STUDY OF A SAMPLE OF DUSKY GROUPERS, *EPINEPHELUS MARGINATUS* (LOWE, 1834), CAUGHT IN A TIDE POOL AT LAJES DO PICO, AZORES

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With 3 figures and 1 table

ABSTRACT. A total of 175 juvenile *Epinephelus marginatus* (LOWE, 1834) (= *E. guaza* (LINNAEUS, 1758)) were collected in a 828 m^2 tide pool at Lajes do Pico, Azores, confirming previous accounts on the unusual high density of that grouper in this area. All fishes were immature, with total lengths (TL) ranging from 4 to 36 cm. Analysis of the length frequency distribution and scalimetry data suggest that four age classes are present: 0+ (4-7 cm TL), 1+ (13-20 cm TL), 2+ (18-25 cm TL) and 3+/4+ (one 36 cm TL specimen). The length/weight relationship is given ($TW=0.01388*TL^{3.065}$) and compared with those from other geographical areas. The stomach contents varied with fish size: smaller groupers contained primarily small crustaceans (amphipods, crabs and isopods), while the larger groupers contained mainly larger crustaceans (shrimps and crabs) and fish.

Present results suggest that the lagoon system of Lajes do Pico is a nursery for *E. marginatus*. Further studies are needed to evaluate the importance of this place to the grouper's local stock and to provide a basis for its management and protection.

INTRODUCTION

The nearshore at Lajes do Pico is a lagoon system formed by two main lagoons separated by an extensive area of intertidal pools (Fig. 1). Juveniles of *Epinephelus marginatus* (LOWE, 1834) are known to occur in shallower waters than the adults (LO BIANCO, 1909; CANNAVIELLO, 1942; TORTONESE, 1947; DIEUZEIDE & GOËAU-BRISSONIÈRE, 1951). Post-metamorphic specimens occasionally occur in tide pools on

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the Azores (SANTOS, 1992). Nevertheless, the concentration of juveniles of this species found at Lajes do Pico is unusually high (PATZNER *et al.*, 1992; pers. obs.).

During an ichthyological survey of this area (integrated in the scientific expedition "Pico/91", of the Department of Biology, University of the Azores), a large sample of dusky groupers was taken from one of the above mentioned intertidal pools. The aim of this paper is to provide a comprehensive analysis of this sample, focusing on the population density, the age and growth, the stomach contents and the sexual maturity.

MATERIAL AND METHODS

The sample of groupers was captured with hand nets, after rotenone had been applied in the tide pool. Groupers were preserved in 10% buffered formaline immediately after capture, the larger fishes being previously injected with the same liquid in the abdominal cavity and muscle.

Measurements of the pool's dimensions were made at the following low tide, to evaluate its area and volume.

Each fish was measured (total length, TL) to the nearest millimeter and weighed (total weight, TW) to the nearest 0.01 g. Fish were subsequently grouped in 1 cm length classes. BHATTACHARYA'S (1967) method was applied to resolve the length frequency data in its gaussian components. The computer program of SPARRE (1967) was used.

Scales were used to evaluate the age of the fishes. From 3-10 fishes of each length class, six scales were taken from under the left pectoral fin and glued on a slide. A total of 74 slides were obtained. Scales were observed independently by two of the authors on a microscope with transmitted light. Discontinuities (checks) in the ring deposition encompassing all or most of the scale diameter were noted. Many of the scales were found to present large, central, non-striated areas and they were disregarded. Of the remaining scales, only those in which there was agreement between the readings of both authors were considered, bringing the number of slides included in this analysis down to 44.

The length/weight relationship was calculated from the regression of $\log_e TL$ on $\log_e TW$, and expressed as $TL=a.TW^b$.

Stomach contents were removed from up to 5 fishes of each length class and preserved in 70% alcohol. A total of 71 fishes were used. The vacuity coeficient was expressed as the number of empty stomachs over the total number of stomachs analysed. Contents were sorted into the lowest possible taxonomic categories under the binocular microscope. For each stomach, items were counted and, whenever possible, weighed to the nearest 0,01 g and their volume assessed to the nearest milliliter (through water displacement on a graduated cylinder). Results are expressed percentually in number (%N, number of a given item / total number of items), frequency (%F, number of stomachs with item / total number of stomachs), wet weight (%W, wet weight of an item / wet weight of all the stomach contents) and volume

(%V, volume of a given item / volume of all the items).

The external appearance of the gonads on the fishes used for stomach content analysis was observed.

