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Recruitment of *Diplodus annularis* and *Spondyliosoma cantharus* (Sparidae) in shallow seagrass beds along the Italian coasts (Mediterranean Sea)

Recrutement de Diplodus annularis *et* Spondyliosoma cantharus *(Sparidae) dans les herbiers superficiels de phanérogames marines, le long des côtes italiennes (mer Méditerranée)*

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ABSTRACT

Guidetti P., S. Bussotti, 1997 - Recruitment of Diplodus annularis *and* Spondyliosoma cantharus *(Sparidae) in shallow seagrass beds, along the Italian coasts (Mediterranean Sea).* Mar. Life, **7** (1-2): 47 - 52.

Observations on the presence and abundance of juveniles of the two sparids Diplodus annularis *and* Spondyliosoma cantharus *were carried out in shallow (between 0.4 m and 7 m depth) meadows of marine phanerogams* (Posidonia oceanica, Cymodocea nodosa *and* Zostera noltii) *in several localities along the Italian coasts. Data were collected by using the non-destructive visual census method and juveniles were counted along transects of prestablished area. Juveniles of* Diplodus annularis *were censused from July to October both in* Posidonia oceanica *and in short-leaved seagrasses (*Cymodocea nodosa *and* Zostera noltii*); juveniles of* Spondyliosoma cantharus *were observed from July to October only in* Posidonia oceanica *beds. Peak of juvenile density (number of individuals . 150 m^{-2}) was recorded in August for both species. Thus, these two species were closely linked to marine phanerogam meadows for settlement. In general, sheltered sites seemed more suitable for settlement than exposed ones. These data highlight the importance of seagrasses in the coastal systems for the biology of the two investigated fish species, mainly during the first phase of their benthic life. This emphasizes the need for correct management and preservation of coastal zones, as alterations caused by any kind of anthropogenic disturbance could dramatically affect their recruitment potential.*

RÉSUMÉ

Guidetti P., S. Bussotti, 1997 - [Recrutement de Diplodus annularis *et* Spondyliosoma cantharus *(Sparidae) dans les herbiers superficiels de phanérogames marines, le long des côtes italiennes (mer Méditerranée)].* Mar. Life, **7** (1-2) : 47 - 52.

La présence et l'abondance des juvéniles de deux espèces de Sparidae, Diplodus annularis *et* Spondyliosoma cantharus, *ont été évaluées dans des sites superficiels (entre 0,4 et 7 m) à phanérogames marines* (Posidonia oceanica, Cymodocea nodosa *et* Zostera noltii). *La méthode non destructive des inventaires visuels a été employée en évaluant le nombre d'individus le long d'un transect de surface établie. Les juvéniles de* Diplodus annularis *ont été observés, de juillet à octobre, non seulement dans les herbiers à* Posidonia oceanica, *mais aussi à* Cymodocea nodosa *et* Zostera noltii *; au contraire, les juvéniles de* Spondyliosoma cantharus *ont été recensés, de juillet à octobre, uniquement dans les herbiers de Posidonies. La densité (nombre d'individus . 150 m^{-2}) maximale a été observée en août pour les deux espèces. Ces deux espèces sont très fortement liées aux herbiers à phanérogames marines pour leur recrutement. En général, les sites les plus protégés, caractérisés par un régime hydrodynamique faible, semblent plus favorables au recrutement de ces espèces que les sites plus exposés.*
Ces résultats montrent l'importance vitale des herbiers de phanérogames marines dans les systèmes littoraux pour le cycle biologique des deux espèces étudiées, surtout en ce qui concerne la première phase de leur vie benthique. Ceci souligne la nécessité d'utiliser correctement et de protéger les zones côtières, car les altérations éventuelles provoquées par l'action humaine peuvent affecter sévèrement leur potentialité de zone de recrutement pour les poissons.

