



ARQUIVOS DO MUSEU BOCAGE

Nova Série, Vol. II, n.º 35, pp. 633-642 4 de Maio de 1996

STRUCTURE AND SPATIAL VARIABILITY OF THE ROCKY FISH FAUNA IN THE PROTECTED MARINE «RESERVA NATURAL DA BERLENGA» (PORTUGAL)

ARMANDO J. ALMEIDA *

INTRODUCTION

The «Reserva Natural da Berlenga» is the first, and until now the only, marine protected area in Portugal continental. This marine protected zone was established by the law nº 264/81 of 3rd September, is limited to the 30 meters depth around the island, and comprises all the small islands and islets for a total land area of about 80 hectares. This protected area is situated in the N. W. of Peniche (39º 25' 10" - 39º 24' 25" N, 9º 30' - 9º 31' W) about 10 Km off the continental land (Fig. 1). In 1988 it was classified by the European Council as a Biogenetic Protected area.

Since there is no available data before the creation of the «Reserva Natural da Berlenga» this study pretends to list the littoral ichthyofauna and to be a starting point to evaluate the effect of this protected area in the abundance and diversity of fish population. In a marine protected area studies should be done by visual censuses, in order to do not interfere or destroy its fauna.

* Laboratório Marítimo da Guia — IMAR (Departamento de Zoologia e Antropologia da Faculdade de Ciências de Lisboa). Estrada do Guincho, 2750 Cascais. Portugal.

STUDY AREA

Seven places (stations) were selected to study the spatial structure of the infralittoral ichthyofauna at rocky area of the Berlenga's marine protected zone, by visual censuses. Stations were chosen for accessibility and exposure to the sea hydrodynamics. The North coast is exposed to strong hydrodynamic factors and the South coast is more protected. On the North coast visual censuses were made at two stations: Carreiro dos Cações (1) and Ilhéu da Velha (2), on the South coast at five stations: Baixa do Iate (3), Carreiro da Fortaleza (4), Carreiro dos Mosteiros (5), Barco Primavera (6) and Melreu (7) (Fig. 1).

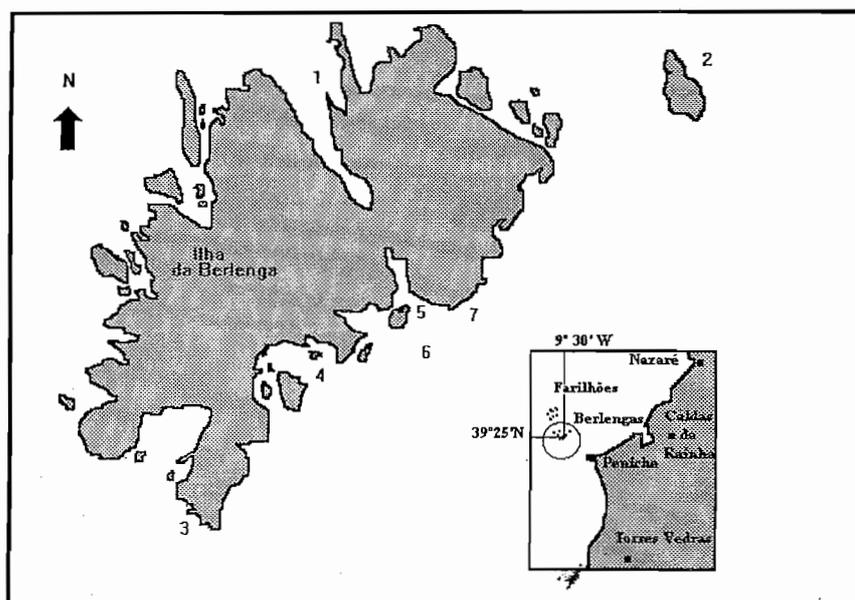


FIG. 1 — Study sites in the Berlenga's marine protected area (the dates and maximum depth reached are indicated).

