

# NOTES ON THE FOOD HABITS AND PREDATORY BEHAVIOUR OF THE DUSKY GROUPER, *EPINEPHELUS MARGINATUS* (LOWE, 1834) (PISCES: SERRANIDAE) IN THE AZORES

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Between 1992 and 1995, 57 individuals of *E. marginatus* were collected near Terceira Island. Their sizes ranged from 60 to 138 cm, total length, with two size categories. Stomach contents were analysed. Vacuity coefficient was 44,0% for medium size specimens and 31,3% for large specimens. Octopus and fishes were the dominant prey. Two different hunting postures were also observed and described.

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Entre 1992 e 1995, foram colhidos e examinados 57 exemplares de *E. marginatus* da ilha Terceira. Os seus comprimentos totais variaram entre 60 e 138 cm com duas categorias de tamanho. O coeficiente de vacuidade observado foi de 44,0% para exemplares de médio porte e 31,3% para grandes exemplares. As presas predominantes foram o polvo comum e peixes. Duas posturas de caça diferentes foram observadas e são descritas.

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## INTRODUCTION

The dusky grouper, *Epinephelus marginatus* (Lowe, 1834) is a well known teleost fish of the rocky shores of the Azores. The species has a wide geographical range and has been recorded from the British Isles to South Africa, southern Mozambique, Mediterranean, Azores, Madeira, Canaries and Cape Verde (HEEMSTRA 1991). It is also recorded from Brazil to Uruguay (RIGUELET & ARAMBURU 1960), India (REDDY 1984) and the island of Réunion (TAQUET & DIRINGER 1992).

Studies on *E. marginatus* have been carried out, mainly in the Mediterranean, where it became a symbol of marine life in the early 40's when scuba diving began to develop and expand as a leisure/sport activity. Several aspects of the biology of the species were studied by BOU-AIN et al. (1983), BRUSLÉ (1985) and GHAFIR & GUERRAB (1992) while aspects of the reproductive biology have been reported by BRUSLÉ & BRUSLÉ (1976), BOU-AIN & SIAU (1983) and SKARAMUCA et al. (1989). Growth studies (BRUSLÉ & PRUNUS 1980; CHAUVET 1988) have shown relevant aspects of the species length/weight relationship. Demography and

general behaviour were reported by NEILL (1967) and CHAUVET & FRANCOUR (1988) and feeding by CASTELLO-ORVAY et al. (1992) and DERBAL & KARA (1996).

In the Azores, only some aspects of the biology of the dusky grouper were studied. Juvenile ontogeny was described by PATZNER et al. (1992) and AZEVEDO et al. (1995).

BARREIROS (1995), BARREIROS & SANTOS (1996) and PORTEIRO et al. (1996) published preliminary results on its reproduction and feeding behaviour.

Groupers are a diverse taxon of predators with a wide distribution, thus resulting in a wide prey choice. The genus *Epinephelus* comprises more than 100 species distributed worldwide in tropical and temperate waters (NELSON 1994). The dusky grouper is the only *Epinephelus* species occurring in the Azores (SANTOS et al. 1997) and is probably the most common large (> 100 cm) benthopelagic predator from the surface down to 100 meters.

Knowledge of its food habits and thus its ecological role as a top predator is an important step towards the understanding marine foodwebs of the Azores.

Besides its ecological importance, the dusky grouper has a special protection status in the Azores (SANTOS et al. 1995), where spearfishing for this species is prohibited.

## MATERIAL AND METHODS

All specimens sampled were collected near Terceira Island by spearfishing under permit. This method prevents regurgitation (e.g. BOWEN 1983) and makes selection easier (DERBAL & KARA 1996).

Material was collected and ethological observations made throughout the year during daytime. The specimens were sexed, measured to the nearest millimetre with a measuring board,

and weighed, with a dynamometer, with a precision of 0.01 g.

## FOOD HABITS

Stomachs were removed and preserved in the freezer. In the laboratory, food items were thoroughly examined and identified to the lowest possible taxonomic level. After drying with absorbing paper, food items were weighed in an analytical balance to the hundredth of the gram.

