TROPHIC RELATIONSHIPS AND FEEDING HABITS OF DEMERSAL FISHES FROM THE AZORES: IMPORTANCE TO MULTISPECIES ASSESSMENT

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ABSTRACT

In the present work, the feeding habits of several commercial demersal fishes of the Azores (fork-beard, *Phycis phycis*; alfonsinos, *Beryx splendens* and *B. decadactylus*; axillary sea-bream, *Pagellus acarne*; tope shark, *Galeorhinus galeus*; conger eel, *Conger conger*; silver scabbardfish, *Lepidopus caudatus*; black spot sea-bream, *Pagellus bogaraveo* and thornback ray, *Raja clavata*) are studied as part of a large research program that aims to assess multispecies demersal fishery in the Azores. Data was collected during the demersal cruise surveys that took place aboard the R/V "Arquipélago" during the spring of 1996 and 1997. Fish stomach contents were analyzed to infer biological interactions between these species through their diet composition. The diet composition results permit to identify four major groups. The first group is represented by the fork-beard and thornback ray, which are nocturne benthic predators. In the second one the top predators (tope shark, conger eel and silver scabbardfish) are represented. The third represented by the alfonsinos is closely related to the fourth group represented by the sea-breams. Both alfonsinos and sea-breams are generalist feeders displaying feeding vertical migrations. However, alfonsinos are predominantly water column feeders while sea-breams feed primarily on benthic organisms. Observation of the stomach contents of all the species in the study did not show a significant presence of important commercial fishes. These results clearly suggest that multispecies assessment of Azorean demersal fisheries should emphasize the technical interactions rather than biological ones.
Keywords: Azores, demersal fishes, feeding habits, interspecies relationships.

INTRODUCTION

In the 80´s, a quick evolution of the demersal fisheries took place in the Azores, with the introduction of new vessels, fishing gears and strategies. This resulted in significant changes on the quantity and diversity of local captured species and local fisheries economy. With time and with the vulgarization of the bottom longline technique, fisheries in the Azores began to focus on species that lived in greater depths. In particular, it was after 1983, with the substantial increase in the fleet capacity that these changes were mostly observed (e.g. increased capacity for exploring new areas within the EEZ) (SILVA *et al.*, 1994; MENEZES, 1996).

The bottom longline is a multispecies fishery, where more than 20 different species are involved. The black spot sea-bream (*Pagellus bogaraveo*) is the most important species but others have had increased interest: e.g. bluemouth rockfish (*Helicolenus dactylopterus*), fork-beard (*Phycis phycis*), alfonsinos (*Beryx splendens* and *B. decadactylus*), conger eel (*Conger conger*), offshore rockfish (*Pontinus kuhlii*), common sea bream (*Pagrus pagrus*), wreckfish (*Polyprion americanus*). About 70% of the total local demersal fisheries operate vertically within the 300 to 500 m depth interval (MENEZES, 1996). The demersal fishery has an important impact in the local economy. In fact, even though these fisheries don't overcome 5000 tons. of fish captured per year they represent a considerable commercial value (SILVA *et al*., 1994).

Contrarily to other fisheries in the region (like the tuna fishery), demersal species are local resources characterized by a great sensitivity to exploitation that results from their biological and ecological characteristics (as it was recognized recently by the Study Group on the Biology and Assessment of Deep-Sea Fisheries Resources of the ICES, 1994) and from their spatial limitation imposed by the non-existence of a continental platform around the islands. Over-exploitation also means greater demand (due to increased commercial value) of target species and this requires conservation measures for protection based on intensive fisheries research (MENEZES, 1996). Intensive studies are already routinely underway based on the general methodology of single species models for stock assessment but the more general multispecies ones are required to deal with the diversified correlation that we can find among different competing species.

Within the present context, the Group on the Biology, Ecology and Assessment of Demersal and Deep-Sea Fisheries Resources of the Department of Oceanography and Fisheries from the University of the Azores, is trying to use different tools in the multispecies assessment of demersal fisheries.

Multispecies research in fisheries can be divided in three main components: technical, biological and economical interactions. Technical interactions deals with the analysis of situations were many species are caught by the same fleet. Biological interactions deal with interactions between fish species in form of predation and competition. This case is being studied in the Azores since 1996 in order to assess if the inter- and intra-species predation mortality of demersal fishes is important to the estimation of natural mortality. This paper will deal exclusively with biological interactions.

An overview of the multispecies research in fisheries can be found at DAAN & SISSENWINE (1991) while an overview of the theory an applications of multispecies virtual population analysis (MSVPA) can be found at POPE (1979); HELGASON & GISLASON, (1979), GISLASSON & HELGASON (1985), DAAN (1987), SPARRE (1991), POPE (1991), MAGNÚSSON (1995). The most extensive work on the MSVPA has been carried out by ICES's Multispecies Assessment Working Group in applying it to the North Sea.

Species interactions (predation and competition) can influence substantially both the structure and energy flow within fishery systems. Predation in pre- or postrecruits may be a very significant if not the dominant linkage affecting fish production, leading to direct competition between predator and fisheries (DAAN, 1987). The important feature being that natural mortality is not a fixed input parameter, but is at least partially modulated by inter- and intraspecific predation (ANONYMOUS, 1980).

The key information required for evaluating interactions within an assemblage of species is the feeding habits of the various species (POPE & KNIGTHS, 1982; DAAN, 1986). Investigation of the use of food is also the best starting point for understanding how fish communities function. However, in practice there is a clear discrepancy between this progress in the theoretical field and the standstill in practical food investigation, which are required to estimate the suitable indices (ANONYMOUS, 1980).

This paper is an approach to the study of the feeding habits of demersal species in order to assess if the inter- and intra-predation mortality of demersal fishes is an important factor to the estimation of natural mortality.

MATERIAL AND METHODS

FIELD SAMPLING

The stomach contents sampling took place during a wider research program aimed to study the Azorean Demersal Fisheries using longline onboard the R/V “Arquipélago” of the University of the Azores. During 1996, the first year of sampling, we mainly tested methodologies and techniques. A general taxonomic identification of prey was made. During the second year of sampling, a great effort was made in order to identify all possible prey found in the stomach contents. We will use the data from 1996 cruises to describe the feeding habits of fishes, and then we will briefly describe the data from 1997.

The 1996 and 1997 Demersal Survey Cruises took place between March and May and covered the Central (area 2) and Eastern (area 3), Western (area 6) groups of the Archipelago as well as Princes Alice Bank and Açores Bank (area 1), Mar da Prata Bank (area 4) and one area designated as Other Submarine Mounts (area 5) (Fig. 1). The cruise followed a stratified random sampling design and two variables were looked upon: 5 geographical areas (the coast of the islands and the banks referred above) and 24 depth-strata from 50m to 1200m depth (each stratum 50m long). The longline used in the experiments is identical to the one often used in commercial fisheries in the Azores. The standardized longline fishing were performed with ca. 128 hooks (MUSTAD 2335, no 9) per skate mounted on 40cm branch-lines at ca. 1m intervals and baited with pieces of salted sardine (for more detailed description see SILVA & MENEZES, 1996). Line setting began at 05.00 h and hauling started at about 07.00 h, 07.30 h later.

For biological sampling fishes were sorted by species and depth strata. Data on length, sex and maturity stage was recorded. Stomachs of all sampled fishes were examined onboard, immediately after capture, in order to be classified as: Everted (E; stomachs pushed out as a result of expansion of the swimbladder during the hauling), Regurgitated (R; stomachs showing evidence of regurgitation), with Bait (B; stomachs with bait), Empty (0; stomachs without food or with skeletal remains and also without signs of regurgitation), one quarter-full (1), half-full (2), three quarter-full (3) or full (4). Stomachs of category E, R and B were excluded from any further analysis, as they do not give any relevant information. When stomachs were sampled, sometimes individuals were found which obviously had been eating fish on the longline. As this situation does not reflect natural feeding behaviour, it was decided that fish with this phenomenon should be discarded. The stomachs with contents were deep frozen (-18ºC) and transported to land laboratory where they were completely analyzed.

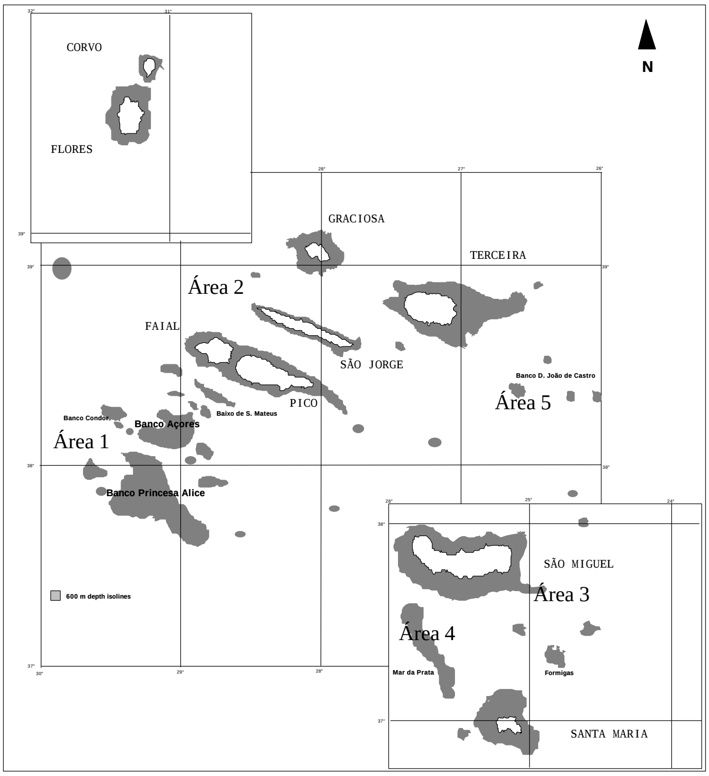

Fig. 1 – Sampling areas at the Azorean Archipelago.

SPECIES

Species were selected according to the importance for fisheries and to the amount of biological material collected (*vide* Results). The species are: fork-beard (abrótea), *Phycis phycis*; alfonsinos, *Beryx splendens* (alfonsim) and *B. decadactylus* (imperador); axillary sea-bream (besugo), *Pagellus acarne*; tope shark (cação), *Galeorhinus galeus*; conger eel (congro), *Conger conger*; silver scabbardfish (peixe-espada-branco), *Lepidopus caudatus*; black spot sea-bream (goraz), *Pagellus bogaraveo* and thornback ray (raia-lenga), *Raja clavata*.

LABORATORY ANALYSIS OR STOMACH ANALYSIS

The stomach contents were weighed and fixed in 4% buffered formalin for 24 h. After this period of time the formalin was replaced by 70% alcohol. The items were carefully separated, weighed, after removing the surface water by blotting them in tissue paper, and identified to the lowest taxon possible. The stomach contents of tope shark and thornback ray were made up partly of a turbid suspension and were washed with water on a nylon net of ca. 0.5 mm mesh size to make the examination easier.

