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Community structure of the juvenile of coastal pelagic fish species in the Canary Islands waters*

TERESA MORENO and JOSÉ J. CASTRO

Departamento de Biología, Universidad de Las Palmas de Gran Canaria,
Apdo. 550., Las Palmas de Gran Canaria, Canary Islands, Spain.

SUMMARY: The coastal pelagic fish community structure during the juvenile stages was analysed with the objective of understanding the segregation of fish species for better exploitation of habitat resources (food and vital space). Fish segregate in spatial and temporal dimensions, food being the principal factor that regulates the community structure. Fish species were classified under three trophic categories: the first one, composed by the most frequently caught species, included strict zooplanktivorous species, at least during their coastal stage (*Atherina presbyter*, *Sardina pilchardus* and *Boops boops*); the second one was composed by species (*Scomber japonicus*, *Sardinella aurita* and *Oblada melanura*) less frequent in catches and whith mixed diets of fish and zooplankton. Specimens of *A. presbyter* and juveniles of *S. pilchardus* were found in the stomach contents of fish of the second category. The third one was composed of another species (*Trachynotus ovatus)* which was relatively highly abundant in catches and shaved a more specific diet based on insects and in which zooplankton played a less important role. There was a simultaneous development in space and time of juveniles of *Atherina presbyter*, *Sardina pilchardus* and *Boops boops*. Juveniles of *Scomber japonicus* were only detected seasonally coinciding with the presence of early juveniles of the later species.

Key words: Community structure, Pelagic species, Juveniles, Resource partitioning, Coastal area, Canary Islands.

RESUMEN: ESTUDIO DE LA COMUNIDAD DE JUVENILES DE ESPECIES PELÁGICO COSTEROS EN AGUAS DE LAS ISLAS CANARIAS. – La estructura de la comunidad costera de peces pelágicos durante la fase juvenil fue analizada con el objetivo de comprender la segregación de las especies para una mejor explotación de los recursos del hábitat (alimento y espacio vital). Los peces se segregan según dimensiones espaciales y temporales, siendo el alimento el principal factor que regula la estructura de la comunidad. Las especies de peces fueron clasificadas en dos categorías tróficas: la primera, compuesta por las especies más frecuentes en las capturas, incluye los zooplanctívoros estrictos, al menos durante la fase costera (*Atherina presbyter*, *Sardina pilchardus* y *Boops boops*); la segunda categoría se compone de especies menos frecuentes en las capturas y con dietas mixtas (*Scomber japonicus*, *Sardinella aurita* y *Oblada melanura*). Especímenes de *A. presbyter* y juveniles de *S. pilchardus* se encontraron formando parte de los contenidos estomacales de las especies agrupadas en la segunda categoría. Otras especies relativamente abundantes en las capturas presentan dietas más específicas, en las cuales el zooplancton juega un papel menos importante. Éste es el caso de *Trachinotus ovatus*, que preda sobre insectos. Hubo un desarrollo simultáneo en el espacio y en el tiempo de los juveniles de *Atherina presbyter*, *Sardina pilchardus* y *Boops boops*. Los juveniles de *Scomber japonicus* únicamente se detectaron estacionalmente, coincidiendo con la presencia de los juveniles tempranos de las especies anteriores.

Palabras clave: Estructura de la comunidad, Peces pelágicos, Juveniles, Reparto de recursos, Área costera, Islas Canarias.

INTRODUCTION

Pelagic and demersal species which temporally forage and migrate to coastal areas (Muus, 1967; Pihl, 1982), juvenile fish which utilize sheltered and shallow habitats of high localized productivity as nurseries (Zijlstra, 1972; Mann, 1982), and resident species are components of many littoral fish assemblages in the marine coastal zone (Pihl *et al.*, 1994). Juvenile fish of many species move inshore

