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Study on the Ecological Situation and the Nursery Function of the *Posidonia oceanica* (L.) Delile, 1813 Prairies on the Islands of Ventotene e Santo Stefano

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

On behalf of the Management of the Protected Marine Area of the island of Ventotene and Santo Stefano the Marine Ecology and Biology Institute of Piombino (ITALY) carried out a very in dept study aimed at knowledge of the ecological situation of the Posidonia Oceanica (L.) Delile, 1813 meadows. The most appropriate methodologies were used to be able to identify all the benthic species present in order to evaluate the efficiency of the nursery function of the prairies investigated. The results of the numerous species captured in the juvenile stage have demonstrated the excellent nursery function of the meadows of the island of Ventotene.

Keywords: Nursery; biocenoses; Marine Protected Area.

1. INTRODUCTION

After carring out a study on the vagile biocenoses an in-depth study was carried out on the ecological situation and on the very important nursery function of the *Posidonia oceanica* (L.) Delile, 1813 prairies in the Marine Protected Area of the islands of Ventotene and Santo Stefano (Fig. 1).

All the methods were used, both in immersion and in the laboratory, suitable for identify all the

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vagile and sessile species present on the leaves and in the prairie.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

The study was performed in three zones of the AMP (a, b, c) at two bathymetric intervals (4-7 m and 12-18 m) (Fig. 1 and Table 1).

The methods used are the following:

2.1 Visual Census

Diving through a transept of 25 m along the bathymetric profile (Figs. 2 and 3) [1] conspicuous sessile and floating species have been identified along the bathymetric profile by noting and phothogeaphyng the observed species and their abundance [2,3,4]. 4 replicates were performed for each bathymetric interval.

2.2 Sampling with a Plankton Net

To evaluate the nursery function [5,6,7,8,9,10,11], a diving biologist with a plankton net (with 1 mm mesh) captures juvenile species, in reproduction species present on and between the *P. oceanica* leaves (Fig. 4) that have been taxonomically defined [12, 13, 14]. 3 replicates were performed for each bathymetric interval (Fig. 5).

2.3 Bunch Counting

To evaluate the leaves density in each prairie a diving biologist used a 30x30 cm square for counting the *P. oceanica* bunches (Fig. 6). After that the density of the bunches was calculated x m^2 [15, 16,17].

3. RESULTS

3.1 Bunch Counting (3 replicates)

The count of the bunches indicate a very good situation in the prairies investigated which show a very particular conformation given by a continuous presence of boulders in the prairies.

3.2 Visual Census

Sampling with a Plankton Net

The study was not possible to carry out in the bathymetric interval 0-3 m as far as this depth is no *P. oceanica* in any of the studied areas.

Fig. 1. Map showing study area

Table 1. Coordinates of study area

Zone of the Marine Protected Area	Bathymetric interval (m)	WGS84 coordinates of the survey sites
Zone A	4-7	40°47'24.7"N 13°26'57.1"E
	12-18	40°47'13.8"N 13°27'25.2"E
Zone B	4-7	40°47'22.9"N 13°25'47.1"E
	12-18	40°47'04.8"N 13°24'32.9"E
Zone C	4-7	40°47'41.8"N 13°26'9.38"E
	12-18	40°47'38.3"N 13°26'09.2"E

Fig. 2. Transept placement

Fig. 3. Visual census

Fig. 4. captures juvenile species *from P. oceanica* leaves

Fig. 5. Sampling

Fig. 6. Bunch counting

Area A at the bathymetric interval 4-7 m	Bunch number x m^2 = 800; 744; 700	Very dense prairie
Area B at the bathymetric interval 4-7 m	Bunch number x m^2 = 511; 600; 622	Dense prairie
Area C at the bathymetric interval 4-7 m	Bunch number x m^2 = 822; 767; 789	Very dense prairie
Area A at the bathymetric interval 12-18 m	Bunch number x m^2 = 822; 844; 756	Very dense prairie
Area B at the bathymetric interval 12-18 m	Bunch number x m^2 = 778; 711; 678	Very dense prairie
Area C at the bathymetric interval 12-18 m	Bunch number x m^2 = 844; 733; 800	Very dense prairie