Fish otoliths were identified by specialist through comparison with a collection and from literature (SMALE *et al.*, 1995). The individuals of each identified taxon were counted and when fragments were found, the number of individuals was taken as the smallest possible number of individuals from which fragments could have originated. Cephalopod beaks were kept for posterior identification. When undigested items were found their lengths were measured according to each group standard measure. It was also established for all items a subjective classification to evaluate the degree of digestion, from 1 (undigested) to 4 (only remains of hard parts).

DATA ANALYSIS

Characterization of food habits

Several indices can be used in the diet analysis of fish species and some comments on their use can be found in literature (see HYNES, 1950; PILAY, 1952; WINDELL & BOWEN, 1978; BERG, 1979; HYSLOP, 1980; MACDONALD & GREEN, 1983; HERRÁN, 1988; CORTÉS, 1997 and MARSHALL & ELLIOTT, 1997; for a review).

The number of empty stomachs as a percentage of the total number of stomach sampled (Vacuity Index -VI; HUREAU, 1970) and stomach content weight as a percentage of fish body weight (Replection Index -RI, BLEGVAD, 1917 in HYNES, 1950) were used to evaluate the fish feeding activity. In order to measure the repletion index fish body weights were estimated from length-weight relationships. Estimates for fork-beard (*Phycis phycis*) were taken from $W=0,0054xLt^{3,205}$ (SILVA, 1985), for alfonsinos (*Beryx splendens* and *B. decadactylus*) $W= 0.0168xLf^{3.094}$ and $W=0.0236xLf^{3.017}$ respectively (ISIDRO, 1996), black spot sea-bream (*Pagellus bogaraveo*) $W=0.0094xLf^{3.2183}$ (KRUG, 1994).

Three simple indexes can be used to describe the diet of fish: frequency of occurrence, percentage by number and percentage by weight (CAILLIET *et al*., 1986). Each one was conceived to attend different questions and should be discussed separately (MACDONALD & GREEN, 1983). The following indexes were calculated separately for each item and then for each group considered ecologically consistent in all samples.

The frequency of occurrence of one item is given by the percentage of predators that contains that item (%FO= number of stomachs containing item i/total number of stomachs with prey x 100). The number of prey belonging to each item can be expressed as a percentage of the total number of prey found in all the examined stomachs (%N= number of prey from item i/total number of prey x 100). The weight of the prey belonging to each food item can also be expressed as a percentage of the total weight of the prey found in the examined stomachs (%W= weight of all prey from item i/total weight of the stomach contents x 100). Wet weight was used to determine this particular index removing the superficial water of each item with soft paper (PILLAY, 1952; GLEN & WARD, 1968).

The Index of Relative Importance (IRI=(%N + %W) x %FO) proposed by PINKAS *et al*. (1971) was calculated for each prey category and used to assess preferred preys. Food items were grouped into categories of preference using the method proposed by GOMES (1995). The categories were measured according to the equations:

IRI ≥ 30 x (0.15 x Σ%FO) -main important prey (MIP)
30 x (0.15 x Σ %FO) > IRI > 10 x (0.05 x Σ%FO) -secondary prey (SP)
IRI ≤ 10 x (0.05 x Σ%FO) -occasional prey (OP)

The preference limits were: for fork-beard IRI ≥1115.9 (MIP), 1115.9> IRI >123.9 (SP), IRI ≤123.9 (OP); for alfonsino (*Beryx splendens*) IRI ≥1034.1 (MIP), 1034.1> IRI >114.9 (SP), IRI ≤114.9 (OP); for axillary sea-bream IRI ≥977.6 (MIP), 977.6> IR I>108.6 (SP), IRI ≤108.6 (OP); for tope shark IRI ≥660.7 (MIP), 660.7> IRI >73.4 (SP), IRI ≤73.4 (OP); for conger eel IRI ≥621.6 (MIP), 621.6> IRI >69.6 (SP), IRI≤ 69.6 (OP); for silver scabbardfish IRI ≥631.3 (MIP), 631.3> IRI >70.1 (SP), IRI ≤70.1 (OP); black spot sea-bream IRI≥ 536.2 (MIP), 536.2> IRI >59.6 (SP), IRI ≤59.6 (OP) and for thornback ray IRI ≥870.8.9 (MIP), 870.8> IRI >96.7 (SP), IRI ≤96.7 (OP).

For diet comparison, prey taxa were grouped into categories based on taxonomy and ecology. Prey taxa which occurred only few times were included in a higher taxonomic level or in group “others”.

Species interactions

The use of diet overlap indexes among fish species or among size classes of a single species has been calculated in several studies to help explain community structure or to clarify competitive relationships (WALLACE, 1981). Reviews on the use of such indexes (ex.: HURLBERT, 1978; ABRAMS, 1980; LAWLOR, 1980; WALLACE, 1981; LINTON *et al.* 1981), demonstrated that only SCHOENER’s index (1970) estimate overlap accurately. Cluster analysis provides a relatively simple way of preparing, visualising and comparing data from feeding studies (BORTONE *et al.*, 1981). ROSS (1978) demonstrated the usefulness of cluster analysis in comparing stomach contents from different species or size groups, as well BORTONE *et al.* (1981) demonstrated that cluster analysis may also be used to compare data from several different sources.

Dissimilarity matrix based on SCHOENER’s (1970) diet overlap index were computed. Cluster analysis, using UPGMA algorithm and Euclidean distance measure, were applied to the matrix in order to identify groups with similar diets. An arbitrary level of 60% dissimilarity was used to separate groups.

C_{xy}= 1-0.5 (Σ |p_{xi} -p_{yi}) (SCHOENER, 1970)
where: C_{xy} – overlap between diet of species *x* and *y*;
p_{xi} – proportion of food category *i* in the diet of species *x*
p_{yi} - proportion of food category *i* in the diet of species *y*

RESULTS

During the 6th Demersal Survey Cruise that took place in the Azores during the spring of 1996, 5314 individuals of 48 different fish species were sampled (Table I). Vacuity index (V.I.) estimated for the several species presented very high values with the exceptions of conger eel, thornback ray, tope shark, mackerel and horse-mackerel (V.I.<50%). These last two species were not considered in this study for being strongly pelagic and secondary. The alfonsinos, the fork-beard, the silver scabbardfish and the black spot sea-bream show very high vacuity index values (60.98%, 84.52%, 81.87%, 82.78% and 87.58% respectively) nevertheless considering their importance in the local fisheries, the number of individuals captured as well as the need to know their feeding habits, diet sampling was processed.

Table I- Species sampled and Vacuity Index estimated. Species with less than 5 individuals were grouped in "Others".

SPECIES	PORTUGUESE COMMON NAME	NUMBER	STOMACHS W/ CONTENTS	VACUITY INDEX
Aphanopus carbo	Peixe-Espada-Preto	5	0	100.00
Anthias anthias	Canário-do-Mar	6	1	83.33
Serranus atricauda	Garoupa	7	0	100.00
Nezumia aequalis	Rato-Redondo	9	2	77.78
Etmopterus spinax	Lixinha-da-Fundador (Sp. 1)	9	3	66.67
Phycis blennoides	Abrótea-do-Alto	16	1	93.75
Polyprion americanus	Cherne	16	0	100.00
Benthodesmus elongatus	Peixe-Espada (Sp. 1)	18	0	100.00
Coelorhinchus coeloehincus	Rato-Bicudo	19	1	94.74
Deania calceus	Sapata (Sp. 1)	20	4	80.00
Daenia profundorum	Sapata (Sp. 2)	22	6	72.73
Synaphobrachus kaupi	Congrinho	28	5	82.14
Diplodus sargus	Sargo	31	0	100.00
17 species	Others	36	8	77.78
Muraena helena	Moreia	38	3	92.10
Pagrus pagrus	Pargo	53	6	88.67
Aspitrigla cuculus	Cabrinha	76	8	89.47
Etmopterus pusilus	Lixinha-da-Fundura (Sp. 2)	101	7	93.07
Conger conger	Congro	116	69	40.52
Beryx decadactylus	Imperador	123	48	60.98
Phycis phycis	Abrótea	155	24	84.52
Pagellus acarne	Besugo	171	31	81.87
Raja clavata	Raia-Lenga	184	107	41.85
Scomber japonicus	Cavala	241	149	38.17
Trachurus picturatus	Chicharro	322	204	36.64
Mora moro	Melga	328	1	99.70
Galeorhinus galeus	Cação	332	173	47.89
Pontinus kuhlii	Bagre	363	18	95.04
Lepidopus caudatus	Peixe-Espada	424	73	82.78
Beryx splendens	Alfonsim	448	308	31.25
Pagellus bogaraveo	Goraz	757	94	87.58
Helicolenus dactylopterus	Boca-Negra	840	26	96.90
Total		5314	1380	74.03

DIET COMPOSITION

FORK-BEARD (Phycis phycis)

The 23 fork-beard individuals examined for stomach contents measured 24 to 64 cm TL. Capture depths ranged from 0 to 350 m, although most specimens were obtained from strata 50-150m. Almost all individuals caught were females with different maturity stages.

A bluemouth rockfish (*Helicolenus dactylopterus*) was found in the stomach of a fork-beard. This particular individual had still the hook on his mouth as an evidence of having been predated only after being caught in the line. According to this, this item was excluded from the analysis.

Fishes are the most important group in the fork-beard diet (IRI=11825.74), presenting the highest values for all the calculated indexes. They make 49.56% of total prey, they weight 81.14% of total stomach contents weight and occur in 90.48% of the sampled fork-beards The decapoda reptantia crustaceans constitute the second important group of the diet (IRI=1628.7), making about 20% of the prey and occurring in 43.48% of the sampled stomachs. Other groups like mysidacea (IRI= 193.66) and decapoda natantia (IRI= 60.94) also comprise the fork-beard diet (Table II).

Table II -Prey categories and values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W) and Index of Relative Importance (IRI) for each one.

Prey groups	N	%N	%W	%FO	IRI
Pisces	57	49.56	81.14	90.48	11825.74
Decapoda Reptantia	23	20.01	17.45	43.48	1628.76
Mysidacea	25	21.74	0.52	8.70	193.66
Decapoda Natantia	5	4.35	0.32	13.05	60.94
Other Crustacea	2	1.74	0.39	8.70	18.53
Outros	2	1.74	0.16	8.70	16.53

A total of 114 prey belonging to 21 food items were found in stomachs of fork-beard (Annex 1, Table I). The highest IRI values were obtained for two fish species (*Capros aper*, IRI= 3396.79 and *Macrorhamphosus scolopax*, IRI= 1119.92). The non-identified fishes also compose an important part of the diet (IRI=786.51). Of the 17 non-identified fishes, 9 were mere vertebrae remains, 2 were bone structures remains and the last 6 were muscular tissue. The mysidacea and some crustacean species (ex., *Galathea* sp., *Liocarcinus corrugatus* and *Homola barbata*) are also part of the stomach items found in this species. The preference categories for food items indicate the presence of two main important prey (*Capros aper* and *Macroramphosus scolopax*), one secondary (Mysidacea) and 14 occasional prey.