- 1 — Carreiro dos Cações (June 1990 and October 1991) (20 m)
- 2 — Ilhéu da Velha (May 1991) (15 m)
- 3 — Baixa do Iate (June 1990, April and June 1991, June and July 1992) (20 m)
- 4 — Carreiro da Fortaleza (June 1990, May, October and November 1991, May, June, July and November 1992) (10 m)
- 5 — Carreiro dos Mosteiros (March and May 1990) (5 m)
- 6 — Barco Primavera (April, May, June, and November 1991, June and July 1992) (25 m)
- 7 — Melreu (May 1991 and 1992) (5 m)

METHODS

The variability in species composition and numerical abundance of the ichthyofauna of Berlenga's marine protected area was evaluated by a non destructive method as described by HARMELIN-VIVIEN & HARMELIN (1975). This technique was tested and compared with classic methods (nets, rotenone, traps) (BROCK, 1982, HARMELIN-VIVIEN *et al.*, 1985; HARMELIN, 1987; DIBBLE, 1991; BORTONE *et al.*, 1991; HARMELIN-VIVIEN & FRANCOUR, 1992). Differences were found to depend on the relative abundance of pelagic and benthic species. However it was proved that visual census is a valuable method and is preferable in protected areas.

This study took place between 1990 and 1992 at seven stations around the Berlenga Island (Fig. 1). Visual censuses were made during the day in rocky and adjacent areas. Counts of five minutes for observation were taken at different depths, at five meters intervals from the bottom to the surface. Taking into account the mean visibility during the visual censuses, which was generally low, only fishes located within two meters from the observer were considered, for the benthopelagic species, and within one meter for the benthonic species.

RESULTS

During the twenty hours of visual census performed by scuba-diving a total of 5422 individuals of 51 different species belonging to 19 families were recorded (Table I—the individuals number is reported to 30 minutes of observations). Mugilidae and Scorpaenidae were not identified to species due to the difficulty of making a correct identification *in situ*.

As we can see *Boops boops*, *Diplodus vulgaris* and *Gobiusculus flavescens* were the more abundant species. (Table I).

Families Gadidae (5 species), Sparidae (9 sp.), Labridae (9 sp.), Gobiidae (6 sp.) and Blenniidae (5 sp.) are the most abundant in number of species and in number of individuals. Mugilidae is also an important taxon in number of individuals. (Fig. 2, 3 and 4). The spatial distribution of species differed from the North to the South coasts (Fig. 3 and 4). On the North coast we observed (during 30 minutes of visual census) 82 individuals of 17 species and at South coast 227 individuals of 48 species. So, a greater diversity of the fish fauna was recorded on the South coast than on the North coast, as confirmed by the SHANNON-WIEVER diversity index (Table II).

TABLE I— Species observed at Berlenga's marine protected area between 1990 and 1992, and mean number of individuals observed (30 minutes observation in each station)