Table 2. animal species and quantity. The quantities are reported according to the scheme required by the Coastal Fish Fauna Monitoring Program in the Marine Protected areas of the Ministry of the 62nvironment and the Protection of the Territory and the Sea

Zone				**A**				
Bathymetric interval	4-7 m				12-18 m			
Replica transetto	5	6	7	8	9	10	11	12
Cnidaria								
Pelagia noctiluca Forsskål, 1775			1					
Ctenophora								
Leucothea multicornis Quoy & Gaimard, 1824	1							
Echinodermata								
Ophidiaster ophidianus Lamarck, 1816				1				
Chordata								
Chromis chromis Linnaeus, 1758	75	20	75	40	20	20	20	40
Coris julis Linnaeus, 1758	5	3	2	1	2	3	2	
Diplodus sargus Linnaeus, 1758							1	
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817	8	5		8	5		6	2
Oblada melanura Linnaeus, 1758	8	4	3		20	3		5
Sarpa salpa Linnaeus, 1758		8		8	3		8	8
Serranus scriba Linnaeus, 1758		1						1

Symphodus ocellatus Linnaeus, 1758								2
Thalassoma pavo Linnaeus, 1758	1	1				2		1

Zone			**B**					
Bathymetric interval	4-7 m				12-18 m			
Replica transetto	17	18	19	20	21	22	23	24
Cnidaria								
Pelagia noctiluca Forsskål, 1775	1							
Chordata								
Chromis chromis Linnaeus, 1758	75	75	40	75	40	40	75	40
Coris julis Linnaeus, 1758	2	1			5	6		2
Dentex dentex Linnaeus, 1758					1			
Diplodus puntazzo Walbaum, 1792								1
Diplodus sargus Linnaeus, 1758							2	
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817			2	7	2			
Oblada melanura Linnaeus, 1758	20	20	20	20	8	20		1
Sarpa salpa Linnaeus, 1758			3	1			20	20
Serranus scriba Linnaeus, 1758	1						1	
Symphodus ocellatus Linnaeus, 1758				2		3		
Thalassoma pavo Linnaeus, 1758		1					1	1

Zone				**C**				
Bathymetric interval	4-7 m				12-18 m			
Replica transetto	29	30	31	32	33	34	35	36
Chordata								
Apogon imberbis Linnaeus, 1758								11

Atherina hepsetus Linnaeus, 1758					150			150
Chromis chromis Linnaeus, 1758	40	40	75	75	75	40	40	40
Coris julis Linnaeus, 1758		3	2	1	1		2	1
Diplodus sargus Linnaeus, 1758				2			1	
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817		2	1	7		1		3
Mullus barbatus Linnaeus, 1758						2		
Oblada melanura Linnaeus, 1758	10			20				
Pagellus acarne Risso, 1827						1		
Sarpa salpa Linnaeus, 1758				20	3	8	3	1
Serranus scriba Linnaeus, 1758	2	1			1	1		1
Symphodus tinca Linnaeus, 1758		1					1	
Thalassoma pavo Linnaeus, 1758	1				2		2	5

Table 3. In the table are expressed the quantity and size of taxonomically determined species

Zone			**A**			
Bathymetric interval	4-7 m			12-18 m		
Replica di campionamento	4	5	6	7	8	9
Mollusca						
Bittium latreillii Payraudeau, 1826	3		2			2 (juv.)
Pusillina philippi Aradas & Maggiore, 1844	1					
Rissoa auriscalpium Linnaeus, 1758			1 (0.6 cm)			
Rissoa guerinii Récluz, 1843				1		2
Rissoa membranacea J. Adams, 1800			1 (0.4 cm)			

Rissoa violacea Desmarest, 1814			1 (0.5 cm)			1 (juv.)
Arthropoda						
Cestopagurus timidus P. Roux, 1830 [in P. Roux, 1828-1830]		2 (juv.)	4 (di cui 3 juv.)			
Hippolyte holthuisi Zariquiey Álvarez, 1953						1 (1.0 cm) 1 (0.9 cm) 1 (0.7 cm)
Hippolyte inermis Leach, 1816	1 (0.9 cm) 1 (0.7 cm)	2 (1.0 cm) 1 (0.7 cm)	2 (1.3 cm) 3 (1.2 cm) 1 (0.9 cm) 1 (0.7 cm)		2	
Chordata						
Symphodus roissali Risso, 1810						1 (1.6 cm)