INTRODUCTION

The complex life history of marine littoral fishes often involves a first dispersive larval stage followed by the recruitment of juveniles to benthic habitats and a more or less benthic adult phase. The recruitment represents, therefore, a crucial event which plays an important role in fish population dynamics (Doherty and Fowler, 1994) ensuring the permanence of adult stocks (Jones, 1990; Meekan *et al.*, 1993). During this phase, marked changes in morphology, habitat, diet and behaviour patterns occur (Brother and McFarland, 1981). Main factors affecting the success of recruitment are shelter and food availability, competition, density of adults and recruits (Doherty, 1982; Sweatman, 1985; Behrents, 1987; Jones, 1987; Forrester, 1990; Levin, 1993). It is well known, furthermore, that settlement of juveniles of many fish species occurs in very shallow-waters (Warburton and Blaber, 1992; Harmelin-Vivien *et al.*, 1995).

The bulk of studies focused on recruitment patterns and choice of suitable habitats by juvenile fishes have been mainly carried out in tropical regions for coral reefs or in temperate areas for different types of substrate (Sale *et al.*, 1984; Safran, 1990; Levin, 1993; Warburton and Blaber, 1992; Carr, 1994; Costa *et al.*, 1994; Doherty and Fowler, 1994; Tolimieri, 1995). Nevertheless, in the Mediterranean, little information is currently available on microhabitat requirements and temporal patterns of recruitment for juveniles of littoral fishes. In fact, only recently, increasing attention has been devoted to this problem by Harmelin-Vivien *et al.* (1995) and Garcia Rubies and Macpherson (1995), who mainly took into account different types of substrate mainly in shallow waters. As suggested by Garcia Rubies and Macpherson (1995), substrate type is one of the main factors involved in the process of recruitment and it affects abundance, mortality and growth rates of recruits.

The role of nurseries played by seagrass beds is well documented in different geographical areas (Bell and Pollard, 1989; Costa *et al.*, 1994), while in the Mediterranean, no specific studies have been carried out on the role of these biotopes on the recruitment of littoral fishes. In fact, Harmelin-Vivien *et al.* (1995) and Garcia Rubies and Macpherson (1995) have recently pointed out the existence of links between juveniles of several species (*Mullus surmuletus, Symphodus tinca, Symphodus cinereus, Diplodus annularis, Spondyliosoma cantharus*) and *Posidonia oceanica* beds, but did not report quantitative data. The present paper, therefore, represents a first contribution to the knowledge of the role played by shallow water Mediterranean seagrass beds for the settlement of two sparids, *Diplodus annularis* and *Spondyliosoma cantharus.*

MATERIAL AND METHODS

Study sites

Observations were made in different areas of the Italian coasts (figure 1) represented by: 1) Noli (Ligurian Sea), between July and November 1994; 2) Gulf of Olbia (North-eastern Sardinia), between August 1995 and August 1996; 3) Castello Aragonese (Island of Ischia, Gulf of Naples), between July and November 1996.