RESULTS

1. Population density

The total sample consisted of 175 groupers, weighing a total of 14.4 Kg. The area and volume of the tide pool were estimated as 828 m^2 and 367 m^3, respectively. Grouper density was therefore 0.21 fish/m^2 (the equivalent to one fish per 4.7 m^2) and grouper biomass was 17.4 g/m^2.

2. Age and size

Figure 2 shows the frequency distribution of the length classes and the gaussian curves fitted by the Bhattacharya method. The frequency distribution shows two groups (one between 4 and 7 cm and another between 13 and 25 cm) and one isolated specimen with 36 cm. The Bhattacharya analysis shows two curves: one overlaping the first group in the length frequency distribution; the other partially overlaping the second group in that distribution, leaving out the fishes greater than 22 cm. Thus, two cohorts are well marked and there is an indication that the largest fishes in the second group of the length frequency distribution belong to a third cohort.

The number of scale checks as a function of fish size (Fig. 3) further support this observation. Fishes of the first group of the length frequency distribution (4 to 7 cm) did not show any check on their scales. The smaller fishes of the second group (13 to 17 cm) show only one check while the larger ones (22 to 25 cm) have two checks. Fishes of intermediate size (18 to 21 cm) have either one or two checks on their scales. In two fishes (TL 23 and 24 cm) 3 checks were detected. The checks on the scales of the larger grouper were difficult to interpretate, particularly near the margin. However, at least 4 checks were counted.

4. Length/weight relationship

The length/weight relationship of the groupers is $TW=0.01388.TL^{3.065}$ ($R^2=0.998$).

5. Stomach contents

Of the 71 stomachs analyzed, only 47 had recognizable contents. The vacuity coefficient is therefore 33.8%.

The results of the stomach contents analysis are given in Table 1. Small crustaceans (amphipods, crabs and isopods) dominated in number and frequency the stomach contents of the smaller groupers (4-7 cm). In percent weight and volume shrimp were found to dominate. This was caused by one unusually large shrimp. Omitting this item, the ponderal and volumetric percentages agree with the numeric and frequency ones. Additional items found in this size class were polichaetes and cumaceans. Small crustaceans were rare or absent in the stomach contents of groupers larger than 13 cm. The main items in this size class were crabs, fishes and shrimps, in decreasing order. The fish species found in the stomach contents were *Chelon labrosus, Epinephelus marginatus, Gobius paganellus, Thalassoma pavo* and *Tripterigium delaisi*. Additional items found included polichaetes, small bivalves and gastropods.

6. Maturity

All the fishes observed, including the largest one, possessed immature gonads, colorless and thread-like in appearance.

DISCUSSION

The small sample size and its instantaneous nature do not allow definite statements about the age composition of the sampled grouper population. Nevertheless, if it is assumed that the observed checks reflect annual growth stops, scalimetric data combined with the analysis of the length frequency distribution suggest the presence of at least 4 age groups. The fishes of 4-7 cm would belong to age group 0+. The age groups 1+ to 3+ are superimposed: fishes from the 1+ group would have 13-20 cm, those from the 2+ age group would range from 18 to 25 cm, while the two fishes of 23 and 24 cm would be small specimens of the 3+ age group. The larger grouper would belong to age group 4+ or higher. This assumption is compatible with data compiled by BRUSLÉ (1985) for Mediterranean populations, which show the following total length at age relationship: 1st year, 11.4-17.1 cm; 2nd year, 21.0-23.6 cm; 3rd year, 28.4-29.7 cm; 4th year, 34.8-37.5 cm. A detailed study of the pattern of check formation on the scales of the Azorean groupers is needed, however, before definitive conclusions can be reached.

The length/weight relationship, although computed from preserved specimens, is intermediate between those reported for Senegal by FRANQUEVILLE & FREON (1976) ($TL=0.007485*TW^{3.221}$) and for Tunisia by BRUSLÉ & PRUNUS (1980) ($TL=0.00783*TW^{3.157}$).

There are some contradictions about the feeding period of *E. marginatus*. NEILL (1967) considers it as a diurnal predator, while ABEL (1959, 1962) indicates a more crepuscular feeding period. The present results are not conclusive in this respect. The undamaged nature

of some of the items in the stomachs indicates that they had been ingested shortly before capture. One cannot rule out the possibility that the groupers were able to prey on animals affected by the rotenone, before becoming affected themselves. Since the present sampling took place in the morning, it nevertheless indicates that the dusky grouper will eat during daytime if prey is available.

A carnivorous regimen based on fish and crustaceans coincides with published information on the diet of this grouper (CADENAT, 1954; NEILL, 1967; SMALE, 1986). According to these authors, molluscs (*Haliotis* and cephalopods) are also important items. The only molluscan prey found in the present study were small bivalves and gastropods. In the sea, however, larger groupers are known to prey on *Octopus vulgaris* (J. M. M. BRUM, pers. comm.). VIVIEN (1973) points out that groupers tend towards piscivory as they grow, and this tendency is supported by the present results.