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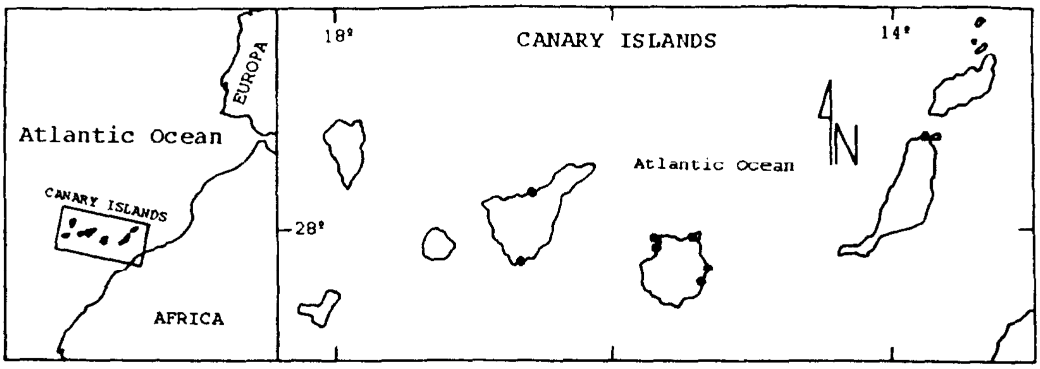

FIG. 1. – Sampling locations.

seasonally, living in this fluctuating coastal environment and experience a transition from these nursery areas to a much more homogenous and stable habitat where adults continue growing (BAS and MORENO, 1993). Furthermore, there are not many studies on either interaction and competition between juvenile stages of fish species, despite being key factors for evaluating parameters such as natural mortality and recruitment.

Fish community structure is characterized by a resource partitioning, which is how different species make use of available resources (TOFT, 1985). Differences may be due to many factors, one of them being competition for food and space. Species may segregate along general resource dimensions that are usually measured by spatial, temporal and trophic axes. Fish assemblages in marine systems seem to be mainly separated more on a trophic basis than a habitat one. Food is a principal factor regulating growth, abundance and migration in pelagic fish (ROSS, 1986; JAMES, 1988). Trophic dimension includes ontogenetic shifts in feeding, that occur for many fish species (ROSS, 1978; LIVINGSTON, 1982; WERNER and GILLIAM, 1984; MITTELBACH *et al.*, 1988; WERNER and HALL, 1988; UIBLEIN, 1991; CASTRO, 1993; LIRMAN, 1994; MOOKERJI and RAMAKRISHJNA RAO, 1994), as well as diet overlap that show how species differ when resources might be limited (SCHOENER, 1968). Many fish assemblages, especially coastal ones, are temporally structured using a given habitat for only part of the year or period of their life cycle (ROSS, 1986).

The purpose of the present study is to analyse the coastal pelagic fish community structure during the juvenile stage around the Archipelago. It is important to bear in mind that coastal waters around the Canary Islands are considered to extend from the surf zone to no more than 20 m deep, being almost one-two miles wide, due to the narrow and sloping shelves of these oceanic islands.

MATERIAL AND METHODS

Juvenile of different coastal pelagic fish species were sampled from commercial catches taken from the coastal fishing grounds around Gran Canaria, Tenerife and Fuerteventura islands (Fig. 1) between April 1990 and April 1991. Samples were obtained with beach-seine nets on rocky and rocky-sandy bottoms in shored areas between 5 and 20 m of depth. It is important to note that data used for the analysis of community structure of juvenile coastal pelagic fish in the Canary Islands came from commercial catches directed to the exploitation of *Atherina presbyter*, and therefore, the obtained results should be treated with caution for the possible bias. Juvenile stages for each species were defined as those in which individuals were immature. In this paper adults of *A. presbyter* and *Engraulis encrasicholus* were included in the analysis of data due to the small range of size of both species.

Total body length (TL), wet mass, sex and maturity stage were recorded from samples selected randomly from the total catch. Stomach contents were preserved in 70% ethanol. Diet composition of all species in catches was analysed. All food items from stomachs were placed on filter paper to remove excess moisture and weighed. The stomach fullness (SF) index was calculated as:

$$SF = [(\text{Mean wet mass of gut contents})/(\text{Wet mass of fish})] \times 100$$

Values of SF less than 1 were considered as empty stomachs.

