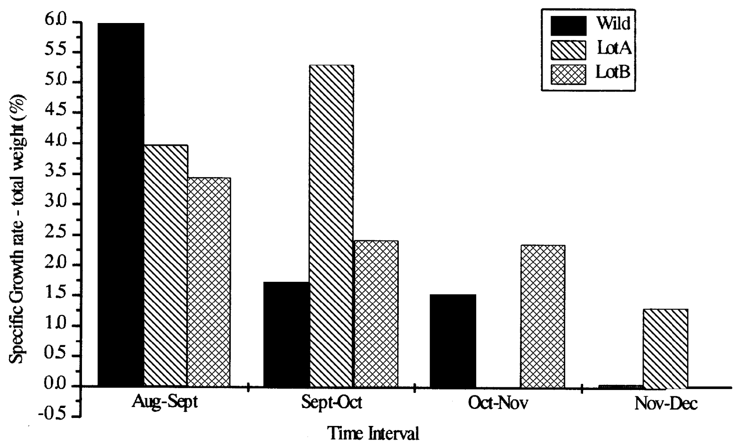

Figure 2 Specific growth rates (%) for total weight of the three lots of *Seriola dumerili*.

Results

Seriola dumerili

The growth trends of the three lots of fish are shown in Fig. 1. Lot A reached the largest dimensions (1150 ± 172 g), while lot B and wild fish reached dimensions of 576 ± 139 g and 777 ± 90 g respectively. In lot A, a sharp increase in weight was recorded in October (from 158 g in September to 777 g in October).

The specific growth rate of lot A was higher between September and October (Fig. 2). The other two lots showed more constant growth rates, except in November to December, when the minimum levels were recorded. In lot B only, 3.12% mortality was recorded at the beginning of the experiment. The quantity of food supplied to lot A over the entire cultivation period (300 days) was 3545 kg, the biomass reached was 919.2 kg, the final density was ≈12.3 kg m^{-3} and the food conversion ratio was 3.86:1. Lot B was supplied with 1362 kg of food pellets and reached a biomass of 461 kg at a final density of 6.14 kg m^{-3}.The food conversion ratio was 2.95:1.

Diplodus puntazzo

The growth trend of lot C fish is shown in Fig. 3. Lot C reached a final mean size of 228 ± 14.4 mm and a final weight of 228 ± 40 g. Lot C fish showed decreases in weight in February (from 171 g in January to 163 g in February) and again from 237.8 g in May to 228 g in June. Specific growth rate decreased with the increase in size and the decrease in temperature (Fig. 4). During February and March, the specific growth rate in terms of weight showed an increase but then diminished again during the following months, reaching its minimum value during January and February (–0.16%).

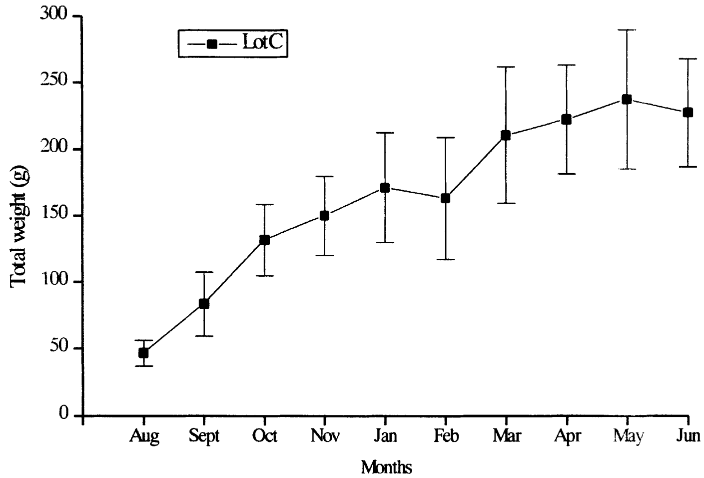

Figure 3 Monthly trend in total weight (g) of *Diplodus puntazzo* (lot C).