	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	Total
CONGRIDAE								
<i>Conger conger</i> (ARTEDI, 1738 LINNÉ, 1758)				1				1
SYNGNATHIDAE								
<i>Syngnathus acus</i> LINNÉ, 1758						1		1
GADIDAE								
<i>Gaidropsarus mediterraneus</i> (LINNÉ, 1758)				1				1
<i>Trisopterus luscus</i> (LINNÉ, 1758)			1			4		5
<i>Trisopterus minutus</i> (LINNÉ, 1758)						2		2
<i>Pollachius pollachius</i> (LINNÉ, 1758)			1	1		4		6
<i>Phycis phycis</i> (LINNÉ, 1766)	1							1
ZEIDAE								
<i>Zeus faber</i> LINNÉ, 1758				1				1
SERRANIDAE								
<i>Serranus cabrilla</i> (LINNÉ, 1758)	2		1	1		1		5
MORONIDAE								
<i>Dicentrarchus labrax</i> (LINNÉ, 1758)	2		4	1				7
CARANGIDAE								
<i>Pseudocaranx dentex</i> (BLOCH & SCHNEIDER in SCHNEIDER, 1801)				1	1			2
<i>Seriola sp.</i>				1	1			2
<i>Trachurus trachurus</i> (LINNÉ, 1758)				2				2
MULLIDAE								
<i>Mullus surmuletus</i> LINNÉ, 1758			1	3		3	4	11
SPARIDAE								
<i>Boops boops</i> (LINNÉ, 1758)	57		58	31		22	150	318
<i>Diplodus sargus</i> (LINNÉ, 1758)			13	24	16	17		70
<i>Diplodus vulgaris</i> (E. GEOFFROY SAINT-HILAIRE, 1817)	38	1	39	44	22	48	60	252
<i>Diplodus cervinus</i> (LOWE, 1841)			1	1				2
<i>Diplodus annularis</i> (LINNÉ, 1758)			1		5			6
<i>Puntazzo puntazzo</i> (GMELIN, 1789)				1				1
<i>Sarpa salpa</i> (LINNÉ, 1758)				16	25	10		51
<i>Spondylisoma chantharus</i> (LINNÉ, 1758)			1		10	9		20
<i>Sparus aurata</i> LINNÉ, 1758				1		1		2
LABRIDAE								
<i>Centrolabrus exoletus</i> (LINNÉ, 1758)	3	2	6	2		14		27
<i>Coris julis</i> (LINNÉ, 1758)	4					1		5
<i>Ctenolabrus rupestris</i> (LINNÉ, 1758)	4	1	1	2		5	1	14
<i>Labrus bergylta</i> ASCANIUS, 1767	1	3	2	4	3	1	3	17
<i>Labrus bimaculatus</i> LINNÉ, 1758			1	1		2		4
<i>Labrus viridis</i> LINNÉ, 1758	6		4	1	1			12
<i>Labrus merula</i> LINNÉ, 1758				2	1			3
<i>Symphodus bailloni</i> (VALENCIENNES, in CUV. VAL., 1836)		2				1		3
<i>Symphodus melops</i> (LINNÉ, 1758)	5		5	5	7	4		26

	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	Total
GOBIIDAE								
<i>Gobius auratus</i> RISSO, 1810				8	1	6	2	17
<i>Gobius paganellus</i> LINNÉ, 1758						1		1
<i>Gobius cruentatus</i> GMELIN, 1789						2		2
<i>Gobiusculus flavescens</i> (FABRICIUS, 1779)	3		170	31	40	4	20	268
<i>Pomatochistus</i> spp.				11		8		19
<i>Thorogobius ephippiatus</i> (LOWE, 1839)						1		1
CALLIONYMIDAE								
<i>Callionymus maculatus</i> (RAFINESQUE, 1810)				1				1
BLENNIIDAE								
<i>Lipophris trigloides</i> (VALENCIENNES, 1836)				1	1			2
<i>Lipophris pholis</i> (LINNÉ, 1758)				1				1
<i>Coryphoblennius galerita</i> (LINNÉ, 1758)				1				1
<i>Parablennius gattorugine</i> (LINNÉ, 1758)			2	1	2	1		6
<i>Parablennius pilicornis</i> (CUVIER, 1829)	4	2	2	13	1	3		25
TRIPTERYGIIDAE								
<i>Tripterygion delaisi</i> CADENAT & BLACHE, 1871	3	4	2	9	1	2		21
MUGILIDAE								
	15		17	17	1			50
SCORPAENIDAE								
				1				1
TRIGLIDAE								
<i>Trigla lucerna</i> LINNÉ, 1758				1				1
SCOPHTHALMIDAE								
<i>Zeugopterus punctatus</i> (BLOCH, 1787)				2				2
BALISTIDAE								
<i>Balistes carolinensis</i> GMELIN, 1789			1					1
GOBIESOCIDAE								
<i>Lepadogaster lepadogaster</i> (BONNATERRE, 1788)	1			2				3
TOTAL	149	15	334	248	139	178	240	1303

TABLE II — Species diversity and equitability of the fish fauna on the North and South Coast of the marine protected area of Berlenga's Islands.