Prey items were identified to the lowest possible taxonomic level. Total number of prey items were counted and wet masses were determined for each prey category. Percentage composition by number and weight was calculated for each stomach examined.

For the most abundant species in catches, indices of importance by number (IN) and by wet mass (IW) were calculated as follows:

$$IN = [(\% \text{ composition by number}) \times (\% \text{ occurrence})]^{1/2}$$
(WINDELL, 1971; VESIN *et al.*, 1981).

$$IW = [(\% \text{ wet mass}) \times (\% \text{ occurrence})]^{1/2}$$
(CASTRO, 1993).

where, percentage composition by number and percentage wet mass were the mean of percentages of composition by number and weight, respectively, for each prey category in all stomach contents of a given species. Percentage occurrence is the frequency of occurrence of a prey item in the whole stomach examined for each species. Both indices were converted to a scale of 100 units.

In diet analysis, numerical and gravimetrical methods magnified numerous small-sized prey or rare heavy prey respectively (HYSLOP, 1980; BOWEN, 1985). For that reason, an index of global importance (IG) was calculated for each prey category. This index was expressed as the mean value of the indices of importance by number and by weight, as follows:

$$IG = (IN + IW)/2$$

The Morisita's diet overlapping index (MORISITA, 1959; HORN, 1966; KREBS, 1989) was calculated for each season to define trophic groups. Species with high values of overlapping (up to 80%) were included in the same trophic group.

A frequential analysis of the species composition of the catches was carried out. This method supplied complementary information and it showed a simple way to evaluate interspecific competence in the occupation of the coastal area at different time periods of the year.

Statistical analysis was based on a 21 x 13 matrix. Rows were composed of catches, and species were in columns. Terms were codified as 0 (absence in catch) and 1 (presence in catch). With the object of measuring similarities in species composition of catches, Euclidean distances were calculated between each pair of species (CSS: Statistica, 1991). A multidimensional scale analysis was carried out (FIELD *et al.*, 1982; DAVISON, 1983; CUACHES, 1991) and a graphical representation was plotted in three dimensions. The interpretation of the graphs is basically that the nearer two points are, the more similar is the temporal use of the coastal area in both species. From the tridimensional representation, a new grouping of species was established based on their frequence of occurrence in catches as it was mentioned earlier. Finally, these groups were compared with those obtained from diet overlapping indices.

RESULTS

Species composition

Thirteen fish species in the juvenile stages (except *Atherina presbyter* and *Engraulis encrasicholus* that were composed of juveniles and adults specimens) were caught during the studying period (Table 1). Some of these species live permanently in the coastal area (*A. presbyter*, *Boops boops* and *Trachinotus ovatus*) (BAS and MORENO, 1993) and other migrate seasonally from the coast to offshore (*E. encrasicholus*, *Sardina pilchardus*, *Sardinella maderensis* and *Scomber japonicus*).

Relative abundance of juvenile fish

The dominant species in catches by number and weight were, in order of importance, *Atherina presbyter*, *Sardina pilchardus* and *Boops boops* (Table 1). Other species were occasional in catches (*Scomber japonicus*, *Sardinella aurita*, *Oblada melanura* and *Trachinotus ovatus*), and some other were only present in small quantities.

Length-frequency distributions

Length-frequency distributions of the most abundant species in catches (Fig. 2 and Table 2) showed a simultaneous development in space and time of juveniles of *Atherina presbyter*, *Sardina pilchardus* and *Boops boops*. Juveniles of *Scomber japonicus* were only detected in spring, coinciding with the presence of early juvenile stages of other fish species, especially *S. pilchardus*.

Length-frequency distributions of *Atherina presbyter* contained a complete length rank from 20 mm and 110 mm of TL. *Sardina pilchardus* ranged between 30 and 160 mm of TL, *Boops boops* 40-180 mm and *Scomber japonicus* 70-150 mm.