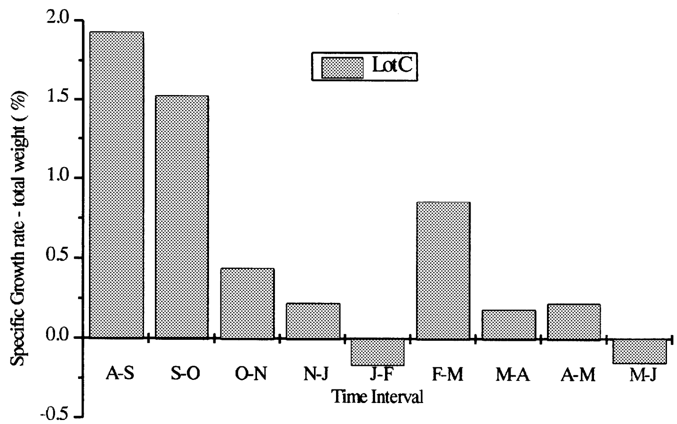

Figure 4 Specific growth rates (%) for total weight of *Diplodus puntazzo* (lot C).

The total quantity of food supplied to lot C over the entire cultivation period was 1365 kg. Cage biomass reached a maximum of 535.24 kg, and the stock final density was 7.13 kg m^{-3}. The food conversion ratio during the trials was 3.26:1.

Crassostrea gigas

The two lots of oysters placed at the two depths showed similar growth rates, although after 12 months, the group placed at a depth of 7 m had reached a slightly larger size and weight (47.50 ± 12.30 mm and 0.13 ± 0.04 g dry weight at –7 m and 41 ± 11.43 mm and 0.11 ± 0.04 g dry weight at –13 m respectively). The specific daily growth rates showed that there was similar growth in somatic (Fig. 5) growth terms at 7 m, while at 13 m, the two groups showed a clear difference in energetic allocation between the different months. A comparison of the monthly growth trends, in terms of both length and dry weight, shows differences between the groups from the two depths during the months of June, September, November, March and April.

Mytilus galloprovincialis

The adult lots (A7 and A13) were initially composed of subadult specimens (see *Materials and methods*). The specific growth rates of the two subadult lots (Fig. 6A) showed degrowth periods occurring in early summer and late autumn, while during the rest of the year, growth rate values were positive. Lot A13 specimens were found to spawn in September and March (about 35% and 55% of the population respectively). The A7 specimens spawned in November and March (about 36% and 65% of the population respectively). After 12 months, specimens in the A7 group reached 58 ± 6.6 mm total length and 0.6 ± 0.1 g dry

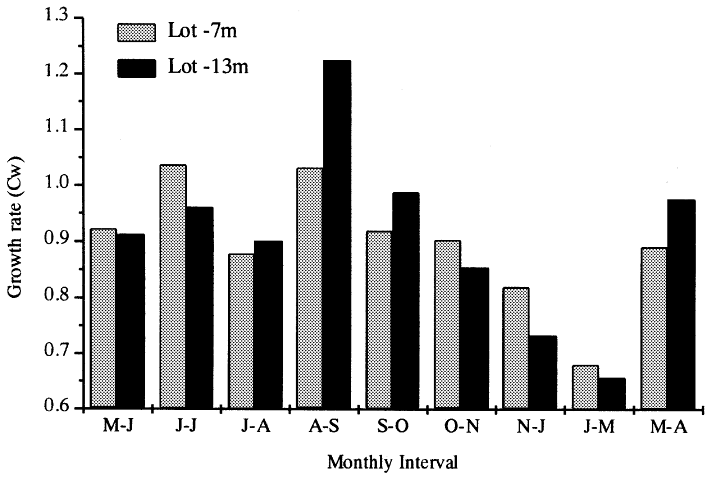

Figure 5 Specific growth rates for dry weight of *Crassostrea gigas* (lot −7 m and −13 m).

weight, while those in the A13 group reached a mean size of 63 ± 8.3 mm and 0.9 ± 0.1 g in length and dry weight respectively.

The specific growth rates of the juvenile lots (J7 and J13) alternated between positive and negative values throughout the year (Fig. 6B). Excluding the peak in May and June, the specific growth rates of the two juvenile lots did not show the same temporal pattern as the adults. After 10 months, the juveniles that were placed at −7 m reached a mean total length of 37 ± 5 mm and 0.20 ± 0.08 g dry weight, while individuals of the J13 group had a mean total length of 43 ± 4.9 mm and a mean dry weight of 0.33 ± 0.09 g.