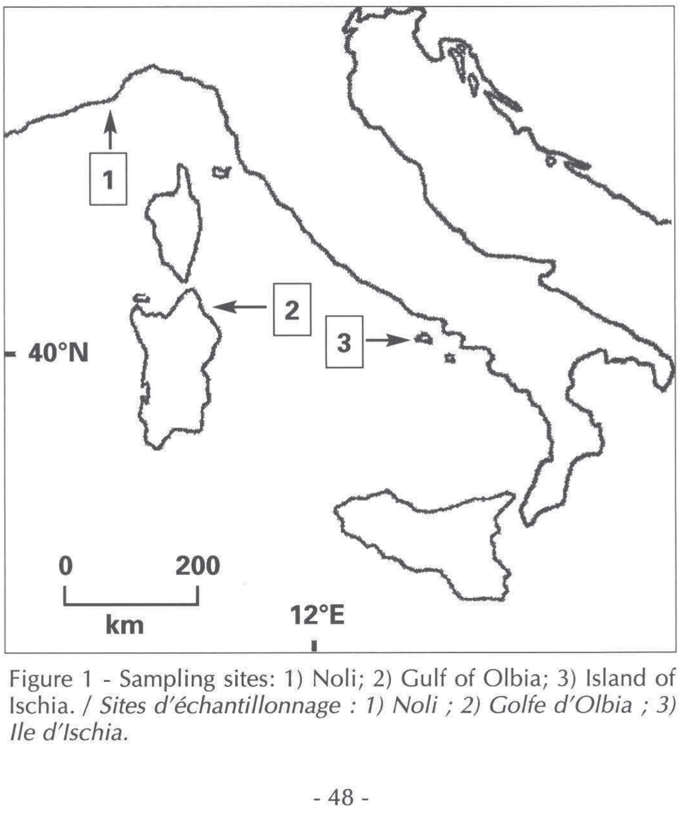

Figure 1 - Sampling sites: 1) Noli; 2) Gulf of Olbia; 3) Island of Ischia. / *Sites d'échantillonnage : 1) Noli ; 2) Golfe d'Olbia ; 3) Ile d'Ischia.*

The first site is represented by a *Posidonia oceanica* bed characterized by a comparatively high hydrodynamism. Observations were carried out both at 2 m (where the shoot density was 400 shoots . m^{-2}) and 7 m depth (350 shoots . m^{-2}). The study site located in the Gulf of Olbia is a sheltered bay colonized by a mixed *Cymodocea nodosa* and *Zostera noltii* meadow extending homogeneously between 0.4 and 1.5 m depth on soft bottom with rare rocky formations covered by photophilic algae. The shoot density widely varied throughout the sampling year showing the minimum value in December 1995 (954.5 shoots . m^{-2}) and the maximum in August 1995 (1776.0 shoots . m^{-2}; Guidetti and Bussotti, 1997). The Castello Aragonese site is represented by a *Posidonia oceanica* meadow showing a thick "matte" and a shoot density of about 1000 shoots . m^{-2} at very shallow stands (Gambi, unpublished data); the transect was placed at 2 m depth in the protected bay adjacent to the Aragonese castle. Some complementary observations were also conducted in August 1996 at Punta S. Pietro (Island of Ischia), characterized by some patches of *Posidonia oceanica* at about 1.5 m depth and a *Cymodocea nodosa* meadow at about 2-2.5 m depth, and in the Marine Reserve of Miramare (Trieste, North Adriatic Sea), where phanerogams have completely disappeared since 1990 (Odorico and Bressan, 1994). At Miramare, observations were made both on a bottom completely covered by the brown alga *Halopteris scoparia* (~3 m depth) and along a portion of rocky shore mixed with sand and pebbles (1-3 m depth). Except for the rocky shore at Miramare, all sites were characterized by a gentle slope.

Sampling method

Data were collected by snorkelling and scuba diving by two observers (the authors). Monthly observations (samplings) were carried out by performing a number of two to five censuses (replicates) (table I) along transects of prestablished area. Thus, juveniles of *Diplodus annularis* and *Spondyliosoma cantharus* were censused along transects 25 m long and 6 m wide (150 m^2) at constant depth; the abundance and size (± 0.5 cm) of specimens were recorded in situ on a PVC tablet. The recorded total number of juveniles of the two sparids was expressed as density (number of individuals . 150 m^{-2}). Data on shoot density were collected by using metal frames 40 x 40 cm for *Posidonia oceanica* and 20 x 20 cm for *Cymodocea nodosa* and *Zostera noltii*. Measurements were replicated five times and the resulting mean value was converted into number of shoots per square meter.

RESULTS

Diplodus annularis was observed to settle both in the investigated *Posidonia oceanica* beds and in the mixed meadow composed of *Cymodocea nodosa* and *Zostera noltii*. Juveniles of this species were censused at Noli from July to October 1994 and at Castello Aragonese from August to October 1996. In the Gulf of Olbia, small sized *Diplodus annularis* were observed between August and October 1995 and in July and August 1996 (table II). In general, except for the shallower site at Noli, peaks in the abundance of juveniles were observed in August (table II).