TABLE 1. – Species composition as percentages of total number and weight.

Family	Species	%N	%W
Clupeidae	*Sardina pilchardus*	39.93	29.89
	Sardinella aurita	3.08	0.34
Engraulidae	*Engraulis encrasicholus*	0.03	0.03
Belonidae	*Belone belone*	< 0.01	< 0.01
Carangidae	*Trachurus trachurus*	< 0.01	< 0.01
	Trachynotus ovatus	0.14	0.01
Sparidae	*Boops boops*	11.22	5.27
	Oblada melanura	0.17	0.05
	Sarpa salpa	< 0.01	< 0.01
Scombridae	*Scomber japonicus*	0.43	0.08
Sphyraenidae	*Sphyraena* sp.	< 0.01	< 0.01
Mugilidae	*Liza* sp.	< 0.01	< 0.01
Atherinidae	*Atherina presbyter*	45.03	64.27
Total species		13	
Total numbers		375399	
Total weight (g)		421640	
Number of samples		20	

TABLE 2. – Number of individuals by month and species used in length-frequency distributions (Fig. 2).

Year		*Atherina presbyter*	*Scomber japonicus*	*Sardina pilchardus*	*Boops boops*
1990	April	6	50	33	-
	May	34	-	17	11
	June	91	-	-	-
	July	1060	-	-	-
	August	636	-	18	51
	September	135	-	40	12
	October	195	-	51	-
	November	55	-	52	-
1991	January	85	-	54	-
	February	47	-	-	-
	March	144	60	161	106
	April	48	-	14	55
Total		2536	110	440	235