Zone			**B**			
Bathymetric interval	4-7 m			12-18 m		
Replica di campionamento	13	14	15	16	17	18
Mollusca						
Rissoa guerinii Récluz, 1843			1			
Rissoa violacea Desmarest, 1814	1 (0.4 cm) 1 (0.3 cm)	1 (juv.)		1 (0.4 cm)		
Arthropoda						
Hippolyte inermis Leach, 1816	1 (1.1 cm) 2 (0.7 cm)	1 (1.0 cm) 1 (0.9 cm) 1 (0.7 cm)	1 (1.7 cm) 1 (1.1 cm) 1 (0.9 cm)	2 (0.9 cm) 1 (0.7 cm) 1 (0.6 cm)	1 (1.6 cm) 1 (1.2 cm) 2 (0.9 cm) 2 (0.7 cm)	
Hippolyte varians Leach, 1814 [in Leach, 1813-1815]				1 (0.7 cm)		
Chordata						
Symphodus roissali Risso, 1810		1 (1.2 cm)				

Zone			**C**			
Bathymetric interval	4-7 m			12-18 m		
Replica di campionamento	22	23	24	25	26	27
Mollusca						

Aplus dorbignyi Payraudeau, 1826					1		
Bittium reticulatum da Costa, 1778			1				
Cratena peregrina Gmelin, 1791				1			
Gibbula ardens Salis Marschlins, 1793						1	
Ocenebra edwardsii Payraudeau, 1826				1			
Pusillina lineolata Michaud, 1830				1			
Rissoa auriscalpium Linnaeus, 1758	1		1		1		
Rissoa membranacea J. Adams, 1800	1						
Rissoa violacea Desmarest, 1814		1					
Arthropoda							
Hippolyte inermis Leach, 1816	2 (0.8 cm) 1 (0.7 cm) 2 (0.4 cm)	1 (1.2 cm) 2 (1.0 cm) 1 (0.4 cm)	1 (1.3 cm) 1 (1.1 cm) 1 (0.9 cm) 3 (0.6 cm)	1 (0.9 cm) 1 (0.7 cm)	2 (0.9 cm) 2 (0.7 cm) 1 (0.4 cm)	1 (1.1 cm) 1 (0.8 cm) 2 (0.7 cm)	
Chordata							
Syngnathus acus Linnaeus, 1758		1 (8 cm; juv.)					

Table 4. species taxonomically determinated by the observation of photos and videos taken in the study area

Zone				**A**			
Bathymetric interval				4-7 m			
Video (num.)/photo	0821	0828	0831	0832	0834	0836	photo
Cnidaria							
Pelagia noctiluca Forsskål, 1775					1		
Echinodermata							
Ophidiaster ophidianus Lamarck, 1816							1

Chordata															
Chromis chromis Linnaeus, 1758	75		40		40			75				40		1	
Coris julis Linnaeus, 1758	1 (♀/♂) 8 (♂)							1 (♀/♂) 2 (♂)				2		2 (♂)	
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817	10		3		9			2						10	
Oblada melanura Linnaeus, 1758	1														
Sarpa salpa Linnaeus, 1758														40	
Serranus scriba Linnaeus, 1758														2	
Serranus scriba Linnaeus, 1758								1							
Spondyliosoma cantharus Linnaeus, 1758	1		2												
Symphodus ocellatus Linnaeus, 1758	1														
Thalassoma pavo Linnaeus, 1758	1 (♀)														

Zone	**A**														
Bathymetric interval	12-18 m														
Video (num.)/photo	0783	0784	0787	0790	0792	0795	0796	0797	0802	0804	0805	0810	0812	0813	photo
Cnidaria															
Cladocora caespitosa Linnaeus, 1767														1	
Pelagia noctiluca Forsskål, 1775															1
Mollusca															
Luisella babai Schmekel, 1972					3				3						
Chordata															
Apogon imberbis Linnaeus, 1758			8												8