ALFONSINO (Beryx splendens)

A total of 294 alfonsinos were sampled, mainly in Area 1, in Azores Bank to be more precise (214 individuals), and in stratum 10 (450-500m). The individual forcal lengths varied between 18 and 39 cm.

The diet of alfonsino is mainly composed by fish and crustacean. Fishes, that occur in 88.26% of the sampled stomachs, are the most important groups (IRI=6022.86) followed by mysidacea (IRI= 583.50) that constitute 53.03% of the counted food items but occur in only 6.69% of the alfonsinos. Salps (IRI=126.15), cephalopods (IRI=85.00), amphipods (IRI=69.38) and other crustaceans are also part of alfonsino food diet (Table III).

Table III - Prey categories and values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W) and Index of Relative Importance (IRI) for each one.

Prey groups	N	%N	%W	%FO	IRI
Pisces	763	24.48	43.76	88.26	6022.86
Mysidacea	1653	53.03	34.19	6.69	583.50
Others Crustacea	177	5.68	7.54	33.44	422.08
Thaliacea	84	2.70	5.16	16.05	126.15
Others	54	1.73	3.91	16.05	90.52
Cephalopoda	91	2.92	0.61	24.08	85.00
Amphipoda	263	8.43	1.94	6.69	69.38
Decapoda Natantia	26	0.83	2.85	4.35	20.97
Decapoda Reptantia	6	0.19	0.04	0.67	0.33

A number of 3117 prey from several groups were identified in alfonsino stomachs (Annex 1, Table II). Mysidacea are the more abundant item (%N=53.01), followed by amphipods of the family Hyperidea (IRI=304.46) and salps (IRI=126.18). It should be mentioned that cephalopods are a very important item in this species diet. Although they present very low IRI value (IRI=85.06) they do occur in 24.08% of the analysed stomachs. From the 91 cephalopods identified, 43 had only the beak while the other 48 had only the eyeballs. The 21 fishes were identified through otolith identification. The non-identified fishes (742 individuals) were mainly pairs of eyeballs (376 cases), non-identifiable otoliths due to strong digestion rate (63 cases) and bone structures remains together with muscular tissue (243 cases). The different items prey categories reveal the presence of 3 secondary prey (*Lophogaster* sp., salps and Hyperidae) and 19 complementary ones. No main important prey was found.

AXILLARY SEA-BREAM (Pagellus acarne)

A total of 29 individuals with stomach contents were sampled exclusively in areas 2 and 3 mainly in stratum 2 (50-100m). The forcal length varied between 21 and 28 cm. Most individuals were females.

Fish and several groups of invertebrate constitute the more abundant prey in the stomachs analysed. The fish that occur in 89.66% of the stomachs are the more important group (IRI=9070.15) in the axillary sea-bream diet. Ophiurids (IRI=322.09) are the most abundant item in the stomachs (%N=42.66). Echinoidea, bivalvia and decapoda constitute other important groups in the diet of this species (IRI=288.62, IRI=130.44 and IRI=126.79, respectively) (Table IV).

Table IV- Prey categories and values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W) and Index of Relative Importance (IRI) for each one.

Categoria	N	%N	%W	%FO	IRI
Pisces	34	23.78	77.39	89.66	9070.15
Other	8	5.59	10.69	24.14	393.03
Ophiurida	61	42.66	4.05	6.90	322.09
Echinoidea	13	9.09	2.87	24.14	288.62
Bivalvia	7	4.90	0.51	24.14	130.44
Decapoda	11	7.69	1.50	13.79	126.79
Thaliacea	4	2.80	2.30	13.79	70.36
Oth. Crustacea	5	3.50	0.70	10.34	43.38

In the stomachs of axillary sea-bream 143 prey from different taxa were identified (Annex 1, Table III). Non identified fish are the food item with the highest IRI value (3111.93) due to the advanced digestion condition that turns identification into a complex task. *Macroramphosus scolopax* is the more important prey classified as a secondary prey (IRI=741.68) representing 37.42% of the contents total weight and occurring in 17.24% of the analysed stomachs. Similarly the ophiuridea, although relatively important (IRI=322.09) were observed in few predators (%FO=6.9). Nevertheless the high number of identified individuals (%N=42.66) makes it possible to classify it as a secondary prey. Data obtained to describe this species diet does not indicate a principal prey but describes 2 secondary prey other than 9 complementary ones.

TOPE SHARK (Galeorhinus galeus)

A total of 169 tope sharks with stomach contents were captured mainly in the second stratum (50-100m) of area 2. The captured individuals were mostly juvenile (TL<105 cm for females and TL<90 cm for males) and immature. The number of males was similar to the number of females.

During the diet analysis 5 spanish mackerels (*Scombrus japonicus*) and one bluemouth rockfish (*Helicolenus dactylopterus*) were excluded because predators captured them on the line. The tope shark diet is almost exclusively composed by fish (IRI=19744.34) (Figure 7). This group occurs in all sampled stomachs (%FO=100.00) and weights 99.45% of the total contents weight. Other groups that constitute the tope shark diet are crustaceans and cephalopods (Table V).

Table V- Prey categories and values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W) and Index of Relative Importance (IRI) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces	732	97.99	99.45	100.00	19744.34
Crustacea	11	1.47	0.53	3.47	6.94
Cephalopoda	4	0.54	0.00	2.31	1.24

In this species 744 prey from several groups were identified (Annex 1, Table IV). Of these prey 583 are non-identified fish, 467 of which are merely eyeballs, 107 are bone remains and muscular tissue and the last 12 highly digested otoliths. *Capros aper* is the principal prey occurring in 39.31% of the analysed stomachs. The mackerel (*Scomber japonicus*) is considered a secondary prey due to her significance in weight (%W=60.00). Of the 7 items considered to be complementary it should be mentioned the occurrence of cephalopods was identified by the presence of eyeballs and beaks.

CONGER EEL (Conger conger)

A total of 66 conger eels with stomach contents, captured especially in Azores and Princes Alice Banks (Area 1) and in strata 5, 6 and 7 (200-350m). The captured individuals measured between 73 and 186 cm of total length. No data on sex and maturity stage were collected.

In the diet analysis 3 individuals of *Pontinus kuhlii*, 3 bluemouth rockfishes (*Helicolenus dactylopterus*) and 2 alfonsinos (*Beryx splendens*) were excluded from the analysis because they were captured while caught in the line. The diet of this species is practically composed by fish (IRI=19212.40). This group occurs in 96.92% of the sampled predators and weights 99.56% of the total identified contents. Fish constitute 98.67% of the food items counted (Table VI).

Table VI - Prey categories found in conger eel stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%Cn	%Cp	%FO	IRI
Pisces	148	98.67	99.56	96.92	19212.40
Crustacea	1	0.67	0.03	1.54	1.08
Cephalopoda	1	0.67	0.38	1.54	1.61

In the stomachs of this species 150 prey from different groups were identified. As a result of the diet analysis 2 principal prey were found (*Capros aper* and *Macroramphosus scolopax*). Some important commercial species were identified from the stomach contents of conger eel. Although, it is very difficult to understand whether or not this fishes were caught as a result of natural behaviour. Only 3 blackspot sea-bream, 1 fork-beard and 2 silver scabbard fish were found. It should also be mentioned the presence of one crustacean and 2 cephalopods in the diet of this species (Annex 1, Table V).

SILVER SCABBARDFISH (Lepidopus caudatus)

During this cruise 70 silver scabbard fishes with stomach contents were caught. Most individuals were captured in Area 1 (n=58) and in Area 2 (n=11) although there was an individual caught in Area 4. Forcal length varied between 74 and 173 cm and most individuals were females (n=40), but males were also found.

The silver scabbard fish diet is entirely composed of fish and crustaceans, fish being the dominant group, in number (%N=90.00) and in weight (%W=99.69) (Figure 9). All the stomachs sampled had fish in their contents (%FO=100.00) (Table VII).

Table VII - Prey categories found in scabbard fish stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces	144	90.00	99.69	100.00	18969.11
Crustacea	16	10	0.31	14.49	149.40

A total of 160 prey were found in the 70 stomachs sampled. *Capros aper* was the dominant prey occurring in 55.56% of the analysed stomachs weighting 54.85% of the total weight. This prey was considered important (IRI=5130.44). Non identified fish make an important part of the diet (IRI=4411.56). This group, with 78 prey, is composed of highly digested items where eyeballs, bone remains and otoliths in bad condition are the main occurrence. Other fish species like horse mackerel (*Trachurus picturatus*) and *Macroramphosus scolopax* are also part of this predator diet. An important fact is the occurrence of cannibalism in this species identified by the presence of just one individual in the contents (n=1, *Lepidopus caudatus*). Most of the identified crustaceans (16 individuals) are decapods and amphipods with little importance in the global diet of the scabbardfish (Annex 1, Table VI).

BLACKSPOT SEA-BREAM (Pagellus bogaraveo)

The sampling accomplished on board the R/V “Arquipélago” collected 92 black spot sea-bream with stomach contents. These individuals, captured mainly in area 2 and in strata 2 and 5 (50-250m) measured between 12 and 47 cm of forcal length. Males and hermaphrodites were dominant.

The diet of the black spot sea-bream is composed of fish and invertebrates (Table VII). Although fish dominate in weight (%Pw=68.48) as in number (%Pn=42.53), salps and ophiureds constitute a considerable importance in the diet of this species (IRI=1560.29 and IRI=276.86, respectively).

Table VII- Prey categories found in black spot sea-bream stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces	74	42.53	68.48	89.86	9974.84
Thaliacea	37	21.26	18.60	39.13	1560.29
Others	21	12.07	6.74	24.64	463.59
Ophiurida	37	21.26	2.61	11.59	276.86
Crustacea	5	2.87	3.54	7.25	46.52

Of the fish found in the stomachs of black spot sea-bream, myctophids are the most important group in this diet (IRI=252.06). *Macroramphosus scolopax* (IRI=122.66), *C. aper* (IRI=6.27) and the non identified fish are the other elements of this group. Salps are the most important item in the black spot sea-bream diet occurring in 28.72% of the analysed stomachs and weight 18.61% of the total weight of stomach contents. Other important item is ophiureds (IRI=216.64) that account for 22.84% of the total prey. Salps are considered the principal prey of the black spot sea-bream diet, myctophids, *M. scolopax* and the ophiurids are considered secondary, while all the others complementary (Annex 1, Table VII).

ALFONSINO (Beryx decadactylus)

The 46 alfonsinos with stomach contents were caught mainly in areas 1 and 2, between strata 7 and 17 (300-850m). Individuals measured between 23 and 48 cm of forcal length and belong to both sexes.

In Table IX it is possible to verify that fish, crustaceans, decapods and mysids are the most important diet groups for this species. Fish, due to their great importance in weight and to the fact of occurring in 70.83% of the individuals, are the group with the highest IRI (IRI=6124.18).