Discussion

One of the main aims of research in aquaculture is to initiate the cultivation of new species and, thus, to increase diversification. The four species studied in this paper showed great potential for cultivation in an oligotrophic area that had previously not been exploited for mariculture.

Mortality (3.12%) was observed only in *S. dumerili* in the pellet-fed lot (lot B) in the initial phase of cultivation. This may have resulted from the fact that *Seriola* is a carnivorous species, which has been shown to prefer fish scraps to pellets, despite the fact that the latter seem to provide superior nutrition (Garcia-Gomez 1993). A diet of fish scraps produced greater biomass and allowed fish to reach larger individual sizes than were produced in either the wild lot or in lot B. Lot B fish, on the other hand, grew more slowly and reached smaller dimensions, presenting a growth rate that was similar to that of the wild fish.

The growth rate and sizes of lot A were found to be higher than those obtained in previous studies (Giovanardi *et al.* 1984; Cavaliere *et al.* 1989; Porrello, Andaloro, Vivona & Marino 1993; Garcia-Gomez 1993; Greco *et al.* 1993). The food conversion ratio of lot B can be considered to be high in comparison with the nutritional value of the food supplied (Garcia-Gomez 1993). The food conversion ratio of lot A, which was higher than that of lot B, is in agreement with the results reported in previous studies (Greco *et al.* 1993) and demonstrates the low efficacy of fish scraps (Garcia-Gomez 1993).

Only recently has information been obtained on the behaviour of *D. puntazzo* under captive conditions (Faranda *et al.* 1985; Gatland 1995; Marangos 1995). In this study, the growth trajectory of this species was not homogeneous, with accentuated phases of decrease in weight. This phenomenon, which was observed during the winter, confirms that temperature values of around 13–14 °C influence the growth performance of *D. puntazzo* negatively. The effect of low temperature was very probably amplified by the adverse winter meteorological conditions, which often impeded daily feeding, highlighting the elevated sensitivity of *D. puntazzo* to dietary deficiencies when compared with other Sparids (Marangos 1995). The food conversion ratio was similar to that observed in other studies (Gatland 1995), but the overall results clearly show that a better formulation of diet, which takes into account feeding habits, is needed for this species (Ceccarelli, Fresi, Plastina & Scardi 1983; Porcile *et al.* 1987; Mirto, Scilipoti, Lopiano, Badalamenti & Mazzola 1994).