	North coast	South coast
Shannon-Wiener index (H')	2,1001	2,7784
Equitability (J)	0,7416	0,7177

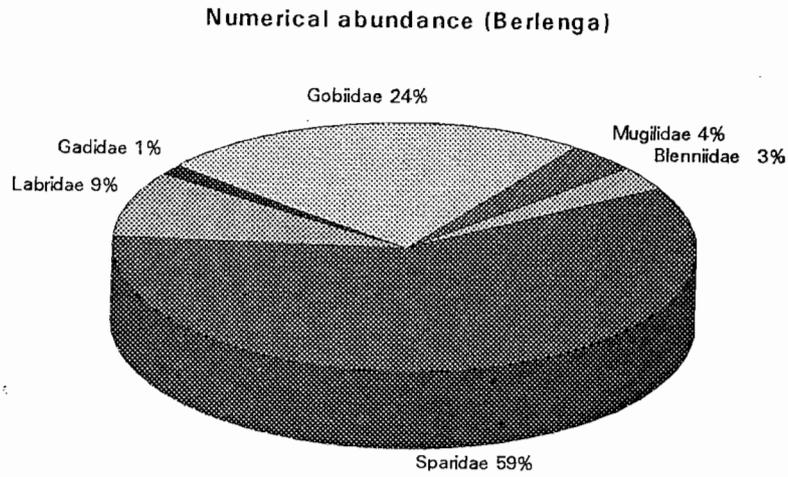


FIG. 2 — Abundance of the most numerous fish families observed at Berlenga's protected marine area.

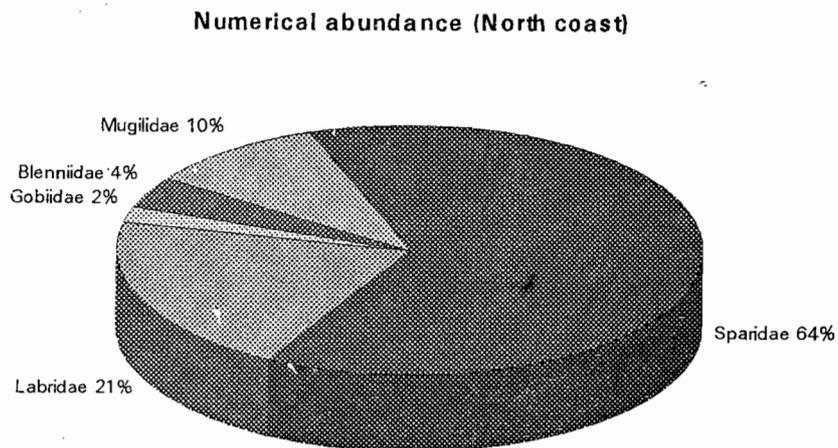


FIG. 3 — Abundance of the most numerous fish families observed on the North coast of Berlenga's protected marine area.

The spatial distribution of the fish species, according to the classification of HARMELIN (1987), was organized into three divisions (nectonic, epibenthic and cryptobenthic species) subdivided into six classes.

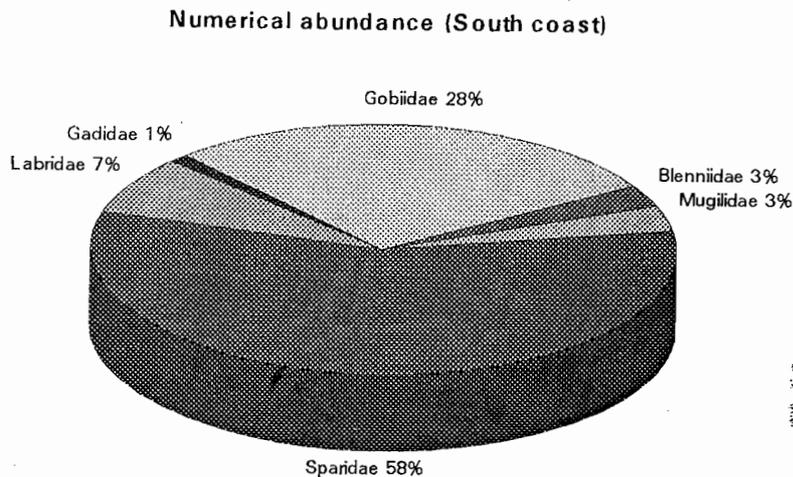


FIG. 4 — Abundance of the most numerous fish families observed at South coast of Berlenga's protected marine area.