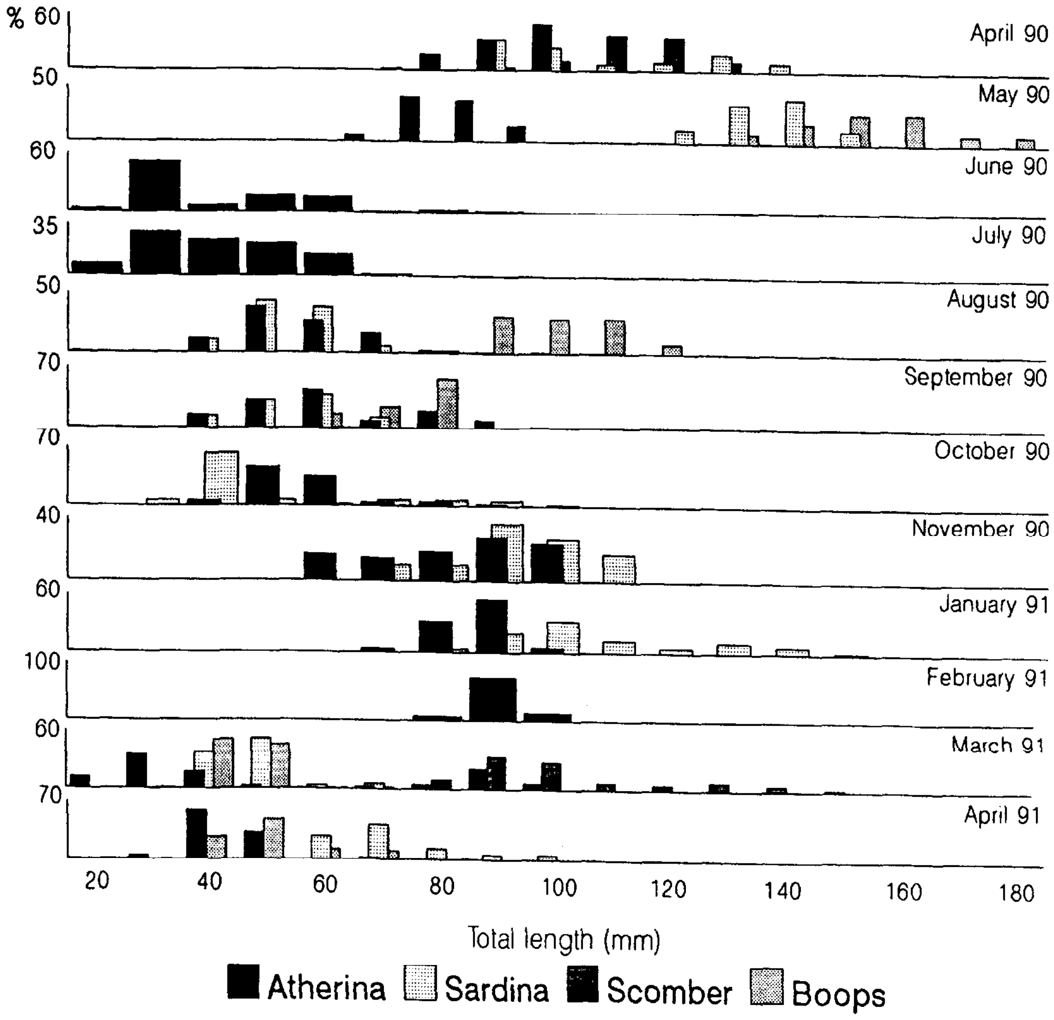

FIG. 2. – Length frequency distributions.

Stomach contents

A total number of 502 stomach contents were analysed from 13 fish species (204 of *Atherina presbyter*, 94 of *Sardina pilchardus*, 60 of *Boops boops*, 40 of *Sardinella aurita*, 39 of *Scomber japonicus*, 21 of *Engraulis encrasicholus*, 14 of *Trachurus* sp., 10 of *Trachinotus ovatus*, 9 of *Oblada melanura*, 8 of *Sarpa salpa*, 1 of *Sphyraena* sp., 1 of *Belone belone* and 1 of *Liza* sp.).

The percentage of empty stomachs was 100% for *Sarpa salpa*, *Belone belone* and *Liza* sp., 30% for *Trachynotus ovatus*, 24% for *Atherina presbyter*, 21% for *Scomber japonicus* and *Trachurus* sp., 19% for *Engraulis encrasicholus*, 9% for *Sardina pilchardus* and 0% for *Boops boops*, *Sardinella aurita*, *Oblada melanura* and *Sphyraena* sp..

The values of indices of importance by number, by weight and by global importance (Tables 3a, 3b and 3c) for each prey category permitted the classification of the dominant species in catches into three feeding groups: the first one included zooplanktivorous species, at least during coastal stages (*Atherina presbyter*, *Sardina pilchardus* and *Boops boops*) (Table 3a); the second one was composed of mixed diet species consuming zooplankton and fish (*Scomber japonicus*, *Sardinella aurita* and *Oblada melanura*) (Table 3b); and, the third trophic group was composed of only one species (*Trachynotus ovatus*) that showed a more specific diet, based on insects, in which zooplankton played a less important role (Table 3c). Juveniles of *A. presbyter* and *S. pilchardus* were usually hunted by the species of the second trophic group.

TABLE 3a. – Index of importance (%) of prey items by number (IN), wet mass (IW) and global (IG). Zooplanktivorous species.

	Atherina	*presbyter*		*Sardina*	*pilchardus*		*Boops*	*boops*	
Taxon	IN	IW	IG	IN	IW	IG	IN	IW	IG
Foraminifers	11.4	7.9	9.7	1.8	0.8	1.3	-	-	-
Polychaetes	0.5	0.6	0.6	-	-	-	0.7	0.5	0.6
Ostracods	3.5	4.1	3.8	1.5	1.6	1.6	2.8	2.8	2.8
Copepods	71.4	70.4	70.9	68.3	62.0	65.2	57.6	55.6	56.6
Amphipods	0.1	0.3	0.2	0.6	0.3	0.5	1.2	0.9	1.1
Isopods	0.7	0.8	0.8	0.5	1.4	1.0	0.1	0.7	0.4
Mysids	0.2	0.3	0.3	0.1	0.7	0.4	2.3	5.1	3.7
Euphausiids	0.1	0.5	0.3	0.5	1.6	1.1	0.1	0.9	0.5
Decapods	0.9	5.1	3.0	3.5	9.5	6.5	0.3	0.9	0.6
Molluscs	6.2	5.5	5.9	4.8	4.4	4.6	2.0	1.2	1.6
Appendicularians	1.0	0.6	0.8	14.3	10.1	12.2	22.5	16.3	19.4
Eggs	3.9	4.0	4.0	4.3	7.7	6.0	10.5	15.2	12.9