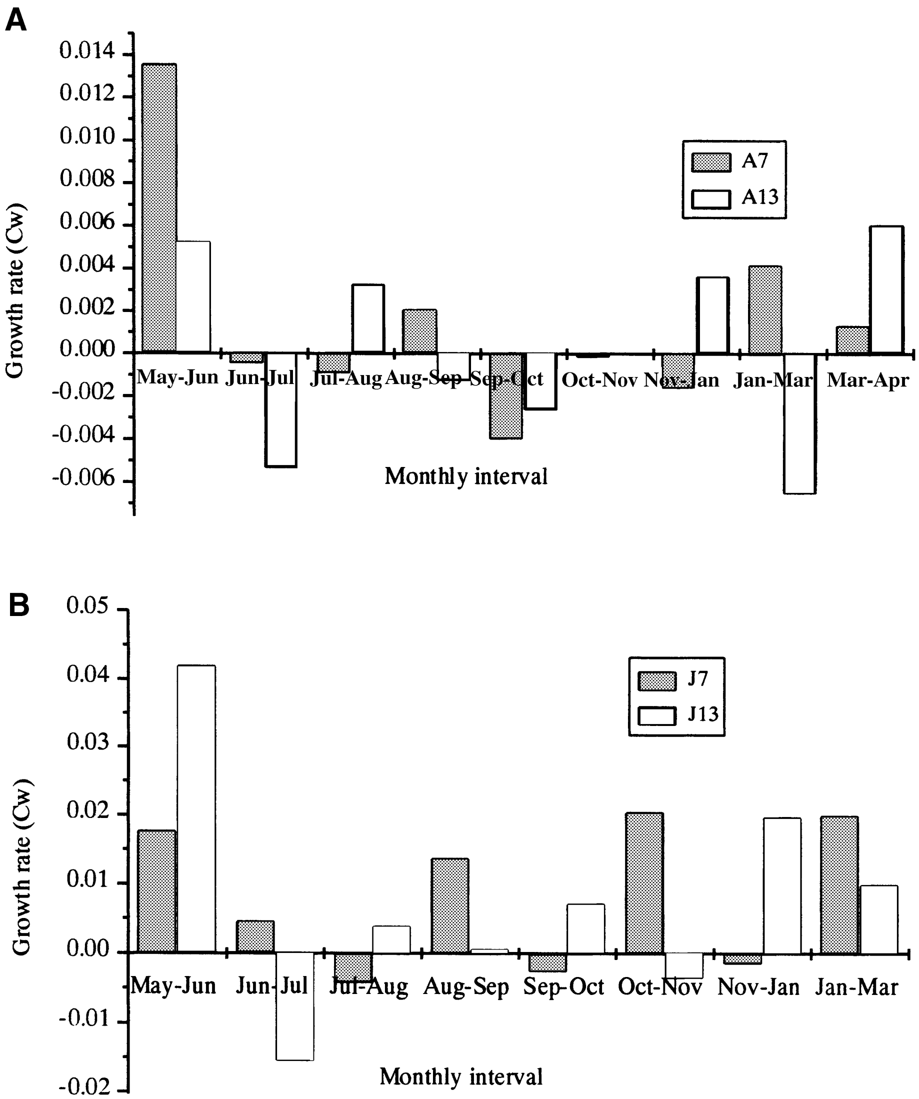

Figure 6 (A) Specific growth rates for dry weight of *Mytilus galloprovincialis* (lots A7 m and A13 m). (B) Specific growth rates for dry weight of *Mytilus galloprovincialis* (lots J7 m and J13 m).

It has been demonstrated previously that the study area is characterized by strongly oligotrophic waters and that the particulate organic matter in the Gulf of Castellammare is considerably diluted in an inorganic matrix of terrigenous continental nature (Sarà 1994). Despite this, the quality and quantity of the particulate organic matter seems to be ideal for the cultivation of edible filter molluscs, as demonstrated by the presence of autochthonous populations of *Ostrea edulis* on hard substrates (D'Anna, Sparla & Riggio 1990). The experience of cultivating *C. gigas* and *M. galloprovincialis* also allowed us to conclude that allochthonous populations of bivalve molluscs can find the trophic conditions ideal for growth to commercial size. Molluscs are filter feeders that regulate their food intake, adapting their filtering rhythm to the concentration and quality of the resources available (Dame 1996). It is also likely that the bacterial component plays an important role in the diet of oysters in the Gulf (Dame 1996; Sarà & Mazzola 1997). Although the resource inputs (i.e. surplus pellet and ejection) originating from cultivated fish were not quantified, we cannot at present rule out this factor, hypothesizing that these resources may play a certain role in supplying the energy requirements of molluscs. Further information is necessary if we are to understand better the relationships between molluscs and fish cultivated in the same system.

It is clear that the integrated system tested in this study can provide information of great value, which can be passed on to the managers of local small-scale fisheries. The cultivation of the greater amberjack by small farms that operate seasonally (August to December), the cultivation of sharpsnout seabream as a species with a longer stock period and the integration of long-line systems of filter molluscs all contribute to accelerating the process of development through the creation of small nuclei of production. Such initiatives can offer fishermen the chance to supplement their income, with only a modest investment, while continuing with their usual working activities. Coastal mariculture can provide a further opportunity to transform fishing activities that are no longer profitable, redirecting the skills involved to closely related sectors.

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References

Boix J., Fernandez J.V. & Macia G. (1993) El cultivo de *Seriola* (*Seriola dumerili*, Risso, 1810) en jaula flotante en el termino maritimo de Les Cases d'Alcanar (Tarragona). In: *Actas IV Congreso Nacional Acuicoltura.* La Toja, Galicia, pp. 133–136.