Chromis chromis Linnaeus, 1758	75	75	75		40	75	75		1					
Coris julis Linnaeus, 1758			3 (♂)		2 (♂)	3 (♂)	1 (♂)	1 (♂) 4 (♀)	2 (♂)	2 (♂) 1 (♀)	1 (♀)			1 (♂)
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817						2	2		1					1
Oblada melanura Linnaeus, 1758		20	3											
Sarpa salpa Linnaeus, 1758		1		10					4					8
Seriola dumerili Risso, 1810												1		1
Spondyliosoma cantharus Linnaeus, 1758					1									
Symphodus tinca Linnaeus, 1758									1	1				
Thalassoma pavo Linnaeus, 1758			1 (♀)						1 (♀)	2				

Chlorophyta												
Caulerpa cylindracea Sonder, 1845				Some specimens								

Zone	**B**										
Bathymetric interval	4-7 m										
Video (num.)/photo	0734	0735	0736	0744	0745	0754	0755	0758	0759	0760	photo

Chordata											
Chromis chromis Linnaeus, 1758	150	75	75	75	150	40	40	40	75	75	40
Coris julis Linnaeus, 1758			1 (♂)	3 (♂)	2 (♀/♂) 1 (♂)	2 (♂)			4 (♂) 1 (♀/♂)	3 (♀/♂)	2 (♀/♂)
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817										1	
Oblada melanura Linnaeus, 1758			2		1				8	6	
Sarpa salpa Linnaeus, 1758							17				40
Serranus scriba Linnaeus, 1758					1			1			
Symphodus tinca Linnaeus, 1758				2							
Thalassoma pavo Linnaeus, 1758				2 (♂) 2 (♀)		1 (♂)					

Zone	**B**				
Bathymetric interval	12-18 m				
Video (num.)/photo	0719	0720	0725	0731	photo
Chordata					
Chromis chromis Linnaeus, 1758	40	75	75	75	75
Coris julis Linnaeus, 1758	3 (♂)	1 (♂)			1 (♂)
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817			2	7	1
Oblada melanura Linnaeus, 1758	10	2	3	44	9
Sarpa salpa Linnaeus, 1758					20
Serranus scriba Linnaeus, 1758					2
Thalassoma pavo Linnaeus, 1758					

Zone					**C**				
Bathymetric interval					4-7 m				
Video (num.)/photo	0899	0900	0905	0906	0908	0909	0914	photo	
Chordata									
Apogon imberbis Linnaeus, 1758		1						1	
Chromis chromis Linnaeus, 1758			75	9	20		75	40	
Coris julis Linnaeus, 1758	2 (♂)							1 (♂)	
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817	1				3			2	
Oblada melanura Linnaeus, 1758			20		20	20	8		
Serranus scriba Linnaeus, 1758								1	
Spondyliosoma cantharus Linnaeus, 1758								1	

Zone						**C**															
Bathymetric interval						12-18 m															
Video (num.)/photo	0860	0861	0863	0864	0865	0868	0869	0870	0871	0873	0877	0880	0881	0883	0884	0885	0886	0887	0888	0889	photo
Chordata																					
Apogon imberbis Linnaeus, 1758											1										4
Atherina hepsetus Linnaeus, 1758	150	150				150															150
Chromis		40	75							75		40	40	40	40			40	40	40	20

chromis Linnaeus, 1758																					
Coris julis Linnaeus, 1758								1 (♂) 1 (♀)		1 (♂) 1 (♀)			1 (♂)								2 (♂) 1 (♀)
Diplodus annularis Linnaeus, 1758												1	1								
Diplodus sargus Linnaeus, 1758									1												
Diplodus vulgaris Geoffroy Saint-Hilaire, 1817			1									2									1
Mullus surmuletus Linnaeus, 1758							2														
Oblada melanura Linnaeus, 1758	2					1															
Sarpa salpa Linnaeus, 1758		20															2				4
Serranus scriba Linnaeus, 1758				1																	

Serranus scriba Linnaeus, 1758	1					1	1	2
Spondyliosoma cantharus Linnaeus, 1758	20							
Symphodus tinca Linnaeus, 1758		1				1		1
Thalassoma pavo Linnaeus, 1758		2 (♀)	1 (♂) 1 (♀)					4 (♀) 1 (♂)