As far as *Spondyliosoma cantharus* is concerned, juveniles were never censused at the *Cymodocea nodosa* and *Zostera noltii* meadow of Olbia, while only 3 specimens were recorded in August 1996 at the Castello Aragonese site. This species, on the contrary, was abundant in the *Posidonia oceanica* bed of Noli, where it was observed from July to October (table III). Very high densities were measured at Noli in the deeper transects in August (40.7 individuals . 150 m^{-2}) and September 1994 (19.0 individuals . 150 m^{-2}). For *Diplodus annularis*, the peak in settlement intensity occurred in August. This suggests a similar temporal trend in recruitment for both the species. Moreover, a comparison between the Noli transects (2 m and 7 m depth), revealed that the recruitment mainly occurred at the deeper site for both *Diplodus annularis* and *Spondyliosoma cantharus* (tables II, III). As regards to the size, mean length values of juvenile specimens from Noli, Olbia and Castello Aragonese sites are reported in table IV, in which data from the two Noli stations are pooled. In fact, juveniles of the two sparids recorded at - 2 and - 7 m depth did not show marked differences in size, deriving from the same reproductive event.
On a single transect performed at the *Cymodocea nodosa* meadow of Punta S. Pietro, two juvenile specimens of *Spondyliosoma cantharus* (3 cm of total length) and 15 of *Diplodus annularis* (2.5-3 cm)

Table I - Sampling sites and periods; N: number of observations (samplings); n: number of censuses (replicates). / *Sites et périodes d'échantillonnage ; N : nombre d'observations (échantillonnages) ; n : nombre total de relevés (répliques).*

Site	Sampling period	N	n
Noli - 2 m	July 1994 - November 1994	5	15
Noli - 7 m	July 1994 - November 1994	5	15
Gulf of Olbia	August 1995 - August 1996	13	57
Castello Aragonese	July 1996 - November 1996	5	18

Table II - Density (mean number of individuals . 150 m^{-2} and standard deviation) of juveniles of *Diplodus annularis* observed at the study sites (in table are not reported the months in which juveniles were not censused). / *Densité (nombre moyen d'individus . 150 m^{-2} et écart type) de* Diplodus annularis *juvéniles observée sur les sites d'étude (dans le tableau, ne sont pas indiqués les mois durant lesquels les juvéniles n'ont pas été recensés).*

Site	Period		Density
Noli -2 m	July	1994	0.3 (0.4)
	August	-	1.0 (1.1)
	September	-	1.5 (0.6)
	October	-	1.0 (0.0)
Noli -7 m	July	1994	2.0 (3.7)
	August	-	8.3 (4.8)
	September	-	1.5 (0.7)
Gulf of Olbia	August	1995	10.5 (6.3)
	September	-	0.3 (0.5)
	October	-	1.3 (0.5)
	July	1996	1.3 (0.5)
	August	-	8.7 (1.7)
Castello Aragonese	August	1996	16.0 (5.7)
	September	-	6.7 (2.5)
	October	-	5.7 (5.6)

were recorded in July 1996. Interesting observations, moreover, were carried out on isolated patches of *Posidonia oceanica* at S. Pietro localized near the shoreline. In July 1996, in fact, 50 juveniles of *Diplodus annularis* (2.5-3 cm) were counted in swimming near the canopy, while they were completely absent from the surrounding area. At Miramare, marine phanerogams have disappeared since 1990 (Odorico and Bressan, 1994), but the presence of rare and isolated juvenile specimens of the two sparids was observed both near rocky shores and on a substrate homogeneously covered by the brown alga *Halopteris scoparia*.