TABLE 3b. – Index of importance (%) of prey items by number (IN), wet mass (IW) and global (IG). Zooplanktivorous and piscivorous species.

	Sardinella	*aurita*		*Scomber*	*japonicus*		*Oblada*	*melanura*	
Taxon	IN	IW	IG	IN	IW	IG	IN	IW	IG
Ostracods	2.2	2.2	2.2	-	-	-	-	-	-
Copepods	48.5	44.3	46.4	60.6	13.1	36.9	49.4	38.9	44.2
Amphipods	-	-	-	1.0	0.1	0.6	11.0	10.1	10.6
Isopods	-	-	-	4.3	6.7	5.5	-	-	-
Mysids	-	-	-	9.6	43.0	26.3	15.5	14.3	14.9
Decapods	0.6	3.3	2.0	6.7	15.8	11.3	16.7	27.9	22.3
Molluscs	4.0	3.1	3.6	-	-	-	-	-	-
Appendicularians	35.1	28.0	31.6	9.4	1.6	5.5	4.0	2.2	3.1
Fish	0.2	1.5	0.9	6.1	10.4	8.3	3.4	6.7	5.1
Eggs	9.2	17.5	13.4	2.3	9.3	5.8	-	-	-

TABLE 3c. – Index of importance (%) of prey items by average number (IN), average wet mass (IW) and global importance (IG). Insectivorous species.

	Trachinotus ovatus		
Taxon	IN	IW	IG
Ostracods	0.9	0,3	0,6
Copepods	22,8	17,8	20,3
Decapods	4,6	5,5	5,1
Molluscs	38,4	41,6	40,0
Eggs	19,5	13,1	16,3
Insects	13,8	21,6	17,7

Diet overlapping

Based on diet overlapping values, different trophic groups were distinguished by year seasons (Table 4).

There were three trophic groups during the spring, one of which was composed of *Atherina presbyter*, *Sardina pilchardus*, *Sardinella aurita* and *Boops boops*. All of these species were mainly zooplanktophagous, however *S. aurita* showed slightly higher trophic plasticity, with a mixed diet of zooplankton-fish (99:1). The other two trophic groups were composed of one species each, *Scomber japonicus* and *Trachynotus ovatus*, respectively. Furthermore, *S. japonicus* showed a potential overlapping with the first trophic group due to the high proportion of zooplankton in its diet (90%). *T. ovatus* showed no diet overlap with the other species, due to the fact that it shows a totally different diet composition.

In the summer, autumn and winter, only two trophic groups were detected, mainly due to a change of diet suffered by *Trachinotus ovatus* that preyed exclusively on zooplankton. Therefore, one trophic group was composed of *Atherina presbyter*, *Sardina pilchardus* and *Boops boops* during the summer time, and together with *T. ovatus* in autumn, and *Oblada melanura* in winter. The second trophic group was composed of mixed-diet species and it was integrated only with *O. melanura* during the summer and autumn, and *Scomber japonicus* in winter.

Temporary use of the coastal area

From graphical representation of multiscale analysis a new grouping of species was established based on the relative Euclidean distance between them (Fig. 3). Distances between points were highly correlated with original distances between species (stress value = 0.064).

Three groups were considered from the point of view of the longitude of the time period spent in the coastal area: resident, temporary and transitory species (Table 5). Resident species were those with prolonged presence in the coastal zone. Temporary species had a brief use of the area and transitory species showed an anecdotal presence. In accordance with table 1, this last group was also subdivided into casual species, that were infrequent in samples, though relatively abundant when caught, and into rare species, those seldom in catches.