NEILL (1967) and BRUSLÉ & BRUSLÉ (1976) indicate 5 and 9 Kg as the weight at maturation for females and males, respectively. However, less heavy mature fish have been found: a 2 Kg female (SPARTA, 1935) and 3-5 Kg males (BRUSLÉ & BRUSLÉ, 1976). All the fishes in the present sample, the heaviest weighing 893 g, were in the juvenile stage, which is in accordance with the observations of the authors referred above.

The small number of individuals of age class 2+ and older is an indication of a truncated distribution, suggesting that there is a size limit for the groupers on this intertidal pool. Larger fishes probably migrate to deeper waters. If this observation can be extended to all the lagoon system of Lajes do Pico, it implies that this system acts as a nursery for *E. marginatus*. Further studies should be encouraged to evaluate the importance of Lajes do Pico lagoons and tide pools for the local grouper stock, and to provide a basis for its management and protection.

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TABLE 1 - Percent number (%N), frequency (%F), wet weight (%W) and volume (%V) of the food items in the stomach contents of *E. marginatus* (see text for formulas).

	%N			%F			%W			%V		
TL classes (cm):	4-7	13-25	36	4-7	13-25	36	4-7	13-25	36	4-7	13-25	36
Polichaetes	0,9	3,2		7,7	6,1							
Bivalves		4,8			9,1			0,1			0,2	
Gastropods		3,2			6,1			0,02			0,02	
Cumaceans	0.9			7,7								
Isopods	2,5			23,1			8,9			9,6		
Amphipods	79,7	1,6		84,6	3		3,3			2,9		
Shrimps	1,7	14,5		15,4	27,3		62,2	8		57,7	7,9	
Crabs	7,6	53,2	12,5	53,9	78,8	100	25,6	69,1	47,53	29,8	70,6	48,1
Fishes		19,4	87,5		30,3	100		22,8	52,5		21,2	51,9
Miscellaneous	6,8			38,5								