Table IX- Prey categories found in alfonsino stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces	38	26.39	60.07	70.83	6124.18
Crustacea	23	15.97	18.89	31.25	1089.57
Decapoda	8	5.56	13.93	14.58	284.11
Mysidacea	53	36.81	5.62	6.25	265.14
Cephalopoda	7	4.86	1.06	12.50	74.04
Echiuirdea	15	10.42	0.43	2.08	22.60

Mysidacea are the most abundant food item found in the analysed stomachs (%N=36.81) nevertheless they occur in only 6.25% of the individuals and do not represent much in weight (%W=5.56). Cephalopods occur in 12.5% of the stomachs and their significance in weight is also low (Annex 1, Table VIII).

THORNBACK RAY (Raja clavata)

Of the 76 sampled rays that contained stomach contents, 30 were captured in area 2, 28 in area 3 and 17 in area 1. The individuals total length varied between 52 and 84 cm. More females (n=52) than males (n=24) with stomach contents were captured. The sample consisting mainly of immature individuals. Fish, decapods reptantia and a so far non-identified substance, are the main components of the thornback ray diet (Table X). Fish that occur in 77.92% of the sampled individuals weigh 80.67% of the total weigh of the stomach contents, are the most important item of this diet (IRI=9509.44).

Table X- Prey categories found in thornback ray stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces	177	53.15	80.67	77.92	9509.44
Decapoda Reptantia	90	27.03	15.19	31.17	1246.55
Non-identi. mass	0	0.00	14.61	29.87	436.46
Mysidacea	46	13.81	1.47	5.19	78.27
Decapoda Natantia	11	3.30	0.93	6.49	26.60
Crustacea	5	1.50	1.60	6.49	18.61
Others	4	1.20	0.15	5.19	6.90

The thornback food diet has two principal prey, *C. aper* and *M. scolopax* (Annex 1, Table IX). These two species occur in almost half of the analysed stomachs and together with spanish mackerel, black spot sea-bream and myctophids constitute the identified fish prey. Crustaceans decapoda reptantia, namely the species of *Liocarcinus* spp. (the only secondary prey), *Callapa granulata*, *Galathea* sp. and *Scyllarus arctus* constitute an important part of the diet of this species. On the other hand, the 46 individuals of Mysidacea found in the stomachs are considered complementary prey since they occur in only 5.19% of the analysed rays and contribute with only 1.25% of the total weight of the stomach contents.

SPECIES INTERACTIONS

Predation among demersal fishes species is rare. During the 1996 survey we found just 21 important commercial fishes in the stomach contents of all predators. Although, during the 1997 sampling, and with the accurate methods to distinguish natural feeding behaviour, we just found 12 occurrences (Table XI).

Table XI – Number of prey (column) caught by predator (line). In brackets data for 97.

	1	2	3	4	5	6	7	8	9	10	11
1	0; (0)	0; (0)	0; (0)	0; (1)	0; (0)	3, (1)	0; (0)	0; (0)	0; (0)	0; (0)	1; (0)
2	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (2)	0; (0)
3	0; (0)	0; (0)	0; (0)	0; (0)	1; (0)	1; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)
4	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)
5	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)
6	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)
7	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	0; (0)	1; (0)	0; (0)	0; (0)	0; (0)	0; (0)
8	0; (0)	0; (0)	0; (0)	1; (0)	0; (0)	3; (0)	2; (0)	0; (0)	0; (0)	0; (1)	0; (0)
9	0; (0)	2; (0)	0; (0)	0; (4)	0; (0)	4, (2)	1; (0)	0; (0)	1; (0)	0; (0)	0; (1)

Where: 1= thornback ray; 2= fork-beard; 3= alfonsino (*B. splendens*); 4= axillary sea-bream; 5= alfonsino (*B. decadactylus*); 6= black spot sea-bream; 7= silver scabbardfish; 8= conger eel; 9= tope shark; 10 = bluemouth rockfish (*Helicolenus dactylopterus*); 11= Common sea-bream (*Pagrus pagrus*)

Diet composition of all species was compared based on %N of prey groups found in stomach contents (Annex 1, Table X). Schoener's diet overlap index shows very different values, from 0.23 for diet overlap between axillary sea-bream and conger eel, to 0.90 for thornback ray and fork-beard diets (Table XII). Significant diet overlap is considered to thornback ray and fork-beard (0.90), alfonsinos (0.71), silver scabbardfish and conger eel (0.73) and for silver scabbardfish and tope shark (0.69).

Table XII - Values for Schoener overlap index.

	1	2	3	4	5	6	7	8	9
1	1.00								
2	**0.90**	1.00							
3	0.40	0.45	1.00						
4	0.30	0.32	0.25	1.00					
5	0.42	0.48	**0.71**	0.26	1.00				
6	0.28	0.26	0.30	0.53	0.28	1.00			
7	0.54	0.52	0.30	0.26	0.35	0.36	1.00		
8	0.54	0.51	0.26	0.23	0.27	0.34	**0.73**	1.00	
9	0.40	0.37	0.26	0.23	0.27	0.34	**0.69**	0.51	1.00

Where: 1= thornback ray; 2= fork-beard; 3= alfonsino (*B. splendens*); 4= axillary sea-bream; 5= alfonsino (*B. decadactylus*); 6= black spot sea-bream; 7= silver scabbardfish; 8= conger eel; 9= tope shark

The cluster analysis is shown in Figure 2. The arbitrarily chosen borderline for cluster definition was set at 40% dissimilarity and divided the dendogram in 4 groups of species. Cluster number one contained thornback ray and fork-beard and was, thus, distinguished from the second group by about 70% dissimilarity. Cluster number 2 contained tope shark, silver scabbardfish and conger eel, cluster number 3 is characterized by the two species of alfonsinos and the fourth cluster is composed by the two species of sea-breams.

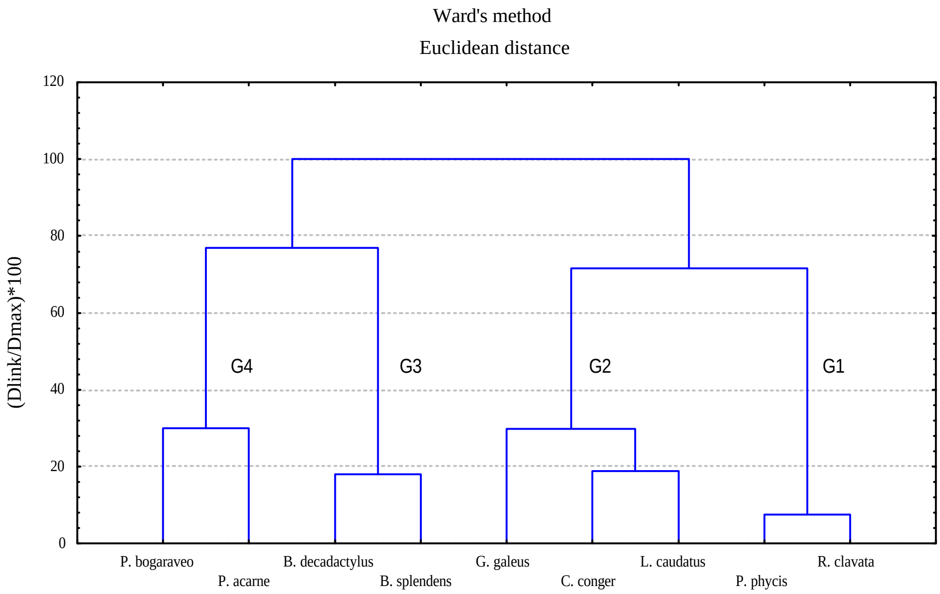

Figure 2 – Dendogram of the cluster analysis (Ward's method, Euclidean distance)

BRIEFLY DESCRIPTION OF 1997 DATA

During the 1997 stomach sampling procedures we have collected 3468 fishes but the stomachs of 86.33% were empty. We have made a great effort to decrease the taxonomic level of prey identification, mainly in what concerns to fish species. This fact is due to the importance of clarifying the intra- and inter- species predation among demersal fishes. In general we have decreased the percent of non-identified fish species for about 60% (from about 1600 to 600 individuals), which allows to have a more precise conclusions about the feeding habits of these fishes. Although, the number of fish eyeballs makes impossible to decrease more the number of non-identified fishes. The lists of food items identified during 1997 sampling are shown in Annex 2, Tables XI to XIX. We will not compare the data of each species from 1996 to 1997. This study is not yet completed.

As regard to species interactions, the same four groups were identified in both years.

DISCUSSION

The use of longline to estimate fish abundance has been discussed by several research groups. The results from the Azores surveys were promising, revealing that longlines could indeed be a possible tool for monitoring fish stock abundance, but showed also that several methodological aspects need improvement. In what concerns studies of feeding habits the use of the longline as a method to collect data must be carefully interpreted.

The longline is considered a very selective fishing method that can influence biological data. The few number of stomachs with contents found, may be due to several reasons. The fact that the longline is a passive fishing method suggest that fish fed to satiation have a low response to bait odour (LOKKEBORG *et al.*, 1995). This means that fishes with full stomachs will not eat the bait. Other reason for the few number of stomachs with contents is the evagination caused by the expansion of swim bladder. This fishing method may also influence the quality of the stomach contents as the hauling can take several hours and the contents turn completely digested and non-identifiable. This sampling method can induce errors in estimation of fullness and food consumption. Longline is also size selective (SILVA *et al.*, 1995; BJORDAL & LOKKEBORG, 1996) which explain the lack of small individuals in the sample. In conclusion, the estimation of parameters for multispecies assessment using long line gear may become a difficult task and that should be taken into account when carrying out this type of projects.

According to the results obtained in this study predation among demersal species is a rare phenomenon. Predator-prey relationships are, with no doubt, a less important factor in the multispecies assessment of Azores Demersal Fishery. Inter- and intra-species predation among commercial demersal species does not affect the estimate of the natural mortality parameter. In this particular case, fisheries research projects should emphasise the technical interactions rather than biological ones. The Group on the Biology, Ecology and Assessment of Demersal and Deep-sea Fisheries Resources is currently conducting projects in this area.

The study about species association is considered by several investigators an important part of fisheries management (MENEZES, 1996). Nevertheless, when feeding associations are approached that doesn't mean that competition among species does occur. The different species of fish may use the same resource without entering into competition for that same resource. MENEZES (1996) describes the existence of three large groups of demersal fishes in the Azores, separated mainly according to depth. The first group is constituted by species of less deep waters that reach 150 or 200 m. This group includes the fork beard (*Phycis phycis*), the moray eel (*Muraena helena*), the black tail comber (*Serranus atricauda*), the axillary sea bream (*Pagellus acarne*) and other species typical of coastal communities. The second group is constituted by species of average depth with distribution between 200 and 600 or 800 m, and includes the species more important commercially and with greater abundance: the black spot sea bream (*Pagellus bogaraveo*), the conger (*Conger conger*), the blue mouth rockfish (*Helicolenus dactylopterus*), the alfonsinos (*Beryx splendens* and *B. decadactylus*) and the silver scabbard fish (*Lepidopus caudatus*). The last group of species, from deeper waters, includes the morid cod (*Mora moro*), the velvet belly (*Etmopterus spinax*), the black spot grenadier (*Coelorhyncus coelorhyncus*), the blue ling (*Molva dipterygia macrophtalma*) and the greater fork-beard (*Phycis blennoides*).