Cahiers options méditerranéennes (1995) *Marine Aquaculture Finfish Species Diversification* (ed. by M. Lasram), pp. 1–169. Ciheam/Medrap II. Zaragoza.

Cavaliere A., Crisafi E., Faranda F., Greco S., Lo Paro G., Manganaro A. & Mazzola A. (1989) Collection of fingerlings and rearing of *Seriola dumerili* in tanks. In: *Aquaculture: a Biotechnology in Progress* (ed. by N. De Pauw, E. Jaspers, H. Ackefors & N. Wilkins), pp. 119–123. Bredene, Belgium.

Ceccarelli R., Fresi E., Plastina N. & Scardi M. (1983) Comportamento alimentare degli stadi giovanili di *Diplodus puntazzo* (Gm.) dell'Isola d'Ischia. *Nova Thalassia* **6,** 503–509.

Crisp D.J. (1984) Energy flow measurements. In: *Methods for the Study of Marine Benthos* (ed. by N.A. Holme & A.D. MacIntyre), pp. 197–279. IBP Handbook no. 16. Blackwell Scientific, Oxford.

D'Anna G., Sparla M.P. & Riggio S. (1990) Note sui banchi filtratori nel Golfo di Castellammare (Sicilia M/W). *Oebalia* **16,** 647–650.

Dame R.F. (1996) *Ecology of Marine Bivalves. An Ecosystem Approach.* CRC Press, Boca Raton.

Divanach P. & Kentouri M. (1984) Sur le possibilités de production de juvenilés de poissons marines par la filière extensive dans le Languedoc. Influence de l'époque et des conditions climatiques. In: *L'Aquaculture Du Bar et Des Sparides* (ed. by G. Barnabè & R. Billard), pp. 175–184. INRA Publishers, Paris.

Faranda F., Cavaliere A., Lo Paro G. & Manganaro A. (1983) Accrescimento di *Puntazzo puntazzo* e *Diplodus vulgaris*. Comparazione di due diverse diete. *Memorie Di Biologia Marina ed Oceanografia* **13,** 37–53.

Faranda F., Cavaliere A., Lo Paro G., Manganaro A. & Mazzola A. (1985) Preliminary studies on reproduction of *Puntazzo puntazzo* (Gmelin 1789) (Pisces, Sparidae) under controlled conditions. *Aquaculture* **49,** 111–123.

Garcia-Gomez A. (1993) Primeras experiencias de crescimiento de juveniles de *Seriola* mediterranea (*Seriola dumerili*, Risso, 1810) alimentados con una dieta semihumeda. *Boletin del Instituto Español de Oceanografia* **9,** 347–360.

Gatland P. (1995) Growth of *Puntazzo puntazzo* in cages in Selonda bay, Corinthos, Greece. In: *Marine Aquaculture Finfish Species Diversification* (ed. by M. Lasram), pp. 51–55. Centre International Hautes Etudes Agronomiques Méditerranéennes, Zaragoza.

Genovese S. (1970) Dati biometrici sulla popolazione di *Mytilus galloprovincialis* LMK. dello Stagno di Ganzirri. *Extraits des Rapports et Proces-Verbaux des Reunions de la CIESMM* **15**.

Georgiou G. & Stephanou D. (1995) Contribution to the study of maturation and spawning problems of the sharpsnout seabream (*Puntazzo puntazzo*). In: *Marine Aquaculture Finfish Species Diversification* (ed. by M. Lasram), pp. 47–50. Centre International Hautes Etudes Agronomiques Méditerranéennes, Zaragoza.

Giovanardi O., Mattioli G., Piccinetti C. & Sambucci G. (1984) Prime esperienze sull'allevamento di *Seriola dumerili* (Risso, 1810) in Italia. *Rivista Italiana di Piscicultura e Ittiopatalogia* **4,** 123–130.

Greco S., Caridi D., Cammaroto S. & Genovese L. (1993) Preliminary studies on artificial feeding of amberjack fingerlings. In: *Production, Environment and Quality* (ed. by G. Barnabè & P. Kestemond), pp. 247–254. Special Publication 18. Bordeaux Aquaculture EAS.