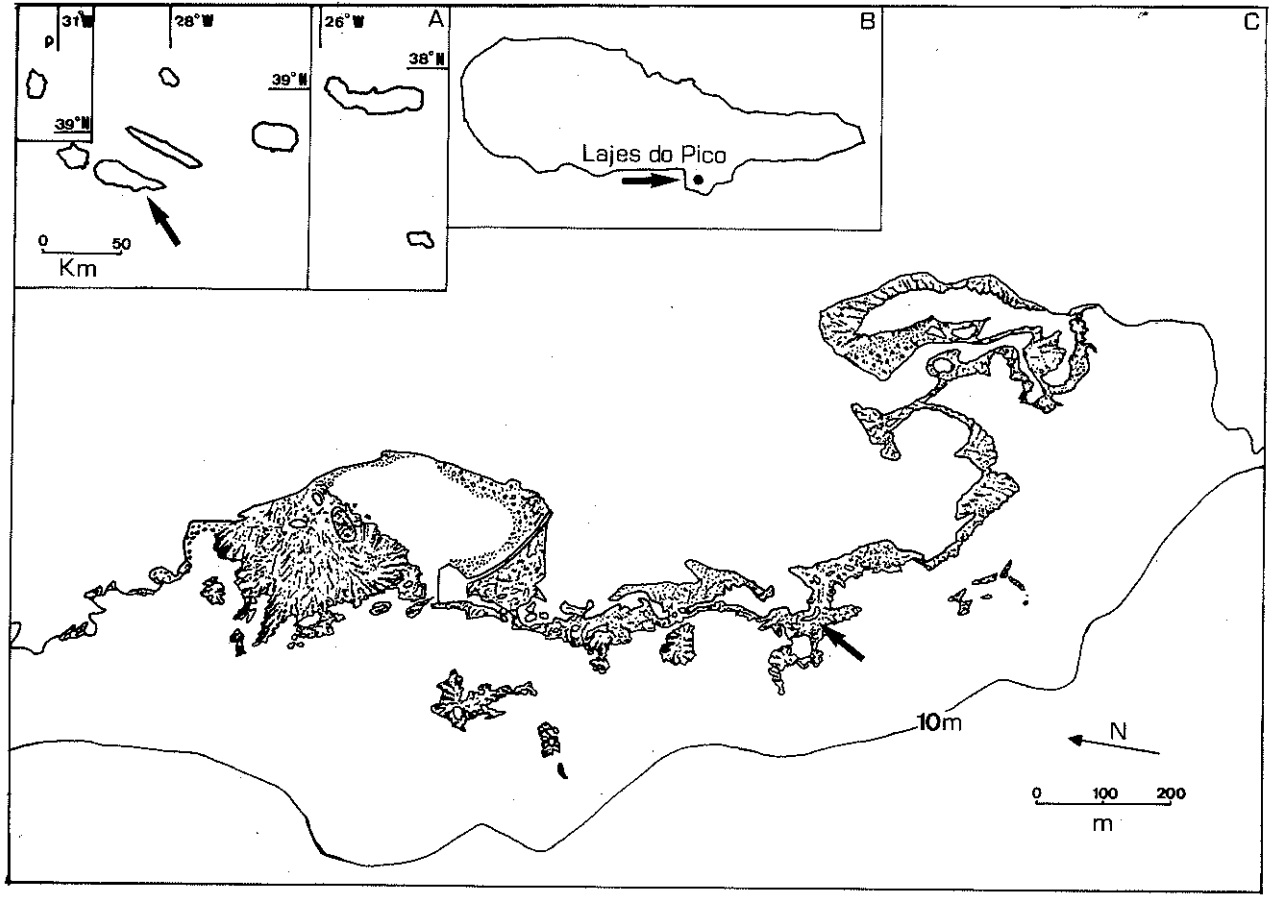

Figure 1 - Location of the study area. Arrows indicate the Pico island (A), Lajes do Pico (B) and the sampled pool (C).

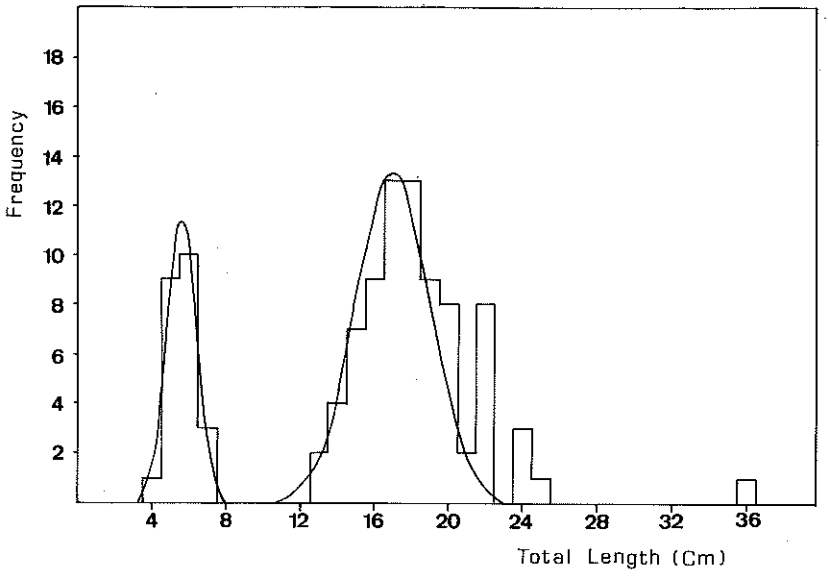

Figure 2 - Length frequency distribution of the *Epinephelus marginatus* sample, with superimposed gaussian curves (BHATTACHARYA, 1967).

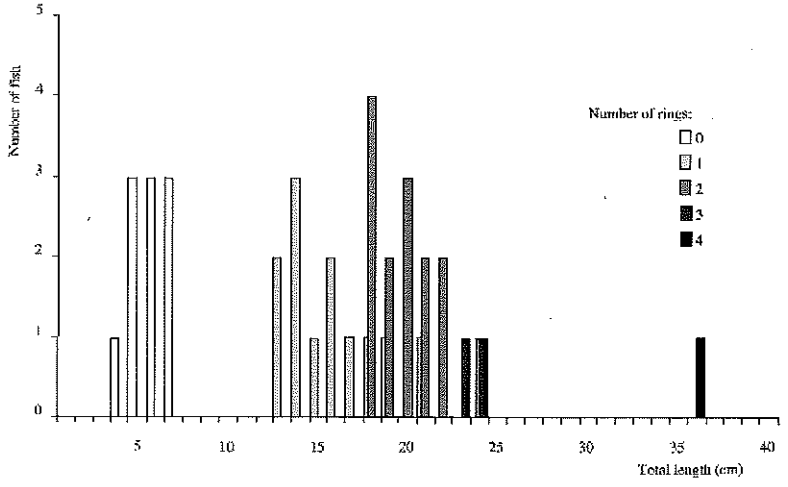

Figure 3 - *Epinephelus marginatus* sample: number of scale checks as a function of fish total length.