The vacuity coefficient (VC) (HUREAU 1970) was determined, in which:

$$VC = N^{\circ} \text{ of empty stomachs} / \text{Total stomachs observed} \times 100$$

Importance of prey items on fish diet was determined based on feeding coefficient (Q) of HUREAU (1970) and GEISTDOERFER (1975) index (F), in which:

$$Q_a = (\%C_{na} \times \%C_{pa}), \text{ being}$$

$$\%C_{na} = n^{\circ} \text{ of } a \text{ preys} / \text{Total } n^{\circ} \text{ of preys} \times 100 \\ \text{and } \%C_{pa} = \text{weight of all } a \text{ preys} / \text{weight of all stomach contents} \times 100$$

GEISTDOERFER (1975) proposed the index "F" for different prey items, in which:

$$F\% = N^{\circ} \text{ of stomachs with the item } a / \text{Total of full stomachs} \times 100$$

The use of index Q gives an idea of the role of a determined item of prey in the whole of the diet while F expresses the frequency in which a prey is captured.

Results are presented for the whole sample and for two size categories: A. medium sized (Total Length - TL < 90 cm) and B. large sized (TL > 90 cm). BARREIROS (1995) indicated that sex change in the population of *E. marginatus* studied in Terceira Island, Azores, occurs when fishes attain a TL of ca. 90 cm.



## PREDATORY BEHAVIOUR

During the sampling fieldwork we made several observations on predatory behaviour (around 100 hours) on *E. marginatus*. These observations were made by carefully approaching (at the closest possible distance, without disturbing the fishes) some individuals that displayed hunting postures, while hiding ourselves as much as possible. The bulk of these observations were made by snorkelling (87 hours) and the remaining with scuba gear (22 hours).

Underwater sketches of the postures observed were made for behavioural illustrations.

## RESULTS

### FOOD HABITS

A total of 57 stomachs were analysed. The vacuity coefficient (VC) for the whole sample was of 38,6%. Larger specimens (> 90 cm TL) had a lower VC (31,2%) than medium sized specimens (44,00%). Forty prey species were found with a total weight of 23,324 kg. Among the prey, five fish (*Centrolabrus trutta*, *Ophioblennius atlanticus atlanticus*, *Synodus saurus*, *Mullus surmuletus* and *Sarpa salpa*), two crustaceans (*Scyllarus arctus* and *Scyllarides latus*) and two molluscs (*Octopus vulgaris* and *Haliotis coccinea*) (Tables 1-3) could be identified to species level. Three teleost fishes were too digested for an accurate identification and bony structures (scales, otoliths, and vertebrae) could not be recognised. In the case of the gastropod *Haliotis coccinea* we did not include it in Q and F calculations because only three empty worn shells were found. Since these were in stomachs that also contained octopus remains, we considered that the shells could be attached to the octopuses, thus not being a true prey item (see Discussion).

Table 1 presents the results for the whole sample and Tables 2 and 3 show the differences found in the two size categories considered.

## PREDATORY BEHAVIOUR

Similar results for both Q and F for *Octopus vulgaris* and whole of fishes show these to be preferred prey (Table 1). Crustaceans are accessory prey (Q) or frequent secondary prey (F). *Centrolabrus trutta* was the most common fish in the diet.

Table 1  
Values of Q and F found in the whole sample of *E. marginatus*  
(n = 35)

SPECIES	Cn%	Cp%	Q	F
<i>Octopus vulgaris</i>	47.5	70.4	3345.9	54.3
Total molluscs	47.5	70.4	3345.9	54.3
<i>Scyllarides latus</i>	5	6.1	30.3	5.7
<i>Scyllarus arctus</i>	7.5	1.4	10.4	8.6
Total crustaceans	12.5	7.4	92.9	14.3
<i>Centrolabrus trutta</i>	17.5	9.2	160.1	11.4
<i>Ophioblennius atlanticus</i>	5	0.5	2.5	5.7
<i>Synodus saurus</i>	2.5	1.3	3.3	2.9
<i>Mullus surmuletus</i>	2.5	1.8	4.5	2.9
<i>Sarpa salpa</i>	2.5	2.5	6.2	2.9
Unid. Teleostei	10	3.0	29.8	5.7
Total fishes	40	18.3	730.4	31.5

In size A class (Table 2), *O. vulgaris*, crustaceans and fishes are main preys (Q). Fish constitute the main preferred prey while Octopuses and the crustaceans are occasional main preys. When considered individually, *Scyllarus arctus*, *Centrolabrus trutta* and *Ophioblennius atlanticus atlanticus* are frequent preys and all other items are secondary preys.

For fish larger than 90 cm TL *O. vulgaris* is the main preferred prey (Table 3), the fish, *Centrolabrus trutta*, and crustaceans were of lesser importance. The hunting posture illustrated in Fig. 1 was observed 23 times. Of these, 87.0% (20 individuals) were smaller than 90 cm. Figures 2 and 3 illustrate another hunting posture, observed on 21 occasions.