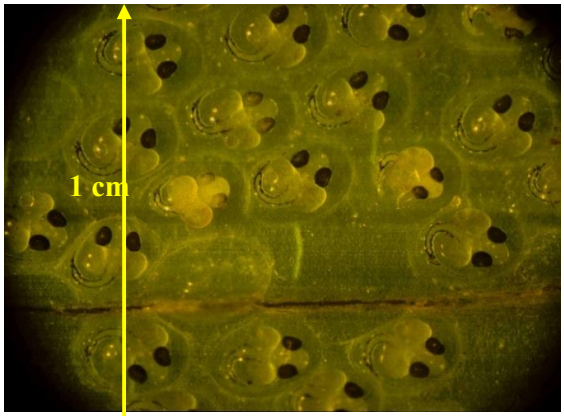

Fig. 7.

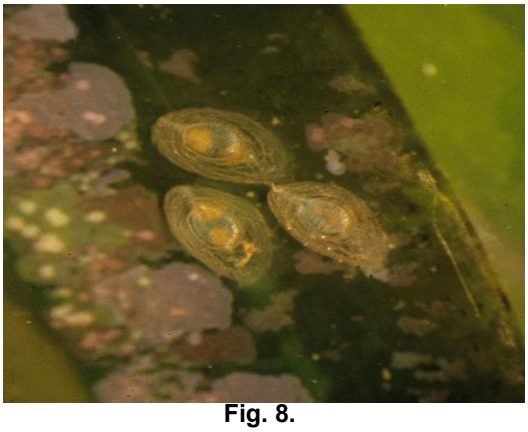

Fig. 8.

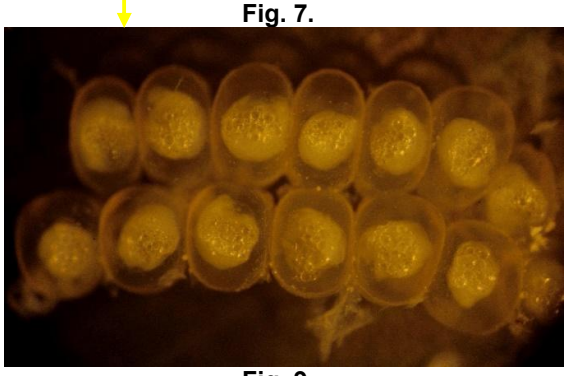

Fig. 9.

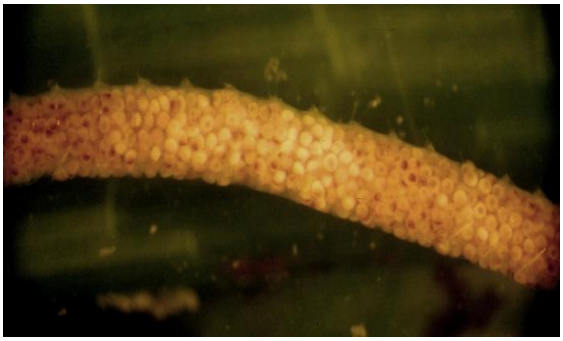

Fig. 10.

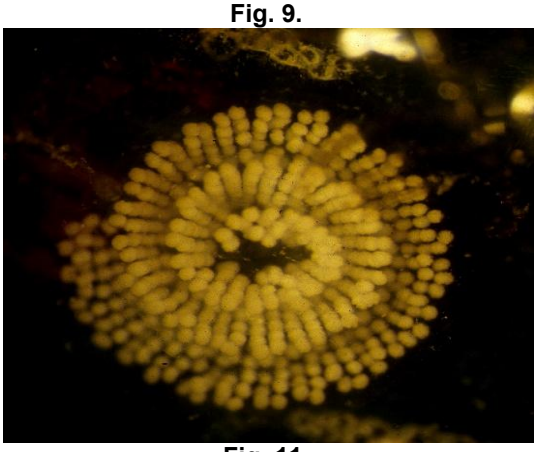

Fig. 11.