NECTONIC SPECIES

Class 1 — Composed by gregarious species, wandering, which move in the water column with a diurnal activity: *Mugilidae*, *Boops boops*, *Trachurus trachurus*, *Dicentrachus labrax*, *Pseudocaranx dentex* and *Seriola* sp..

EPIBENTHIC SPECIES

Class 2 — Gregarious sedentary species, which live in the water column: *Gobiusculus flavescens*.

Class 3 — Composed by gregarious nectobenthic species: *Diplodus sargus*, *D. vulgaris*, *D. cervinus*, *D. annularis*, *Puntazzo puntazzo*, *Sarpa salpa*, *Spondyliosoma cantharus*, *Sparus aurata* and *Balistes carolinensis*.

Class 4 — Species that show low vertical movements, but significant horizontal movement: *Mullus surmuletus* and *Trigla lucerna*.

Class 5 — Sedentary fishes showing weak lateral and vertical movements: *Serranus cabrilla*, *Trisopterus luscus*, *T. minutus*, *Syngnathus acus* and all the *Labridae*.

CRYPTOBENTHIC

Class 6 — Species mainly sedentary which present very weak vertical and lateral movements: *Conger conger*, *Phycis phycis*, *Zeugopterus punctatus*, *Lepadogaster lepadogaster*, *Callionymus maculatus* and all Blenniidae, Tripterygiidae and Gobiidae, *G. flavescens* excepted.

The Blenniidae, Gobiidae and Sparidae which are the most numerous fish families exhibited a strong decrease in number of species and individuals from the South to the North coasts. The differences are probably due to the hydrodynamics on the South and North coasts. As HARMELIN (1987) we concluded that the gregarious and sedentary species preferred the coast with a weak hydrodynamics situation (Fig. 5).

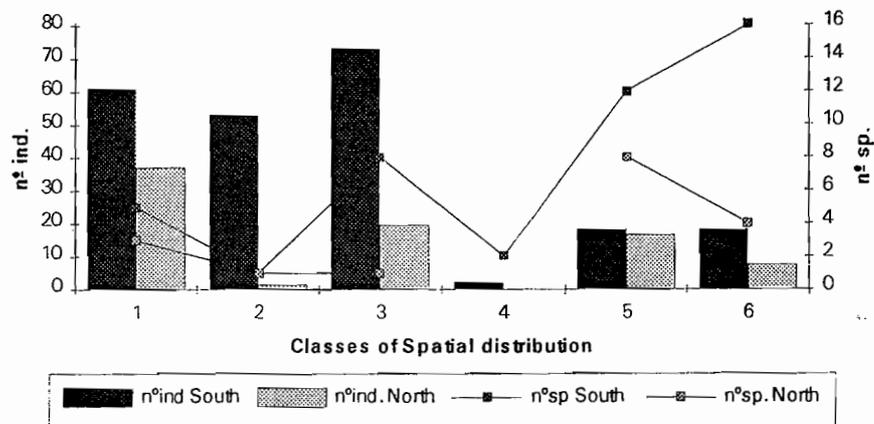


FIG. 5 — Importance of spatial distribution classes on the South and North coasts of Berlenga protected area according to the number of individuals and species.

CONCLUSION

As no data has been recorded before the creation of the Reserva Natural da Berlenga, on September 1981, we could not indicate if some environmental modification has occurred in this protected area since its creation. However, in 1980, one year before protection, the author has made some observations by scuba-diving during a study of the benthic-macrofauna. According to these observations I am convinced that the ichthyofauna is more abundant now and that fishes are more confident. Now we can approach at less than one meter shoals of sea bream, bamboo fish, bogue, mullets, seabass and

surmulletts to improve the accuracy and precision of the observations. Some shoals of Sparidae are composed by more than twenty individuals and measuring over 30-40 centimeters in total length. These observations indicate that the protected area is responsible for the increase in the abundance of ichthyofauna. The number of individuals per square meter (1.75 - 2.94 ind/m²) are identical or higher than those observed in other older marine protected zones, such as the National Park of Port-Cros in France (Mediterranean). In this marine protected area, HARMELIN (1987) found the number of individuals per square meter to be between 1.95 - 2.64. The marine protected area of Berlenga must have also a role as nursery for Sparidae as we have found large numbers of young Sparidae (4-5 cm) during May and June.