Our work describes associations slightly distinct from the ones presented before. Several environmental and ecological factors influence the determination of groups through abundance estimates (see MENEZES, 1996). When associations are quantified according to diets specific composition we are forced to take into account morphological adaptations and the differences that these adaptations originated. In that case, it is not so strange that species like the black spot sea bream and the silver scabbardfish are not "food" associated.

The diet analysis reveals the existence of groups of species that use the same resource. The groups determined by that association are related with the use of similar habitats by species with similar behaviour and/or similar feeding morphology.

GROUP 1

The first group is composed by fork-beard, *Phycis phycis* and thornback ray, *Raja clavata*. Only one study have been published concerning the feeding biology of fork-beard with systematic identification of stomach contents and descriptions of feeding biology. Several studies can be found in literature about feeding habits of thornback ray world-wide, however, only two were made in Portuguese continental waters (MARQUES & RÉ, 1978; CUNHA *et al*., 1986). The results from these studies can therefore not be directly compared due to geographical differences.

Both species feed on a great variety of preys with preferences for fish, decapoda reptantia, mysids and several other crustaceans. This results show the high trophic position of both predators and the ability to change from the third to the fourth Lindeman's (1942 *in* GERKING, 1994) trophic levels. The most important fishes were *Capros aper* and *Macrorhamposus scolopax*, which are empirically known as benthopelagic fishes, which can be found near the bottom. The most important crustaceans reptantia was *Liocarcinus* spp., *Galathea* spp. and *Homola barbata*, which are clearly benthic. In general this results are supported by other studies as KARAGITSOU *et al*. (1986) for fork-beard, and MARQUES & RÉ (1978), AJAYI (1982), CUNHA *et al*. (1986), EBELING (1988) and ELLIS *et al.* (1996) for thornback ray. However, a major difference is found for the last species, in which all the referred authors consider fish as occasional prey. Fork-beard and thornback ray are known for displaying nocturne activity as described by COHEN *et al.* (1990), to the first and by (BIGELOW & SCHROEDER, 1953 *in* AJAYI, 1982), to the second.

This group can generally be defined as nocturne benthic predators. The clearly feeding morphological differences between species may indicate that the use of similar habitats is the major factor in this association.

GROUP 2

The second group is composed by the tope shark, *Galeorhinus galeus*, conger, *Conger conger*, silver scabbard fish, *Lepidopus caudatus*. Published literature concerning the feeding habits of the three species that compose this group is scarce. COMPAGNO, 1984 and WETHERBEE *et al.* (1990) made a general revision of tope shark feeding habits. OLASO & RODRÍGUES-MARÍN (1995) made a briefly description of the diet of conger eel while MEYER & SMALE (1991) and DEMESTRE *et al.* (1993) studied the diet composition of silver scabbard fish from South Africa and Catalan Sea, respectively.

All three species feed almost exclusively on fish prey, although they also prey on crustaceans and cephalopods. These results show the high trophic position of predators, which are ranked at the fourth trophic level of Lindeman (1942 *in* GERKING, 1994). Prey composition indicates that all predators have the ability to feed on fish near the bottom on benthic fishes (as *Synodus* sp., *Mullus* sp.) or in water column on benthopelagic (as *C. aper*, *M. scolopax*) or pelagic ones (as *Trachurus picturatus*, *Scomber japonicus*). In general these are slightly different from others found in literature for different geographical areas. In contrast with our study cephalopods seems to be more important for the diet of tope shark from the Northeast Atlantic (ELLIS *et al.* 1996), crustaceans are present in almost 50% of conger eel studied from Catalan Sea (OLASO & RODRÍGUES-MARÍN, 1995), while MEYER & SMALE (1991) and DEMESTRE *et al.* (1993) show that both crustacean and cephalopod are very abundant in the stomach contents of silver scabbardfish fish. The occurrence of cannibalism in the silver scabbardfish fish needs to be clarified.

In general this group is composed by the top predators among demersal fishes studied.

GROUP 3

The third group is composed by the two species of alfonsinos, *Beryx splendens* and *B. decadtylus*. The last species it is very poorly studied, and the only work found were the one made by ISIDRO (1996) about biology and population dynamics. However feeding habits studies were forgotten. ISIDRO (1996) also studied *B. splendends,* but the only work found about feeding habits was the one made by DUBOCHKIN & KOTLYAR (1989).

Analysis of alfonsinos stomach contents revealed that a board spectrum of food items. Both species feed on fishes, crustaceans, salps, mysids and cephalopods. The most commonly occurring fishes were mesopelagic myctophids which are know for displaying vertical migrations (WHITEHEAD *et al*., 1986), the same is described to the lophogaster mysids (KAARTVEDT, 1985; 1989) which does nocturne vertical migrations to the surface. Prey composition of alfonsinos' diet may confirm the feeding behaviour described by DUBOCHKIN & KOTLYAR (1989) and GALAKTIONOV (1984). Alfonsinos seems to display feeding vertical migrations. During the darkness they concentrate predominantly in the water column and feed on myctophids and mysids. During the day they probably stay near the bottom feeding on benthic preys. The trophic position of the alfonsinos are not clear, however they may be included in the third trophic level of Lindeman (1942 *in* GERKING, 1994).

In general this group is characterized by generalist feeders displaying vertical migrations and feeding primarily on water column preys and secondarily benthic ones.

GROUP 4

The fourth group is composed by the blackspot and axillary sea-breams. Feeding habits studies of these species it's also scarce and it's only described to the Cantabric

The analysis of the stomach contents has shown that the principal dietary components of these species are fish and different types of invertebrates as ophiurides, bivalves, salps and crustacean. Sea bream can be ranked at the third of Lindeman (1942 *in* GERKING, 1994). We have found both oceanic (salps, myctophids) and benthic (ophiurids, bivalves) prey on stomach contents, which may indicate the capability to feed near the bottom and at water column. Several authors described feeding vertical migrations for the axillary sea-bream (eg. DOMANEVSKAYA & PATOKINA, 1984) and for the black spot sea-bream (eg. DESBROSSES, 1938; URANGA, 1990). Slightly differences were found when comparing axillary sea-bream data with other studies which describe the reduce importance of fishes in the diet (OLASO & PEREDA, 1986; OLASO & RODRÍGUEZ-MARÍN, 1995).

In general this group is characterized by generalist feeders displaying vertical migrations and feeding primarily on benthic prey and secondarily on water column ones.

ACKNOWLEDGMENTS

This work is part of a more comprehensive study which is being done at the Department of Oceanography and Fisheries of the University of the Azores with support of the European Union (*Design optimization and implementation of demersal cruise survey in the Macaronesian Archipelagos II. Study contract* DG XIV/C1/95/095). Thanks are due to Drs Helena Krug, João Gonçalves, Ricardo Serrão Santos, Filipe Porteiro for help with identification of stomach contents, and to Pedro Afonso, Susana Lopes, Zé Branco, Angela Canha, Rogério Feio, Domitília Rosa and Jorge Oliveira for the extraordinary days spent at sea and at lab.

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ANNEX 1 – 1996 DATA

TABLE I

List of the food items identified in 1996 forkbeard stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	PC
Pisces						
Caproidae						
Capros aper	21	18.26	46.85	52.17	3396.79	MIP
Macrorhamphosidae						
Macrorhamphosus scolopax	14	12.17	20.03	34.78	1119.92	MIP
Callionymidae						
Synchiropus phaeton	1	0.87	1.03	4.35	8.27	OP
Serranidae						
Anthias anthias	1	0.87	1.86	4.35	11.88	OP
Apogonidae						
Apogon imberbis	1	0.87	5.23	4.35	26.54	OP
Sparidae						
Pagrus pagrus	1	0.87	0.71	4.35	6.87	OP
Myctophidae	1	0.87	0.11	4.35	4.26	OP
Pisces non-identified	17	14.78	5.32	39.13	786.51	
Crustacea						
Decapoda Natantia						
Caridea	1	0.87	0.09	4.35	4.18	OP
Natantia non-identified	4	3.48	0.23	8.70	32.28	
Decapoda Reptantia						
Brachyura						
Portunidae						
Liocarcinus corrugatus	6	5.22	3.58	8.70	76.56	OP
Homolidae						
Homola barbata	2	1.74	5.28	8.70	61.07	OP
Xanthidae						
Xantho sp.	3	2.61	0.26	4.35	12.48	OP
Majidae	1	0.87	0.23	4.35	4.79	OP
Brachyura non-identified	4	3.48	2.67	13.04	80.20	OP
Anomura						
Galatheidae						
Galathea sp.	6	5.22	1.18	13.04	83.46	OP
Munida sp.	1	0.87	4.25	4.35	22.27	OP
Mysidacea	25	21.74	0.52	8.70	193.66	SP
Crustacea non-identified	2	1.74	0.39	8.70	18.53	OP
Others						
Algae	1	0.87	0.01	4.35	3.83	OP
Rocks	1	0.87	0.15	4.35	4.44	
Total	114	100.00	100.00	247.83		

TABLE II

List of the food items identified in 1996 alfonsino (*Beryx splendens*) stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	2	0.06	1.87	0.67	1.29	OP
Berycidae						
Beryx decadactylus	1	0.03	0.00	0.33	0.01	OP
Sparidae						
Pagellus bogaraveo	1	0.03	0.00	0.33	0.01	OP
Myctophidae						
Diaphus branchycephalus	6	0.19	0.19	1.67	0.64	OP
Lampanyctus festivus	1	0.03	0.00	0.33	0.01	OP
Hygophum hygomii	1	0.03	0.00	0.33	0.01	OP
Ceratoscopelus warmingii	4	0.13	0.13	1.00	0.26	OP
Myctophum punctatum	1	0.03	0.00	0.33	0.01	OP
Nemichthydae						
Nemichthys scolopaceus	1	0.03	0.42	0.33	0.15	OP
Paralepididae	1	0.03	0.28	0.33	0.10	OP
Sciaenidae	1	0.03	0.02	0.33	0.02	OP
Muraenidae	1	0.03	0.00	0.33	0.01	OP
Pisces non-identified	742	23.80	40.85	85.95	5557.30	
Crustacea						
Decapoda Natantia						
Caridea	6	0.19	0.43	0.67	0.42	OP
Penaeidea	2	0.06	0.13	0.33	0.06	OP
Natantia non-identified	18	0.58	2.25	3.68	10.41	
Decapoda Reptantia						
Brachyura non-identified	4	0.13	0.02	0.33	0.05	OP
Reptantia non-identified	1	0.03	0.01	0.33	0.01	
Decapoda non-identified	1	0.03	0.04	0.33	0.02	
Mysidacea						
Lophogaster sp.	1653	53.01	34.19	6.69	583.26	SP
Harpacticoida	1	0.03	0.00	0.33	0.01	OP
Amphipoda						
Gamaridae	2	0.06	0.00	0.33	0.02	OP
Hyperidea	247	7.92	1.87	31.10	304.46	SP
Amphipoda non-identified	14	0.45	0.07	3.68	1.91	
Crustacea non-identified	177	5.68	7.54	32.44	428.76	
Cephalopoda	91	2.92	0.61	24.08	85.06	OP
Thaliacea						
Salpa sp.	84	2.70	5.16	16.05	126.18	SP
Gastropoda						
Dracia trispinosa	3	0.10	0.02	0.67	0.08	OP
Polychaeta	1	0.03	0.00	0.33	0.01	OP
Others						
Invertebrate	3	0.10	0.45	1.00	0.55	
Sp2	4	0.13	0.01	1.34	0.19	
Sp3	3	0.10	0.01	0.67	0.07	
Sp4	33	1.06	2.40	11.04	38.20	
Sp5	6	0.19	0.24	2.01	0.87	
Mass non-identified		0.03	0.77	0.03	0.03	
Total	3117	100.00	100.00	229.80		