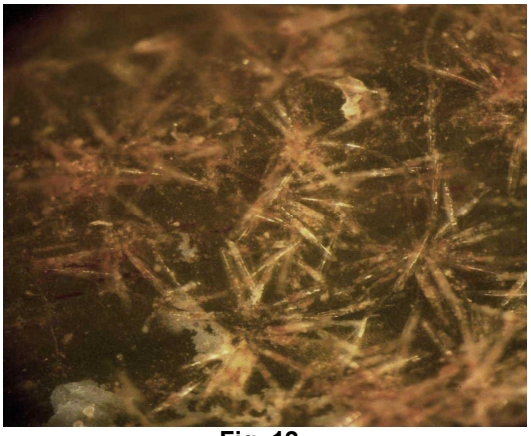

Fig. 12.

Fig. 13.

Fig. 7-13. Eggs on *P. oceanica* leaves

Bryozoans on *P. oceanica* leaves

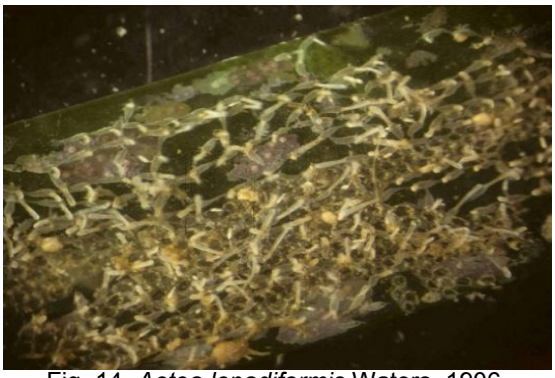

Fig. 14. *Aetea lepadiformis* Waters, 1906

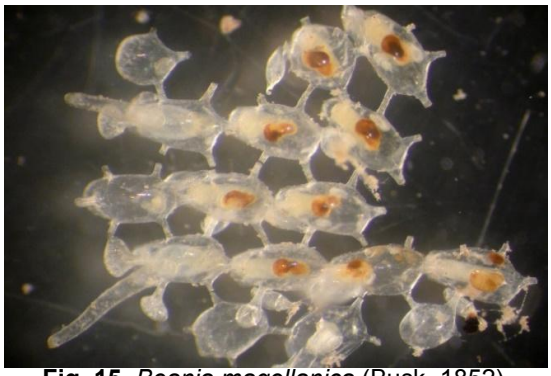

Fig. 15. *Beania magellanica* (Busk, 1852)

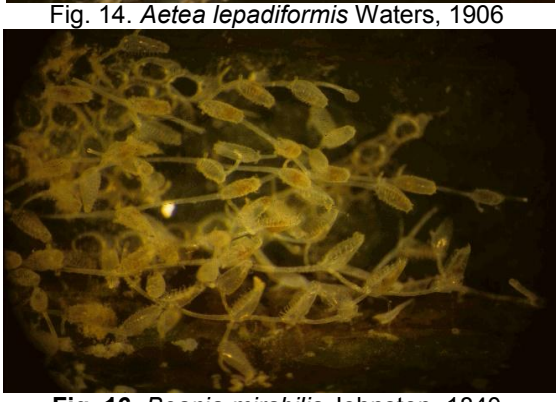

Fig. 16. *Beania mirabilis* Johnston, 1840

Fig. 17. *Cellepora pumicosa* (Pallas, 1766)

Fig. 18. *Crisia ramosa* Harmer, 1891

Fig. 19. *Tubulipora aperta* Harmer, 1898

Fig. 20. *Fenestrulina malusii* (Audouin, 1826)

4. DISCUSSION

Study the very important nursery function of the *Posidonia oceanica* (L.) Delile, 1813 meadows also helps to understand the ecological situation of the entire surrounding area. In this study the peculiarity was the continuous alternation of rocks and the use of numerous and complementary sampling methods to have a real and exact evaluation of the nursery function. The results obtained allow to evaluate the nursery function of the prairie very actively in the Protected Marine Area of Ventotene and Santo Stefano.

5. CONCLUSION

The investigation carried out in the three zones A, B, C of the Marine Protected Areas of the islands of Ventotene and Santo Stefano have highlighted a good ecological situation of the sessile and vagile biocenoses present in the *P. oceanica*. The density of the bunches is almost everywhere very dense. Samplings with plankton nets highlighted the presence of rare juvenile specimens of Hippolytidae and Rissoidae have been captured. Particulary important for demonstration that the prairies investigated perfectly perform they nursery function was the identification, on the leaves studied in our laboratories, of many species of eggs and Bryozoans.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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