DISCUSSION AND CONCLUSION

These data show the important role played by shallow seagrass meadows for recruitment of two sparids *Diplodus annularis* and *Spondyliosoma cantharus*. Our results are consistent with the observations by Harmelin-Vivien *et al.* (1995) and Garcia Rubies and Macpherson (1995), who reported the presence of *Spondyliosoma cantharus* and *Diplodus annularis* in *Posidonia oceanica* beds. As far as *Diplodus annularis* is concerned, Harmelin-Vivien *et al.* (1995) recorded the presence of juveniles between July and September in a *Posidonia oceanica* bed at 5-8 m depth along the coasts of Marseilles. We observed juveniles of the same species in a similar period (July-October at Noli; August-October at the Castello Aragonese and the Gulf of Olbia) and at very shallow depths. This different depth distribution does not depend on a different recruitment pattern, but on a different depth distribution of the investigated *Posidonia oceanica* beds. In fact, marine phanerogam beds can change their distribution patterns in relation to the local level of human disturbance (Pergent-Martini and Pergent, 1996). Furthermore, water quality could affect not only the health status of seagrass meadows, but also the survival of larvae and recruits, which represent stages particularly sensitive to pollutants (Westernhagen, 1988).

The available information on *Spondyliosoma cantharus* is very scarce and only Garcia Rubies and Macpherson (1995) report the presence of this species in *Posidonia oceanica* beds, whithout specifying the settlement period.

In general, the fact that mean values of juvenile density were higher in sheltered embayments (Castello Aragonese and Gulf of Olbia) than in exposed site (Noli site at 2 m depth), demonstrates the high suitability of protected bays colonized by seagrasses for the recruitment of *Diplodus annularis*. It is noteworthy, besides, that juveniles of *Spondyliosoma cantharus* were very abundant at the deeper site at Noli

Table III - Density (mean number of individuals · 150 m^{-2} and standard deviation) of juveniles of *Spondyliosoma cantharus* observed at the study sites (in table are not reported the months in which juveniles were not censused). / *Densité (nombre moyen d'individus . 150 m^{-2} et écart type) de* Spondyliosoma cantharus *juvéniles observée sur les sites d'étude (dans le tableau, ne sont pas indiqués les mois durant lesquels les juvéniles n'ont pas été recensés).*

Site	Period		Density
Noli -2 m	July	1994	2.0 (1.4)
	September	" "	3.2 (2.5)
Noli -7 m	July	1994	1.8 (1.9)
	August	" "	40.7 (8.5)
	September	" "	19.0 (2.8)
	October	" "	2.0 (0.0)
Castello Aragonese	August	1996	1.5 (2.1)

Table IV - Size (mean length and standard deviation) of juveniles of *Diplodus annularis* and *Spondyliosoma cantharus* observed at the study sites. / *Taille (longueur moyenne et écart type) des juvéniles de* Diplodus annularis *et* Spondyliosoma cantharus *observés sur les sites d'étude.*

Site	Species	Period		Length (cm)
Noli	*Diplodus annularis*	July	1994	1.9 (0.4)
		August	" "	2.3 (0.3)
		September	" "	2.8 (0.2)
		October	" "	3.2 (0.3)
	Spondyliosoma cantharus	July	1994	2.2 (0.3)
		August	" "	2.5 (0.2)
		September	" "	2.9 (0.3)
		October	" "	3.4 (0.2)
Gulf of Olbia	*Diplodus annularis*	August	1995	2.5 (0.4)
		September	" "	2.9 (0.3)
		October	" "	3.3 (0.3)
		July	1996	2.2 (0.3)
		August	" "	2.6 (0.3)
Castello Aragonese	*Diplodus annularis*	August	1996	2.5 (0.2)
		September	" "	2.8 (0.3)
		October	" "	3.1 (0.3)
	Spondyliosoma cantharus	August	1996	2.5 (0.0)

(- 7 m) in comparison with the shallower-one (- 2 m); this suggests the existence of a shifted bathymetric range at which juveniles preferentially settle in relation to the local hydrodynamism.