TABLE 4. – Morisita's index of diet overlapping. Data from 1991 are marked with a (*).

		A. presbyter	S. pilchardus	B. boops	S. aurita	S. japonicus	T. ovatus
Spring	*Atherina presbyter*		$0.94^{(*)}$	$0.96^{(*)}$	$0.74^{(*)}$	$0.66^{(*)}$	$0.05^{(*)}$
	Sardina pilchardus	1.00		$0.98^{(*)}$	$0.88^{(*)}$	$0.62^{(*)}$	$0.02^{(*)}$
	Boops boops	0.94	0.95		$0.88^{(*)}$	$0.69^{(*)}$	$0.06^{(*)}$
	Sardinella aurita					$0.52^{(*)}$	$0.07^{(*)}$
	Scomber japonicus						$0.03^{(*)}$
Summer	*Sardina pilchardus*	0.98					
	Boops boops	0.87	0.87				
	Oblada melanura	0.07	0.20	0.00			
Autumn	*Sardina pilchardus*	0.99					
	Boops boops	0.81	0.82				
	Oblada melanura	0.44	0.45	0.42			
	Trachinotus ovatus	0.92	0.92	0.79	0.43		
Winter	*Sardina pilchardus*	0.96					
	Sardinella aurita	0.76	0.85				
	Scomber japonicus	0.35	0.48	0.69			
	Oblada melanura	0.97	0.97	0.93	0.52		

TABLE 5. – Groups of species from multidimensional scale analysis based on frequency of occurence in catches.

RESIDENT	TEMPORARY	TRANSITORY	
		CASUAL	RARE
Atherina presbyter	*Boops boops*	*Sardinella aurita*	*Belone belone*
Sardina pilchardus		*Scomber japonicus*	*Liza sp.*
		Trachynotus ovatus	*Sphyraena sp.*
		Oblada melanura	*Engraulis encrasicolus*
			Sarpa salpa
			Trachurus sp.

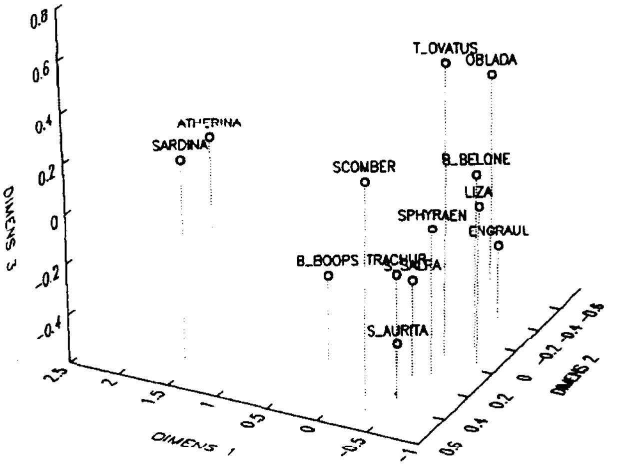

FIG. 3. – Tridimensional representation of multidimensional scale analysis.

Taking into account tables 1 and 5 it was possible to verify that the most abundant species had a prolonged presence in the area. *Sardinella aurita* was an exception, since despite being the fourth species in order of importance by number and weight, it was classified as a casual transitory species because it was captured rarely, but in large quantities.

Moreover, comparing feeding categories (Tables 3a, 3b, and 3c) and trophic groups (Table 4) with frequencial groups (Table 5), it could be observed that species with a high trophic plasticity were those with a short use of the coastal area while zooplanktivorous species were coastal residents, at least during the juvenile stages.

DISCUSSION

The vital space is the main factor that controls the carrying capacity of the coastal ecosystem. Areas whose coast has a reduced available space (very narrow and sloping shelves), like the oceanic islands, are characterized by a low carrying capacity. Furthermore, carrying capacity of any ocean region is also largely dependent on food resources and the composition of the fish biota (LAEVASTU and LARKINS, 1981). Another added problem in oceanic islands is the diffuse frontier between coastal waters and oceanic ones that is reflected in the composition and distribution of fish biota. The limited available space creates an instability in the fish community structure of neritic species.