Table III

List of the food items identified in 1996 axillary sea-bream stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	1	0.70	3.54	3.45	14.60	OP
Macrorhamphosidae						
Macrorhamphosus scolopax	8	5.59	37.42	17.24	741.68	SP
Myctophidae	3	2.10	10.80	3.45	44.46	OP
Pisces non-identified	22	15.38	25.64	75.86	3111.93	
Crustacea						
Decapoda						
Caridea	1	0.70	0.11	3.45	2.78	OP
Natantia non-identified	8	5.59	0.43	3.45	20.77	
Brachyura non-identified	2	1.40	0.96	6.90	16.30	OP
Isopoda	2	1.40	0.67	6.90	14.26	OP
Crustacea non-identified	3	2.10	0.03	3.45	7.33	
Bivalvia						
Parvicardium sp.	1	0.70	0.11	3.45	2.78	OP
Bivalvia non-identified	6	4.20	0.40	20.69	95.12	
Thaliacea						
Salpa sp.	4	2.80	2.30	13.79	70.36	OP
Polychaeta	2	1.40	1.37	3.45	9.53	OP
Classe Stelleroidea						
Ordem Ophiurida	61	42.66	4.05	6.90	322.09	SP
Classe Echinoidea						
Arbaciella elegans	4	2.80	2.33	13.79	70.73	OP
Echinoidea non-identified	9	6.29	0.54	10.34	70.65	
Others						
Stone	2	1.40	0.40	6.90	12.42	
Mass non-identified	4	2.80	8.92	13.79	161.59	
Total	143	100.00	100.00	217.24		

TABLE IV

Prey categories found in 1996 tope shark stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	106	14.19	10.53	39.31	971.77	MIP
Macrorhamphosidae						
Macrorhamphosus scolopax	18	2.41	1.03	8.09	27.81	OP
Sparidae						
Pagellus bogaraveo	2	0.27	4.99	1.16	6.07	OP
Pagellus sp.	2	0.27	4.89	1.16	5.96	
Synodontidae						
Synodus sp.	1	0.13	4.80	0.58	2.85	OP
Gadidae						
Phycis phycis	2	0.27	0.02	1.16	0.33	OP
Trichiuridae						
Lepidopus caudatus	1	0.13	0.02	0.58	0.09	OP
Scombridae						
Scomber japonicus	13	2.14	60.00	8.09	502.87	SP
Pisces non-identified	583	78.05	6.73	79.77	6762.15	
Crustacea						
Isopoda	5	0.67	0.46	2.31	2.61	OP
Crustacea non-identified	6	0.80	0.07	1.73	1.52	
Cephalopoda	4	0.54	0.02	2.31	1.28	OP
Total	744	100	100	146.82		

TABLE V

Prey categories found in 1996 conger eel stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	50	33.33	28.76	47.83	2969.76	MIP
Macrorhamphosidae						
Macrorhamphosus scolopax	47	31.33	11.95	23.19	1003.66	MIP
Sparidae						
Pagellus bogaraveo	3	2.00	17.95	4.35	86.78	SP
Pagellus acarne	1	0.67	2.96	1.45	5.26	OP
Callionymidae						
Synchiropus phaeton	1	0.67	1.58	1.45	3.26	OP
Gadidae						
Phycis phycis	1	0.67	0.03	1.45	1.01	OP
Trichiuridae						
Lepidopus caudatus	2	1.33	3.03	2.90	12.64	OP
Scombridae						
Scomber japonicus	1	0.67	11.36	1.45	17.44	OP
Mugilidae						
Mullus sp.	2	1.33	9.39	2.90	31.09	OP
Carangidae						
Trachurus picturatus	1	0.67	1.11	1.45	2.58	OP
Labridae	1	0.67	2.37	1.45	4.41	OP
Macrouridae	1	0.67	1.54	1.45	3.20	OP
Myctophidae	1	0.67	0.10	1.45	1.12	OP
Pisces non-identified	36	24.00	6.95	31.88	986.69	
Crustacea						
Penaeidea	1	0.67	0.03	1.45	1.02	OP
Cephalopoda						
Teuthoidea	1	0.67	0.38	1.45	1.52	OP
Total	150	100.00	100.00	127.55		

TABLE VI

List of the food items identified in 1996 scabbard fish stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	60	37.50	54.85	55.56	5130.44	MIP
Macrorhamphosidae						
Macrorhamphosus scolopax	1	0.63	0.20	1.39	1.15	OP
Trichiuridae						
Lepidopus caudatus	1	0.63	11.26	1.39	16.51	OP
Carangidae						
Trachurus picturatus	3	1.88	11.41	2.78	36.90	OP
Myctophidae	1	0.63	0.13	1.39	1.05	OP
Pisces non-identified	78	48.75	21.83	62.50	4411.56	
Classe Crustacea						
Decapoda						
Caridea	1	0.63	0.00	1.39	0.88	OP
Natantia	5	3.13	0.12	2.78	9.03	
Decapoda non-identified	1	0.63	0.01	1.39	0.89	
Crustacea non-identified	6	3.75	0.13	8.33	32.34	
Amphipoda						
Hyperidea	3	1.88	0.04	1.39	2.67	OP
Total	160	100.02	100.00	140.28		

TABLE VII

List of the food items identified in 1996 black spot sea-bream stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	1	0.62	5.27	1.06	6.27	OP
Macrorhamphosidae						
Macrorhamphosus scolopax	6	3.70	15.51	6.38	122.66	SP
Myctophidae	16	9.88	16.45	9.57	252.06	SP
Ceratoscopelus maderensis	2	1.23	2.37	2.13	7.68	OP
Lobianchia dofleini	1	0.62	0.17	1.06	0.83	OP
Pisces non-identified	48	29.63	28.70	48.94	2854.65	
Crustacea						
Penaeidea	1	0.62	0.60	1.06	1.29	OP
Crustacea non-identified	4	2.47	2.95	4.26	23.06	
Thaliacea						
Salpa sp.	37	22.84	18.61	28.72	1190.56	MIP
Gastropoda						
Dracia trispinosa	3	1.85	0.06	1.06	2.04	OP
Stelleroidea						
Ophiurida	37	22.84	2.62	8.51	216.64	SP
Bivalvia	2	1.23	0.03	2.13	2.69	OP
Classe Hidrozoa	1	0.62	0.01	1.06	0.67	OP
Others						
Invertebrates	1	0.62	1.32	1.06	2.06	
Algae	1	0.62	0.01	1.06	0.67	
Arthropoda	1	0.62	0.00	1.06	0.66	
Massa non-identified			5.31			
Total	162	100.00	100.00	119.15		

TABLE VIII

List of the food items identified in 1996 alfonsino (*Beryx decadactylus*) stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces					
Myctophidae	2	1.39	4.46	2.08	12.19
Pisces non-identified	36	25.00	54.98	68.75	5498.48
Crustacea					
Decapoda Natantia Caridae					
Pandalidae	1	0.69	1.08	2.08	3.70
Hippolytidae	1	0.69	5.80	2.08	13.52
Caridae non-identified	1	0.69	0.71	2.08	2.93
Penaeidae non-identified	1	0.69	1.22	2.08	3.99
Natantia non-identified	2	1.39	1.90	4.17	13.72
Decapoda non-identified	2	1.39	3.07	4.17	18.57
Mysidacea					
Lophogaster sp.	53	36.81	5.56	6.25	264.77
Euphasiacea	1	0.69	0.17	2.08	1.80
Amphipoda					
Gamaridae	1	0.69	0.11	2.08	1.68
Amphipoda non-identified	1	0.69	0.09	2.08	1.62
Crustacea non-identified	20	13.89	18.33	25.00	805.37
Classe Cephalopoda	7	4.86	1.05	12.50	73.90
Phylum Echuira	15	10.42	0.43	2.08	22.59
Total	146	100.00	99.01	133.33	

TABLE IX

List of the food items identified in 1996 thornback ray stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI	CP
Pisces						
Caproidae						
Capros aper	49	14.71	22.75	33.77	1264.95	MIP
Macrorhamphosidae						
Macrorhamphosus scolopax	52	15.62	16.78	41.56	1346.48	MIP
Scombridae						
Scomber japonicus	2	0.60	11.24	2.60	30.74	OP
Sparidae						
Pagellus bogaraveo	3	0.90	3.17	3.90	15.85	OP
Myctophidae	3	0.90	0.35	2.60	3.24	OP
Pisces non-identified	68	20.42	14.61	42.86	1501.11	
Crustacea						
Decapoda Natantia Penaeidea						
Solenocera menbranacea	1	0.30	0.21	1.30	0.66	OP
Penaeidea non-identified	10	3.00	0.59	5.19	18.65	
Decapoda Reptantia						
Brachyura						
Portunidae						
Liocarcinus marmoreus	12	3.60	4.02	5.19	39.61	SP
Liocarcinus corrugatus	28	8.41	1.61	2.60	26.02	“
Liocarcinus spp.	9	2.70	0.88	3.90	13.94	“
Portunidae non-identified	1	0.30	0.06	1.30	0.46	
Calappidae						
Calappa granulata	7	2.10	1.47	6.49	23.21	OP
Brachyura non-identified	23	6.91	3.81	12.99	139.20	
Anomura						
Galatheidae						
Galathea sp.	2	0.60	0.19	2.60	2.07	OP
Macrura Reptantia						
Scyllaridae						
Scyllarus arctus	4	1.20	0.20	2.60	3.64	OP
Reptantia non-identified	3	0.90	0.72	3.90	6.32	
Decapoda non-identified	1	0.30	0.00	1.30	0.39	
Mysidacea						
Lophogaster sp.	46	13.81	1.25	5.19	78.27	OP
Ordem Isopoda	2	0.60	0.11	2.60	1.86	OP
Crustacea non-identified	3	0.90	1.25	3.90	8.38	
Hirudinea	1	0.03	0.07	1.30	0.13	OP
Others						
Rock	3	0.90	0.06	3.90	3.74	
Mass non-identified			14.61			
Total	333	100.00	100.00	193.51		

TABLE X

%N for prey groups by predator.