The presence of isolated juvenile specimens of the two species at Miramare, where seagrasses are not actually present, could be determined by the supply of pelagic larvae deriving from other or adjacent areas, such as the nearby Istrian peninsula, where marine phanerogams are currently well developped (Zavodnik and Jaklin, 1990; Vukovic and Turk, 1995). In any case, in the alternative habitats mentioned (rocky shores and arborescent algae), the observed low density of juveniles could be due to an increased mortality rate because of the absence of marine phanerogams, which represent the preferential substratum for settlement. In fact, Harmelin-Vivien *et al.* (1995) and Garcia-Rubies and Macpherson (1995) observed young recruits of *Diplodus annularis* and *Spondyliosoma cantharus* only in this biotope.

More generally, in order to assess the role of seagrass beds for recruitment of the whole littoral fish community, specific studies are needed, which, for the evaluation of the habitat characteristics, must take into account structural attributes and environmental features of studied meadows, such as percentage cover, shoot density, habitat patchness, seasonal dynamics, local hydrodynamism and anthropogenic disturbance. These factors, in fact, determine the level of habitat complexity, microhabitat availability and disturbance, which influence the recruitment potential.

Thus, more data, collected on a wider bathymetric range and regularly over time during the settlement period, are needed to highlight the potential role of seagrass meadows at deeper stands.
In conclusion, this work highlighted the importance of marine phanerogams (not only *Posidonia oceanica*, but also the short-leaved seagrasses *Cymodocea nodosa* and *Zostera noltii*) for providing suitable habitats for settlement of juveniles of *Diplodus annularis* and *Spondyliosoma cantharus* in the Mediterranean. These observations and the data obtained by other authors from different shallow water biotopes (Garcia-Rubies and Macpherson, 1995; Harmelin-Vivien *et al.*, 1995), have important implications for the management of the coastal zone, which is the marine area most impacted by human activities and where alterations to the number and efficiency of nurseries may be one of the major causes of the adult fish stock decrease (Riley *et al.*, 1981).

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BIBLIOGRAPHY

Behrents K.C., 1987 - The influence of shelter availability on recruitment and early juvenile survivorship of *Lythrypnus dalli* Gilbert (Pisces: Gobiidae). *J. exp. mar. Biol. Ecol.*, **107**: 45-59.

Bell J.D., D.A. Pollard, 1989 - Ecology of fish assemblages and fisheries associated with seagrasses. In: *Biology of Seagrasses.* A.W.D. Larkum, A.J. Mc Comb, S.A. Shepherd (eds), Elsevier, Amsterdam, pp: 565-609.

Brothers E.B., W.N. McFarland, 1981 - Correlations between otolith microstructure, growth, and life history transitions in newly recruited French grunts (*Haemulon flavolineatum* (Desmaret). Haemulidae). *Rapp. P.-v. Réun. CIEM*, **178**: 369-374.

Costa M.J., J.L. Costa, P. Raposo de Almeida, C.A. Assis, 1994 - Do eel grass beds and salt marsh borders act as preferential nurseries and spawning grounds for fish? An example of the Mira estuary in Portugal. *Ecol. Eng.*, **3**: 187-195.

Carr M.H., 1994 - Effects of macroalgal dynamics on recruitment of a temperate reef fish. *Ecology*, **75** (5): 1320-1333.

Doherty P.J., 1982 - Some effects of density on the juveniles of two species of tropical, territorial damselfish. *J. exp. mar. Biol. Ecol.*, **65**: 249-261.

Doherty P., T. Fowler, 1994 - An empirical test of recruitment limitation in a coral reef fish. *Science*, **263**: 935-939.

Forrester G.E., 1990 - Factors influencing the juvenile demography of a coral reef fish. *Ecology*, **71** (5): 1666-1681.

Garcia-Rubies A., E. Macpherson, 1995 - Substrate use and temporal pattern of recruitment in juveniles fishes of the Mediterranean littoral. *Mar. Biol.*, **124**: 35-42.

