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Polyculture as a tool to increase the economic income: a study case in the Gulf of Castellammare

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ABSTRACT: Polyculture is a practice involving integration between organisms of different trophic levels (i.e. fish with low-trophic-level organism like molluscs and/or algae). This paper, reporting on a field experiment carried out during 2004 in the Gulf of Castellammare (South Tyrrhenian), showed that mussels transplanted in areas under fish farm influence grew up better than mussels transplanted far from fish farm. Thus, results pointed out polyculture as a reliable tool for i) increasing local bivalve production, ii) obtaining the reduction of importation from other countries and iii) increasing the environmental sustainability of fish aquaculture.

Key words: Polyculture, Mollusc, Mitigation, South Tyrrhenian.

INTRODUCTION – The value of polyculture (i.e. the integration between fish with low-trophic-level organisms like molluscs and/or algae) has been emphasised as an ecological engineering practice to limit the environmental impact of waste from fish cultivation (through recycling of particulate and dissolved matters) and for enhancing the total productivity (in weight and in value) (Troell *et al.,* 2003). In particular, the association between fish and bivalves has been proposed as one among the best tool for increasing the bivalve production. Nevertheless, in Italy, the economic value of bivalve importation has reached about 40 millions of euro only in 2003 (ISMEA, 2004), but polyculture is still scantly exploited. A possible reason of the slow development of polyculture would depend on lack of knowledge on the economic performance of this practice and growth performance of bivalves in polyculture. Thus, in the present paper, we tested whether the growth rates of mussels associated with cages of fish cultivation were higher than mussels cultivated far from fish cages.

MATERIAL AND METHODS – The experimental study of integrated cultivation was carried out during 2004 off the northern coast of Sicily, in the Gulf of Castellammare (South Tyrrhenian). Five submersible cages (Farmocean, Sweden; volume = 4,500m^3) and 6 smaller cages (volume = 1,000m^3) were filled with seabass (*D. labrax*) and seabream (*S. aurata*) for a total annual production of about 600 tons of biomass. Seed of *M. galloprovincialis* (from Northern Adriatic hatcheries) was transplanted in sites downstream (hereafter impacts; IMP) and 1,000m upstream from fish cages (hereafter controls; CTRL). Impacts showed higher concentrations of dissolved nutrients and chlorophyll-a (Sarà *et al*. 2006; Sarà *et al.,* in press). Mussels were cultivated in tight nylon net bags for 12 months and samples from CTRL and IMP sites (200 specimens for each date) were sampled bimonthly and measured to the nearest 0.1mm with a digital calliper to determine total shell length (TL; mm) and total thickness (TT; mm), while the total wet weight (TW, g) of individuals was measured to the nearest 0.1g. Soma and valves of each specimen were excised, dried at 105°C (~48h), and combusted at 490-500°C for 24h to obtain total ash-free dry weight (AFDW; g) to the nearest 0.1g (Weinberg, 1978; Lucas, 1993; Sarà *et al.,* in press). To test the difference in biometry and production of mussels cultivated under control and impact conditions, a three-way ANOVA was used (DISTURB, 2 levels; control and impact, fixed; PERIOD; 6 levels; July 2004, September, December, March, June and early August 2005 fixed; site, random). The heterogeneity of variances was tested using Cochran's C test prior to the analysis of variance, and Student-Newman-Keuls (SNK) test allowed the appropriate means comparison. The GMAV (1997) statistical package (University of Sydney, Australia) was used to perform the ANOVA. Lastly, the tendency of bivalve consumption in Italy and the local consumption in different Italian Regions was analysed.

RESULTS AND CONCLUSIONS – Mussels were transplanted in summer 2004 and had an initial average total length of 26.6±1.5mm and weight of 1.27±0.05g (Table 1). After one year of cultivation, the size of mussels was significantly different among controls and impacts (Table 1). Differences in mussel growth under different organic enrichment (CTRL *vs* IMP) were maintained throughout the study period (Table 1). Total biomass values provided a confirmation of previous findings in that, at the end of farming, it was significantly lower (ANOVA, $p<0.05$; 8.02±0.5g AFDW; Table 1) in controls than under farm influence (9.05±1.3g AFDW). Results of the present experiment showed that associated bivalves cultivated close to fish farms (i.e. exploiting the organic surplus coming from cultivated fish) reached the commercial size quicker (e.g. in not more than 1 year) than mussels cultivated in control areas (without influence of organic enrichment of fish farms). This would corroborate the potentiality of polyculture in that it could be used as a reliable economic tool for i) increasing local bivalve production, ii) obtaining the reduction of importation from other countries and iii) increasing the environmental sustainability of fish aquaculture.

Table 1. Statistics of biometric data (TL = total length, TT = total thickness; TW = total weight; AFDW = ash free dry weight; CTRL = control sites; IMP = cage sites).

	Period	1		2		3		4		5		6	
		Mean	± se	Mean	± se	Mean	± se	Mean	± se	Mean	± se	Mean	± se
TL (mm)	CTRL	26.63	1.51	29.19	1.77	32.83	0.59	36.49	0.14	43.92	0.45	53.39	0.39
	IMP	26.63	1.51	29.08	0.92	34.08	0.68	39	1.6	54.66	0.15	57.08	0.79
TT (mm)	CTRL	8.83	0.14	10.05	0.61	11.91	0.2	14.43	0.04	16.87	0.12	19.43	0.28
	IMP	8.83	0.14	9.92	0.38	12.15	0.25	14.17	0.48	20.03	0.09	20.55	0.31
TW (g)	CTRL	1.27	0.05	1.77	0.31	2.74	0.41	3.77	0.02	4.77	0.16	7.6	0.26
	IMP	1.27	0.05	1.56	0.16	2.32	0.13	3.98	0.24	6.83	0.07	8.88	0.27
AFDW (g)	CTRL	4.18	0.43	8.81	1.01	8.18	0.77	15.40	1.75	6.52	0.70	8.02^{A}	0.56
	IMP	3.23	0.28	8.98	1.39	8.61	2.07	14.02	2.13	9.64	1.23	9.05^{B}	1.37

$^{A, B}$ $P < 0.05$.

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