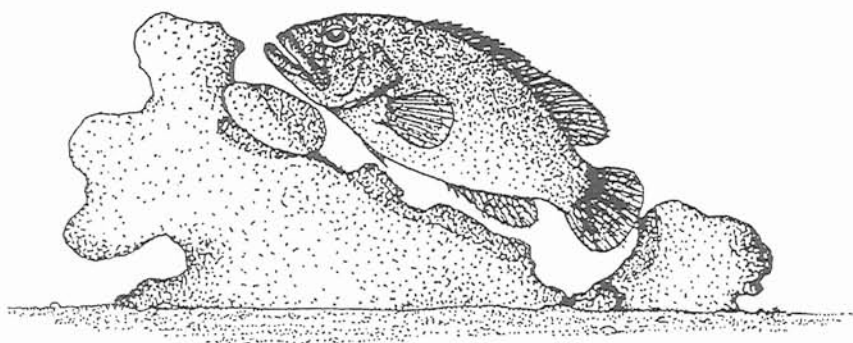


Fig. 1. Hunting posture performed by small to medium-sized (<90 cm TL) individuals when attacking fishes. (Drawings by João Pedro Barreiros).

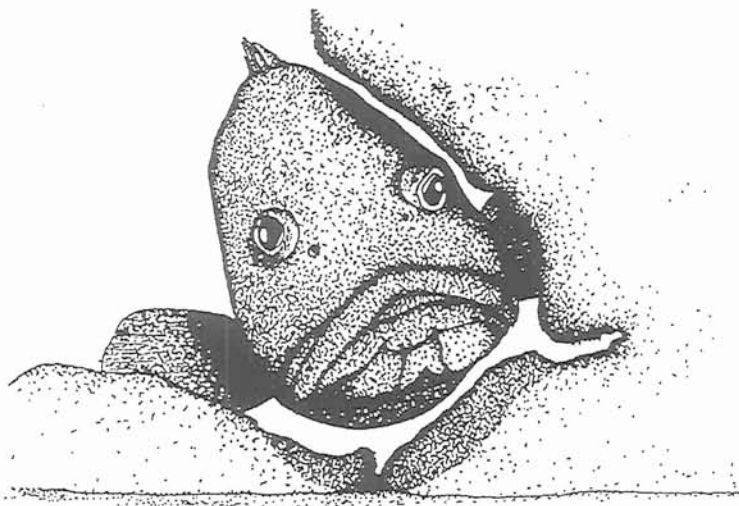


Fig. 2. Hunting posture performed by some large (>100 cm TL) individuals when stalking and attacking octopus.

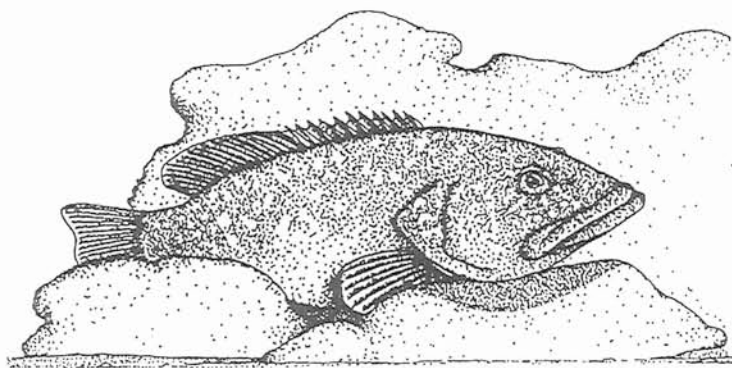


Fig. 3. Hunting posture observed in some large (>100 cm TL) individuals when stalking and attacking octopus.