Guidetti P., S. Bussotti, 1997 - La fauna ittica associata ad un prato misto superficiale di *Cymodocea nodosa* (Ucria) Ascherson e *Zostera noltii* Hornem. (Potamogetoneceae) nel Golfo di Olbia (Sardegna-Italia). *Boll. Soc. Sarda Sci. nat.*, **31** : 61-74.

Harmelin-Vivien M.L., J.G. Harmelin, V. Leboulleux, 1995 - Microhabitat requirements for settlement of juvenile sparids on Mediterranean rocky shores. *Hydrobiologia*, **300-301**: 309-320.

Jones J.P., 1987 - Some interaction between residents and recruits in two coral reef fishes. *J. expl. mar. Biol. Ecol.*, **114**: 169-182.

Jones J.P., 1990 - The importance of recruitment to the dynamics of a coral reef fish population. *Ecology*, **71**: 1691-1698.

Levin P.S., 1993 - Habitat structure, conspecific presence and spatial variation in the recruitment of a temperate reef fish. *Oecologia*, **94**: 176-185.

Meekan M.G., M.J. Milicich, P.J. Doherty, 1993 - Larval production drives temporal patterns of larval supply and recruitment of a coral reef damselfish. *Mar.-Ecol. Prog. Ser.*, **93** (3): 217-225.

Odorico R., G. Bressan, 1994 - Prime osservazioni d'impatto ambientale su fanerogame marine della riserva marina di Miramare (Golfo di Trieste). *Biol. mar. Medit.*, **1** (1) : 281-282.

Pergent-Martini C., G. Pergent, 1996 - Spatio-temporal dynamics of *Posidonia oceanica* beds near a sewage outfall (Mediterranean - France). In: *Seagrass Biology: Proceeding of an International Workshop*, J. Kuo, R.C. Phillips, D.I. Walker, H. Kirkman (eds), Rottnest Island, Western Australia, 25-29 January 1996, pp: 299-306.

Riley J.D., D.J. Symonds, L. Woolner, 1981 - On the factors influencing the distribution of 0-group demersal fish in coastal waters. *Rapp. P.-v. Réun. CIEM*, **178**: 223-228.

Safran P., 1990 - Spatio-temporal variability in the structure of a nectobenthic fish nursery: a descriptive study. *Oceanologica Acta*, **13**: 97-106.

Sale P.F., P.J. Doherty, G.J. Eckert, W.A. Douglas, D.J. Ferrel, 1984 - Large scale spatial and temporal variation in recruitment to fish population on coral reefs. *Oecologia*, **64**: 191-198.

Sweatman H.P.A., 1985 - The influence of adults of some coral reef fishes on larval recruitment. *Ecol. Monog.*, **55** (4): 469-485.

Tolimieri N., 1995 - Effects of microhabitat characteristics on the settlement and recruitment of a coral reef fish at two spatial scales. *Oecologia*, **102**: 52-63.

Vukovic A., R. Turk, 1995 - The distribution of the seagrass *Posidonia oceanica* (L.) Delile in the Gulf of Koper. Preliminary report. *Rapp. Comm. int. Mer Médit.*, **34**: 49.

Warburton K., S.J.M. Blaber, 1992 - Patterns of recruitment and resource use in a shallow-water fish assemblage in Moreton Bay, Queensland. *Mar. Ecol. Prog. Ser.*, **90**: 113-126.

Westernhagen H. von, 1988 - Sublethal effects of pollutants on fish eggs and larvae. In: *The Physiology of Developing Fish. Fish Physiology II.* W.S. Hoar , D.J. Randall (eds), Academic Press, pp: 253-346.

Zavodnik N., A. Jaklin, 1990 - Long-term changes in the Northern Adriatic marine phanerogam beds. *Rapp. Comm. int. Mer Médit.*, **32** (1): 15.

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