	TR	FB	ALF1	AS	ALF2	BSS	SSF	CE	TS
Crustacea	1.50	1.74	5.68	3.50	15.97	2.87	10.00	0.63	1.47
Dec. Natantia	3.30	4.35	0.83	6.29	5.56	0.00	0.00	0.00	0.00
Dec. Reptantia	27.03	20.00	0.19	1.40	0.00	0.00	0.00	0.00	0.00
Mysidacea	13.81	21.74	53.03	0.00	36.81	0.00	0.00	0.00	0.00
Others	1.20	1.74	1.73	5.59	0.00	12.07	0.00	0.00	0.00
Pisces									
C.a. and M.s.	30.33	31.13	0.06	6.29	0.00	4.17	38.12	64.67	16.47
Myctophidae	0.90	0.88	0.42	2.11	1.43	10.73	0.63	0.67	0.00
Other fishes	21.92	18.42	24.00	15.38	24.96	27.63	51.25	33.39	81.52
Thaliacea	0.00	0.00	2.70	2.80	0.00	21.26	0.00	0.00	0.00
Amphipoda	0.00	0.00	8.43	0.00	0.00	0.00	0.00	0.00	0.00
Cephalopda	0.00	0.00	2.92	0.00	4.86	0.00	0.00	0.63	0.54
Ophiurida	0.00	0.00	0.00	42.66	0.00	21.26	0.00	0.00	0.00
Echinoidea	0.00	0.00	0.00	9.09	0.00	0.00	0.00	0.00	0.00
Bivalvia	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.00	0.00
Echuira	0.00	0.00	0.00	0.00	10.42	0.00	0.00	0.00	0.00

Where: TR= thornback ray; FB= fork-beard; ALF1= alfonsino (*B. splendens*); AS= axillary sea-bream; ALF2= alfonsino (*B. decadactylus*); BSS= blackspot sea-bream; SSF= silver scabbardfish; CE= conger eel; TS= tope shark; C.a. and M.s., is the *Capros aper* and *Macroramphosus scolopax* Group.

ANNEX 2 – 1997 data

TABLE XI

List of the food items identified in 1997 fork-beard stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Gastropoda	1	0.72	0.01	3.33	2.43
Cephalopoda					
Octopodoidea	4	2.88	0.15	6.67	20.21
Cephalopoda non-identified	1	0.72	0.05	3.33	2.56
Crustacea					
Decapoda Caridea					
Pandalidae *Pleisonika heterocarpus*	1	0.72	0.21	3.33	3.10
Pleisonika edwardsii	1	0.72	4.11	3.33	16.08
Pleisonika	1	0.72	0.57	3.33	4.30
Pandalina profunda	2	1.44	0.01	6.67	9.67
Palaemonidae *Periclimenes cf scriptus*	1	0.72	0.03	3.33	2.50
Processidae *Processa*	1	0.72	0.02	3.33	2.46
Decapoda Natantia non-identified	7	5.04	0.08	13.33	68.25
Decapoda Palinura					
Scyllaridae *Scyllarus arctus*	2	1.44	0.60	6.67	13.61
Decapoda Anomura					
Galatheidae *Galathea*	3	2.16	2.16	10.00	43.20
Decapoda Brachyura					
Homolidae *Paromola cuvieri*	4	2.88	0.16	6.67	20.28
Homola barbata	9	6.47	4.76	16.67	187.20
Portunidae *Bathynectes maravigna*	3	2.16	3.04	10.00	52.00
Liocarcinus marmoreus	3	2.16	0.23	6.67	15.94
Liocarcinus corrugatus	12	8.63	2.30	10.00	109.30
Xanthidae *Pilumnus inermis*	3	2.16	0.44	6.67	17.34
Xantho	1	0.72	0.51	3.33	4.10
Latreillidae *Latreillia elegans*	1	0.72	0.18	3.33	3.00
Brachyura non-identified	1	0.72	0.03	3.33	2.50
Pisces					
Paralepididae	1	0.72	0.52	3.33	4.13
Myctophidae *Ceratoscopelus maderensis*	6	4.32	2.24	10.00	65.60
Diaphus sp1	1	0.72	0.13	3.33	2.83
Gonichthys coccoi	2	1.44	0.35	3.33	5.96
Lampanyctus festivus	3	2.16	0.04	6.67	14.67
Myctophum punctatum	1	0.72	0.15	3.33	2.90
Lampanyctus pusillus	5	3.60	0.25	6.67	25.68
Myctophidae non-identified	1	0.72	3.18	3.33	12.99
Macrorhamphosidae *Macrorhamphosus scolopax*	28	20.14	19.12	16.67	654.46
Epigonidae *Epigonus*	1	0.72	0.01	3.33	2.43
Serranidae *Anthias anthias*	3	2.16	14.17	6.67	108.92
Caproidae *Capros aper*	6	4.32	4.96	10.00	92.80
Pomacentridae *Chromis limbata*	3	2.16	12.03	10.00	141.90
Labridae *Coris julis*	1	0.72	5.40	3.33	20.38
Nomeidae *Cubiceps gracilis*	1	0.72	0.72	3.33	4.80
Scorpaenidae *Helicolenus dactylopterus*	2	1.44	4.95	6.67	42.62
Pisces non-identified	10	7.18	11.44	23.33	434.40
Algae	2	1.44	0.67	6.67	14.07
Total	139	100	100		

TABLE XII

List of the food items identified in 1997 alfonsino (*Beryx splendens*) stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (%N), percentage by weight (%W), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Hydrozoa					
Siphonophora Calycophorae Diphydae	13	0.68	0.09	3.77	2.90
Gastropoda					
Thecosomata *Diacria trispinosa*	88	4.63	0.96	19.81	110.74
Thecosomata non-identified	4	0.21	0.01	1.89	0.42
Cephalopoda	203	10.68	2.64	55.19	735.13
Crustacea					
Ostracoda	1	0.05	0.00	0.47	0.02
Decapoda Penaeidea					
Sergestidae *Sergia robusta*	43	2.26	5.16	9.43	69.97
SERGIA	11	0.58	0.59	3.77	4.41
SERGESTES	22	1.16	2.85	8.49	34.04
Sergestidae non-identified	23	1.21	0.22	5.66	8.09
Penaeidae *Gennadas valens*	24	1.26	3.79	5.66	28.58
Penaeidea non-identified	1	0.05	0.07	0.47	0.06
Decapoda Caridea					
Oplophoridae *Acantephyra purpurea*	65	3.42	23.35	11.79	315.62
Oplophorus spinosus	7	0.37	1.21	2.36	3.73
Systellaspis debilis	28	1.47	11.19	4.72	59.76
Systellaspis pellucida	1	0.05	0.57	0.47	0.29
Systellaspis	1	0.05	0.51	0.47	0.26
Oplophoridae non-identified	2	0.11	0.72	0.47	0.39
Pandalidae *Pleisonika*	3	0.16	0.54	0.94	0.66
Parapandalus richardi	3	0.16	0.38	1.42	0.77
Caridea non-identified	18	0.95	2.35	7.55	24.92
Decapoda Natantia non-identified	16	0.84	0.85	6.60	11.15
Decapoda Reptantia					
Scyllaridae *Scyllarus arctus*	6	0.32	0.32	2.36	1.51
Homolidae *Paromola cuvieri*	29	1.53	1.76	9.43	31.02
Mysidacea					
LOPHOGASTRIDAE *LOPHOGASTER*	35	1.84	1.13	12.74	37.84
Mysidacea non-identified	18	0.95	0.20	5.19	5.97
Amphipoda					
Hyperiidea Vibiliidae *Vibilia*	83	4.37	1.10	27.83	152.23
Typhidae *Platyscelus*	2	0.11	0.01	0.94	0.11
Lycaeidae *Brachyscelus*	9	0.47	0.17	1.89	1.21
Hyperiidea non-identified	3	0.16	0.01	1.42	0.24
Gammaridea	1	0.05	0.00	0.47	0.02
Amphipoda non-identified	3	0.16	0.01	1.42	0.24
Crustacea non-identified	37	1.95	0.26	13.68	30.23
Thaliacea Salpida	158	8.31	10.21	27.83	515.41
Pisces					
Bathylagidae	1	0.05	0.38	0.47	0.20
Alepocephalidae	3	0.16	1.35	1.42	2.14
Gonostomatidae *Bonapartia pedaliota*	1	0.05	0.63	0.47	0.32
Gonostoma elongatum	1	0.05	2.95	0.47	1.41
Sternoptichidae *Argyropelecus aculeatus*	2	0.11	0.91	0.94	0.96
Maurolicus muelleri	2	0.11	0.19	0.94	0.28
Sternoptyx	1	0.05	0.09	0.47	0.07
Sternoptichidae non-identified	3	0.16	0.04	1.42	0.28
Photichthydae *Ichthyococcus ovatus*	2	0.11	0.03	0.94	0.13
Photichthydae	1	0.05	0.01	0.47	0.03
Stomiidae	1	0.05	0.37	0.47	0.20

Paralepididae		1	0.05	0.99	0.47	0.49
Myctophidae	*Benthosema suborbitale*	1	0.05	0.01	0.47	0.03
	Bolinichthys	19	1.00	0.95	5.19	10.12
	Ceratoscopelus	90	4.73	3.60	26.89	223.99
	Diaphus sp1	7	0.37	0.46	2.36	1.96
	Diaphus sp2	1	0.05	0.01	0.47	0.03
	Diaphus	2	0.11	0.03	0.94	0.13
	Electrona risso	4	0.21	0.06	1.89	0.51
	Gonichthys coccoi	3	0.16	0.55	0.94	0.67
	Hygophum hygomii	10	0.53	0.35	2.36	2.08
	Hygophum reinhardtii	18	0.95	1.78	6.60	18.02
	Lampanyctus ater	7	0.37	1.51	2.83	5.32
	Lampanyctus festivus	6	0.32	0.22	1.89	1.02
	Lampanyctus pusillus	23	1.21	0.44	7.08	11.68
	Lampanyctus	1	0.05	0.01	0.47	0.03
	Lobianchia	24	1.26	0.72	7.55	14.95
	Notoscopelus bolini	1	0.05	0.01	0.47	0.03
	Notoscopelus	7	0.37	0.25	2.83	1.75
	Protomyctophum	8	0.42	0.11	3.30	1.75
	Symbolophorus	1	0.05	0.01	0.47	0.03
Myctophidae non-identified		63	3.31	2.11	21.23	115.07
Phycidae		1	0.05	0.01	0.47	0.03
Gadidae		1	0.04	0.01	0.47	0.02
Merluccidae		7	0.37	0.19	3.80	2.13
Melamphaidae		12	0.63	1.99	4.25	11.14
Diretmidae *Diretmus argenteus*		10	0.53	0.49	3.77	3.85
Macrorhamphosidae *Macrorhamphosus scolopax*		1	0.05	0.01	0.47	0.03
Epigonidae *Epigonus*		9	0.47	0.54	3.77	3.81
Pisces non-identified		581	30.56	2.38	64.15	2113.10
Scaphopoda		1	0.05	0.01	0.47	0.03
Green algae		1	0.05	0.01	0.47	0.03
Mass non-identified		1	0.05	0.01	0.47	0.03
	Total	1901	100	100		