Pelagic species mainly use coastal shallow areas as nurseries due to their high productivity and their favourable environmental conditions for a fast growth of juveniles (MANN, 1982). The pelagic fish community during juvenile stages in the coastal zones shows a relatively high concentration of species. Nevertheless, biomasses of juveniles in several species studied were apparently lower than expected by evaluations of adult biomasses on the shelves of the Canary Islands using hydroacoustical methods (PASTOR and DELGADO DE MOLINA, 1985).

Juvenile pelagic fish exert a variable pressure on food resources throughout the year, generally higher during early spring and lower at the end of summer but depending on stability and coupling between environmental and biological factors, such as water temperature, quality and availability of food, etc. (LAEVASTU and LARKINS, 1981; MARGALEF 1982). These factors describe cycles more or less variable yearly and they determine delays or extensions of spawning periods, growth ranges (LEMM *et al.*, 1993) and even migrations between areas (LAEVASTU and LARKINS, 1981). Furthermore, it is not possible to define trophic levels due to the fact that most of the fish species change their diet composition throughout their life cycle, the seasons of the year and the different growth areas. These changes are related to the spatial and temporal variations in food composition and available food resources (LAEVASTU and LARKINS, 1981; BOWEN, 1985). The use of the coastal pelagic ecosystem by juvenile fish in the Canary Islands could be classified as primary (based on zooplankton), and strongly dependent on environmental conditions.

Juvenile fish exert a strong pressure on the coastal ecosystem reducing its carrying capacity with time. This effect leads to a strong competence for food resources, and consequently space, and it causes a spatial and temporal sequence of species with different strategies of food exploitation and space occupation (MARGALEF, 1982). The general strategy of occupation of pelagic fish is based on high densities of individuals of the same species. This strategy could reduce interspecific competition by space exclusion of other species. Furthermore, it was observed that species exploiting basic levels of the pelagic ecosystem (small-sized zooplankton feeders) exert a more prolonged use of the coastal area. *Atherina presbyter*, sustained by high concentrations of individuals of small size, is the best example of a coastal resident species. This species develops its life cycle in the same ecosystem, without apparent habitat changes. *Sardina pilchardus* and related species, showing similar diets as *A. presbyter*, also complete their life cycle in areas close to the shallow coastal ecosystem.

The utilization of the coastal ecosystem during different periods of time (time-sharing) is another strategy that reduces competition between species for food resources. *Scomber japonicus* remains in this ecosystem only during its early juvenile stages, from the winter (January-February) until the spring (April-May) (CASTRO, 1993). This species is characterized by a high growth rate (HUNTER and KIMBRELL, 1980), and it has a swimming capacity and resistence higher than other species (WARDLE and HE, 1988). The trophic plasticity of this species permits it to prey on fish and, in this way, it probably exerts some biological control on the populations of other species, especially *Sardina pilchardus* and *Atherina presbyter*. When the coastal ecosystem starts to be depleted, these juveniles migrate offshore changing significantly their trophic strategy. At this time specimens have reached 13-15 cm total length (CASTRO, 1993).

Finally, some other species show a trophic specialization to reduce competition with strictly zooplanktivorous species. This fact confers more stability on their populations (WEATHERLEY and GILL, 1987). This specialization could be restricted to a determined stage and it is directly influenced by the presence of a specific food resource (LAEVASTU and LARKINS, 1981). This feeding strategy is observed in *Trachynotus ovatus*, which, during the spring, lives close to the shore and its diet clearly depends on coastal insects.

Definitively, juveniles of pelagic fish species that grow in coastal shallow waters show different strategies of use of space and food resources. The above described strategies must not be strictly considered for all life cycles, because they could be restricted to a specific stage. The combination of different strategies gives a wider spectrum of the possibilities of exploitation of the limited carrying capacity of the coastal ecosystem, thus reducing interspecific competition.

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