Table 2

Food parameters found in size class A (< 90 cm TL) of the sample of *E. marginatus* (n = 13)

SPECIES	Cn%	Cp%	Q	F
<i>Octopus vulgaris</i>	15.4	50.9	782.4	15.4
Total molluscs	15.4	50.9	782.4	15.4
<i>Scyllarides latus</i>	7.7	12.4	95.4	7.7
<i>Scyllarus arctus</i>	15.4	3.2	49.4	15.4
Total crustaceans	23.1	15.6	360.1	23.1
<i>Centrolabrus trutta</i>	15.4	7.9	121.8	15.4
<i>Ophioblennius atlanticus</i>	15.4	1.8	28.3	15.4
<i>Synodus saurus</i>	7.7	4.9	37.9	7.7
<i>Mullus surmuletus</i>	7.7	6.7	51.5	7.7
<i>Sarpa salpa</i>	7.7	9.2	71.1	7.7
Unid. Teleostei	7.7	2.9	22.4	7.7
Total fishes	61.5	33.5	2062.8	61.5

Table 3

Food parameters found in size class B (> 90 cm TL) of the sample of *E. marginatus* (n = 22)

SPECIES	Cn%	Cp%	Q	F
<i>Octopus vulgaris</i>	63.0	77.7	4890.1	77.3
Total molluscs	63.0	77.7	4890.1	77.3
<i>Scyllarides latus</i>	3.7	3.7	13.7	4.5
<i>Scyllarus arctus</i>	3.7	0.7	2.6	4.5
Total crustaceans	7.4	4.4	32.6	9.1
<i>Centrolabrus trutta</i>	18.5	9.6	178.0	9.1
Unid. Teleostei	11.1	3.0	33.4	4.5
Total fishes	29.6	12.6	373.9	13.6

All individuals performing this posture were larger than 100 cm.

These ambushing/hunting postures were and are consistently observed in groupers of all sizes, both in captivity and in natural conditions. From our observations all individuals performing the hunting posture illustrated in Fig. 1 were seen attacking fishes while from the ones performing the hunting posture illustrated in Fig. 2, 18 (86%) were seen carefully approaching octopuses with 7 attacks actually occurring.

However, one must state that these postures may not be exclusively performed during hunting moments. The posture in Fig. 1 may also be displayed as a territoriality/residential stance while resting fishes also performs the one in fig.

2. What can be stated so far is that fishes in these two postures actually performed them while hunting.

## DISCUSSION

The vacuity coefficient of 38,6% is lower than those reported by DERBAL & KARA (1996), of 46,3% and GHAFIR & GHERAB (1992), of 42,1%, for *E. marginatus*. However, in our samples, large specimens had a lower VC (31,3%) than medium ones (44,0%) which is closer to the values above mentioned. This could mean that large fish may have improved hunting strategies, probably due to their older age and, thus, experience. Also the fact that large fishes can eat larger prey could imply that these would remain for longer periods and in identifiable condition in their stomachs.

Other works that focus on food habits of *E. marginatus* (e.g. NEILL 1967; BRUSLÉ 1985; SMALE 1986) largely consider fish and crustaceans as main items of prey. Octopuses and other molluscs (*Haliothis* sp. by NEILL 1967 and small bivalves by AZEVEDO et al. 1995) are also considered and is according to CHAUVET (1991), the preferred prey of *E. marginatus*.

SMALE (1986) working in South Africa observed that larger individuals fed mainly on reef-associated fishes. However, in the Azores, it seems that as *E. marginatus* grows larger it alters the diet towards a higher percentage of *Octopus vulgaris* (AZEVEDO et al. 1995).

This fact is confirmed in our results. For large individuals, octopus represents clearly the preferred prey. Fish constitute the preferred prey of medium sized fish. Here octopus and crustaceans appear only occasionally as main prey. However, the small size of our sample and the high VC for medium sized individuals must lead us to consider this results cautiously.



As we did not study fishes with TL lower than 60 cm, there is a lack of data for small individuals and juveniles. However, AZEVEDO et al. (1995) found crabs, fish (including other *E. marginatus*) and shrimps as main items and polychaetes, small bivalves and gastropods as additional items in the stomachs of small fish from Azorean tidepools.

Many other species could be considered as potential *E. marginatus* prey, since it shows itself as an opportunistic predator. In the Azores, the blacktail comber *Serranus atricauda* was found on one occasion in the stomach of a dusky grouper (J. M. Martins, pers. comm.) and another was seen attacking the triggerfish *Balistes carolinensis* (M. Peixoto, pers. comm.).

We could not find previous descriptions of the hunting postures here shown in Figs. 1, 2 and 3. However, our observations showed that the posture described in Fig. 1 is essentially performed by small to medium sized specimens and Figs. 2 and 3 illustrate a hunting strategy developed by large animals. The oblique stance of Fig. 1 represented a stalking position for fish predation while the other stance, slowly crawling near the bottom, is a strategy for catching octopus or other benthic preys.

Our observations should be regarded as preliminary, and additional studies of this species and other large demersal Azorean fish should be carried out.

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