TABLE XIII

List of the food items identified in 1997 axillary sea-bream stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Pisces					
Caproidae *Capros aper*	3	13.64	72.11	22.22	1905.37
Pisces non-identified	1	4.55	0.27	11.11	53.55
Thaliacea Salpida	8	36.36	19.67	44.44	2489.97
Polichaeta	2	9.09	0.80	22.22	219.76
Sipuncula	2	9.09	4.28	11.11	148.54
Mass non-identified	2	9.09	0.94	11.11	111.43
Brachyura	1	4.55	0.67	11.11	57.99
Echinoidea	1	4.55	0.54	11.11	56.55
Bivalvia	1	4.55	0.40	11.11	54.99
Anthozoa	1	4.55	0.33	11.11	54.22
Total	22	100.00	100.00		

TABLE XIV

Prey categories found in 1997 tope shark stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Cephalopoda					
Octopodoidea	1	2.63	0.79	5.26	17.99
Crustacea					
Isopoda	1	2.63	0.14	5.26	14.57
Pisces					
Macrouridae	1	2.63	0.00	5.26	13.83
Sternoptichidae	1	2.63	0.59	5.26	16.94
Macrorhamphosidae *Macrorhamphosus scolopax*	1	2.63	0.85	5.26	18.30
Sparidae *Pagellus bogaraveo*	2	5.26	7.83	10.53	137.84
Pagellus acarne	4	10.53	18.41	15.79	456.96
Pagrus pagrus	1	2.63	0.38	5.26	15.83
Sparidae non-identified	1	2.63	1.54	5.26	21.93
Caproidae *Capros aper*	6	15.79	2.69	15.79	291.80
Carangidae *Trachurus picturatus*	4	10.53	24.18	21.05	730.65
Scombridae *Scomber japonicus*	2	5.26	31.94	5.26	195.67
Pisces non-identified	13	34.21	10.66	57.89	2597.52
Total	38	100	100		

TABLE XV

Prey categories found in 1997 conger eel stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Crustacea					
Isopoda	1	1.61	1.02	3.23	8,49
Anomura					
Paguridae	1	1.61	2.58	3.23	13,53
Brachyura					
Portunidae *Liocarcinus tuberculatus*	1	1.61	1.37	3.23	9,63
Pisces					
Myctophidae *Ceratoscopelus maderensis*	1	1.61	0.20	3.23	5,85
Macrorhamphosidae *Macrorhamphosus scolopax*	6	9.68	1.12	6.45	69,66
Caproidae *Capros aper*	42	67.74	66.05	58.06	7767,85
Carangidae *Trachurus picturatus*	4	6.45	10.05	9.68	159,72
Moridae *Gadella maraldi*	1	1.61	9.15	3.23	34,75
Scorpaenidae *Helicolenus dactylopterus*	1	1.61	2.33	3.23	12,73
Pisces non-identified	3	4.84	6.08	9.68	105,71
Mass non-identified	1	1.61	0.06	3.23	5,39
Total	62	100	100		

TABLE XVI

List of the food items identified in 1997 scabbard fish stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Cephalopoda	1	2.13	0.01	4.17	8.92
Crustacea Decapoda Caridea non-identified	1	2.13	0.16	4.17	9.55
Pisces					
Myctophidae *Ceratoscopelus maderensis*	1	2.13	1.42	4.17	14.80
Hygophum reinhardtii	1	2.13	1.04	4.17	13.22
Myctophum	2	4.26	2.21	4.17	26.98
Myctophidae non-identified	1	2.13	0.08	4.17	9.22
Macrorhamphosidae *Macrorhamphosus scolopax*	2	4.26	5.20	8.33	78.80
Carangidae *Trachurus picturatus*	4	8.51	4.87	16.67	223.04
Caproidae *Capros aper*	26	55.32	63.52	54.17	6437.56
Nomeidae *Cubiceps gracilis*	4	8.51	9.26	4.17	74.10
Pisces non-identified	4	8.51	12.24	8.33	172.85
Total	47	100	100		

TABLE XVII

List of the food items identified in 1996 black spot sea-bream stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Siphonophora Diphydae	2	3.70	0.20	8.00	31.20
Gastropoda					
Thecosomata *Diacria trispinosa*	8	14.81	0.80	24.00	374.64
Cephalopoda					
Decapoda	1	1.85	4.34	4.00	24.76
Cephalopoda non-identified	1	1.85	7.88	4.00	
Crustacea					0.00
Amphipoda Hyperidea	1	1.85	0.21	4.00	8.24
Thaliacea Salpida	25	46.30	20.10	56.00	3718.40
Pisces					
Sternoptichidae non-identified	2	3.70	8.41	8.00	96.88
Myctophidae *Ceratoscopelus*	3	5.56	8.45	8.00	112.08
Moridae *Gadella maraldi*	1	1.85	1.34	4.00	12.76
Macrorhamphosidae *Macrorhamphosus scolopax*	1	1.85	2.20	4.00	16.20
Pisces non-identified	2	3.70	0.27	8.00	31.76
Esponja	1	1.85	2.34	4.00	16.76
Bryozoa	1	1.85	0.10	4.00	7.80
Invertebrate non-identified	1	1.85	2.40	4.00	17.00
Mass non-identified	4	7.41	40.96	16.00	773.92
Total	54	100	100		

TABLE XVIII

List of the food items identified in 1997 alfonsino (*Beryx decadactylus*) stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Cephalopoda	3	1.18	0.05	13.63	16,76
Crustacea					
Decapoda Penaeidea					
Sergestidae *Sergia robusta*	77	30.31	10.61	31.82	1302,07
Sergia	3	1.18	0.17	9.09	12,27
Sergestes	6	2.36	0.44	13.63	38,16
Penaeidae *Gennadas valens*	19	7.48	3.13	18.18	192,89
Decapoda Caridea					
Oplophoridae *Acantephyra purpurea*	70	27.56	75.58	36.36	3750,17
Systellaspis	1	0.39	0.35	4.54	3,36
Pandalidae *Parapandalus narval*	1	0.39	0.35	4.54	3,36
Pandalidae non-identified	1	0.39	0.19	4.54	2,63
Decapoda Natantia non-identified	3	1.18	0.39	13.63	21,40
Mysidacea					
LOPHOGASTRIDAE *LOPHOGASTER*	1	0.39	0.07	4.54	2,09
Mysidacea non-identified	5	1.97	0.12	9.09	19,00
Crustacea non-identified	1	0.39	0.13	4.54	2,36
Pisces					
Notosudidade *Scopelosaurus*	1	0.39	1.27	4.54	7,54
Macrouridae *Odontomacrurus murrayi*	15	5.91	0.98	9.09	62,63
Macrouridae non-identified	6	2.36	0.20	9.09	23,27
Moridae	3	1.18	0.10	13.64	17,46
Myctophidae *Ceratoscopelus*	1	0.39	0.21	4.54	2,72
Hygophum reinhardtii	1	0.39	0.03	4.54	1,91
Lampanyctus ater	8	3.15	0.68	18.18	69,63
Lampanyctus festivus	2	0.79	1.77	4.54	11,62
Lampanyctus pusillus	4	1.57	1.49	9.09	27,82
Myctophidae non-identified	6	2.36	0.82	18.18	57,81
Trachichthydae *Hoplostethus*	3	1.18	0.10	4.54	5,81
Melamphaidae	2	0.79	0.07	9.09	7,82
Epigonidae *Epigonus*	1	0.39	0.02	4.54	1,86
Caproidae *Capros aper*	1	0.39	0.01	4.54	1,82
Pisces non-identified	8	3.15	0.32	22.72	78,84
Mass non-identified	1	0.39	0.31	4.54	3,18
Total	254	100	100	313.53	

TABLE XIX

List of the food items identified in 1997 thornback ray stomachs as well as the respective values of frequency of occurrence (FO%), percentage by number (N%), percentage by weight (W%), Index of Relative Importance (IRI) and Preference Categories (PC) for each one.

Prey	N	%N	%W	%FO	IRI
Polichaeta	23	7.23	0.36	19.35	146.87
Bivalvia					
Pectinidae *Chlamys*	1	0.31	0.00	1.61	0.50
Cephalopoda					
Octopodoidea *Scaergus unicirrus*	5	1.57	2.12	4.84	17.86
Octopodoidea	1	0.31	0.01	1.61	0.52
Cephalopoda non-identified	1	0.31	0.00	1.61	0.50
Crustacea					
Stomatopoda	1	0.31	0.07	1.61	0.61
Decapoda Penaeidea					
Solenocera	1	0.31	0.25	1.61	0.90
Decapoda Caridea					
Pandalidae	2	0.63	0.17	1.61	1.29
Processidae *Processa intermedia*	1	0.31	0.02	1.61	0.53
Processidae *Processa*	1	0.31	0.01	1.61	0.52
Caridea non-identified	1	0.31	0.00	1.61	0.50
Decapoda Natantia non-identified	2	0.63	0.00	3.23	2.03
Decapoda Anomura					
Diogenidae	10	3.14	4.51	16.13	123.39
Paguridea	1	0.31	0.59	1.61	1.45
Decapoda Palinura					
Scyllaridae *Scyllarus arctus*	24	8.16	0.64	17.74	156.11
Decapoda Brachyura					
Homolidae *Paromola cuvieri*	4	1.26	0.12	6.45	8.90
Calappidae *Calappa granulata*	6	1.89	1.28	8.06	25.55
Parthenopidae *Parthenope*	19	5.97	1.55	1.61	12.11
Portunidae *Liocarcinus marmoreus*	41	12.89	8.27	12.90	272.96
Liocarcinus corrugatus	15	4.72	3.44	11.29	92.13
Brachyura non-identified	6	1.89	0.15	9.68	19.75
Isopoda					
Flabellifera	5	1.57	0.12	4.84	8.18
Amphipoda					
Vibiliidae *Vibilia*	1	0.31	0.01	1.61	0.52
Mysidacea non-identified	1	0.31	0.00	1.61	0.50
Pisces					
Myctophidae non-identified	1	0.31	0.01	1.61	0.52
Macrorhamphosidae *Macrorhamphosus scolopax*	66	20.75	18.93	53.23	2112.17
Caproidae *Capros aper*	48	15.09	30.89	37.10	1705.86
Pomacentridae *Chromis limbata*	1	0.31	0.41	1.61	1.16
Mullidae *Mullus surmulentus*	1	0.31	8.34	1.61	13.93
Sparidae *Pagellus bogaraveo*	1	0.31	3.67	1.61	6.41
Sparidae *Pagellus*	1	0.31	1.73	1.61	3.28
Sparidae non-identified	2	0.63	3.03	1.61	5.89
Moridae *Gadella maraldi*	1	0.31	0.10	1.61	0.66
Scombridae *Scomber japonicus*	1	0.31	0.31	1.61	1.00
Carangidae *Trachurus picturatus*	6	1.89	5.89	8.06	62.71
Pisces non-identified	14	4.40	2.91	14.52	106.14
Algae	2	0.63	0.08	3.23	2.29
Total	318	100.00	100.00		