Jobling M. (1983) Growth studies with fish-overcoming the problems of size variation. *Journal of Fish Biology* **22,** 153–157.

Lazzari A. & Barbera G. (1989) Farming the Mediterranean yellowtail, *Seriola dumerili* Risso, 1810 in concrete ponds: result and perspectives. In:

Aquaculture: a Biotechnology in Progress (ed. by N. De Pauw, E. Jaspers, H. Ackefors & N. Wilkins), pp. 119–123. Bredene, Belgium.

Marangos C. (1995) Larvicolture of the sheepshead bream, *Puntazzo puntazzo* (Gmelin 1789) (Pisces Sparidae). In: *Marine Aquaculture Finfish Species Diversification* (ed. by M. Lasram), pp. 41–46. Centre International Hautes Etudes Agronomiques Méditerranéennes. Zaragoza.

Mazzola A., Sarà G., Favaloro E. & Mirto S. (1996) Sistemi di maricoltura open-sea per l'allevamento di *Seriola dumerili* (Pisces, Osteichthyes) nel Golfo di Castellammare (Sicilia Occidentale). *Biologia Marina Mediterranea* **3,** 176–185.

Mirto S., Scilipoti D., Lopiano L., Badalamenti F. & Mazzola A. (1994) Primi dati sul ritmo alimentare giornaliero di tre specie ittiche nello Stagnone di Marsala (Sicilia). *Biologia Marina Mediterranea* **1,** 335–336.

Navarro J.M., Belmonte A. & Culmarex S.a.L. (1987) Cultivo de *Seriola* en jaulas flotantes en la bahia de El Hornillo (Murcia, SE Espana). *Cuadernos Marisqueras Publicaciones Tecnicas* **12,** 11–16.

Porcile P., Repetto N. & Wurtz M. (1987) Comportamento alimentare di giovani Sparidi in una prateria di *Posidonia oceanica* del Mar Ligure. *Oebalia* **12,** 311–314.

Porrello S., Andaloro F., Vivona P. & Marino G. (1993) Rearing trial of *Seriola dumerili* in a floating cage. In: *Production, Environment and Quality* (ed. by G. Barnabè & P. Kestemont), pp. 299–307. Special publication 18. Bordeaux Aquaculture EAS, Ghent, Belgium.

Quero J.C. & Gueguen J. (1978) Donnees sur la faune ichtyologique du Golfe de Gascogne. 1. Repartition des *Diplodus* (Sparidae, Perciformes) et remarques sur leurs stades juveniles. *Cybium* **3,** 82–94.

Santulli A., Cusenza L., Modica A., Curatolo A. & D'Amelio V. (1991) Fish plasma lipoproteins – comparative observations in Serranides and Sparides. *Comparative Biochemistry and Physiology* **99B,** 251–255.

Sarà G. (1994) *Effects of the Trophic and Environmental Conditions on the Growth of the* Mytilus galloprovicialis *(LMK 1819) in Open-sea Culture in the Gulf of Castellammare (South Tyrrhenian Sea).* PhD Dissertation, University of Messina.

Sarà G. & Mazzola A. (1997) Effects of trophic and environmental conditions on the *Crassostrea gigas* growth in culture. *Aquaculture* **153,** 81–91.

Sarà G., Cortese G., Manganaro A. & Pulicanò G. (1992) Accrescimento di *Mytilus galloprovincialis* (LMK, 1819) in un parco sperimentale open-sea nel Golfo di Castellammare (TP –Sicilia). *Biologia Marina Mediterranea* **1,** 259–260.

Sarà G., Manganaro A., Cortese G., Pusceddu A. & Mazzola A. (1998) The relationship between food availability and growth in *Mytilus galloprovincialis* in the open sea (southern Mediterranean). *Aquaculture* **167,** 1–15.

Stead M.S., Houlihan D.F., McLay H.A. & Johnston R. (1996) Effect of ration and seawater transfer on food consumption and growth of Atlantic salmon (*Salmo salar*) smolts. *Canadian Journal of Fisheries Aquatic Sciences* **53,** 1030–1037.