SUMÁRIO

A Reserva Natural da Berlenga é a primeira reserva em Portugal continental que engloba uma área marinha sendo classificada pelo Conselho da Europa como Reserva Biogenética em 1988.

Estudos ictiológicos de abundância e diversidade foram efectuados por observação directa em 20 horas de mergulho com escafandro autónomo. Contabilizaram-se 5422 peixes pertencentes a 51 espécies distribuídas por 19 famílias. As famílias Gadidae, Sparidae, Labridae, Gobiidae e Blenniidae revelaram-se mais abundantes em número de espécies e em número de indivíduos. *n/*

A avaliação da diversidade pelo índice de Shannoy-Wiener mostrou que existe uma diferença na distribuição das espécies entre a costa Norte e a costa Sul. Esta última apresenta uma maior diversidade. *m/*

SUMMARY

The «Reserva Natural da Berlenga» is the first Natural Reserve in Portugal that includes a marine area. It was classified by the European Council as Biogenetic Park in 1988.

More than 20 hours of scuba-diving visual censuses made possible the abundance and diversity study, of the local fish fauna. Fifty one species belonging to 19 families, summing 5422 specimens were seen. The most abundant families, in number of species and in number of individuals, were Gadidae, Sparidae, Labridae, Gobiidae and Blenniidae.

Diversity evaluation showed that the south coast of the Berlenga Island has higher diversity values.

ACKNOWLEDGEMENTS

Thanks are due to LUIS VICENTE (Co-ordinator of the «Reserva Natural da Berlenga») for the facilities offered, to RAUL SANTOS for all enlightments, to PAULO CRISOSTOMO (Reserve Vigilant) and to CARLOS SANTOS (Reserve Guard) for the support during scuba-diving. I am particularly grateful to the «Reserva Natural da Berlenga» for its financial support. An anonymous referee helped to improve the manuscript quality.

REFERENCES

- BORTONE, S. A., VAN TASSELL, J., BRITO, A., FALCÓN, J. M., & BUNDRICK, C. M., 1991. A visual assessment of the inshore fishes and fishery resources off El Hierro, Canary Islands: A baseline survey. *Scientia Marina*, **55** (3): 529-541.
- BROCK, R. E., 1982. A critique of the visual census method for assessing coral reef fish populations. *Bulletin of Marine Science*, **32** (1): 269-276.
- DIBBLE, E. D., 1991. Comparison of diving and rotenomone methods for determining relative abundance of fish. *Transactions of the American Fisheries Society*, **120**: 663-666.
- HARMELIN, J. G., 1987. Structure et variabilité de l'ichtyofaune d'une zone rocheuse protégée en Méditerranée (Parc National de Port-Cros, França). *Marine Ecology*, **8** (3): 263-284.
- HARMELIN-VIVIEN, M. & HARMELIN, J. G., 1975. Présentation d'une méthode d'évaluation «in situ» de la faune ichtyologique. *Trav. Sci. Parc. natio. Port-Cros*, **1**: 47-52.
- HARMELIN-VIVIEN, M., HARMELIN, J. G., CHAUVET, C., DUVAL, C., GALZIN, R., LEJEUNE, P., BARNABE, G., BLANC, F., CHEVALIER, R., DUCLERC, J., & LASSERRE, G., 1985. Evaluation des peuplements et populations de poissons. Méthodes et problèmes. *Rev. Ecol. (Terre Vie)*, **40**: 467-539.
- HARMELIN-VIVIEN, M. L. & FRANCOUR, P., 1992. Trawling or visual censuses? Methodological bias in the assessment of fish populations in Seagrass beds. *P.S.Z.N.I.: Marine Ecology* **13** (1): 41-51.

Conselho de Redacção:

Prof. Dr. CARLOS ALMAÇA
Dr.ª ANA MARIA NEVES

Editor:

MUSEU BOCAGE
R. Escola Politécnica, 58
1200 LISBOA