A VISUAL SURVEY OF THE INSHORE FISH COMMUNITIES OF GRAN CANARIA (CANARY ISLANDS)

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HAJAGOS, J.G. & J.L. VAN TASSELL 2001. A visual survey of the inshore fish communities of Gran Canaria (Canary Islands). *Arquipélago*. Life and Marine Sciences. 18A: 97-106. Ponta Delgada. ISSN 0873-4704. (Previously published in *Arquipélago*. Life and Marine Sciences. Supplement 2 Part B: 95-99 (2001) but without accompanying figures and tables).

An in situ visual survey technique (5 minutes and 100 m^2 area) was used to assess the inshore fishes off Gran Canaria. In 1996, 211 visual surveys were conducted at 7 localities. Locations differed significantly among each other with regards to the number of species per survey (ANOVA: $p < 0.01$). The five most abundant species were *Chromis limbatus*, *Boops boops*, *Pomadasys incisus*, *Abudefduf luridus*, and *Thalassoma pavo* with respective mean abundances of 65.6, 37.4, 16.7, 8.7, and 4.5 per 100 m^2. Detrended Correspondence Analysis, a multivariate ordination technique showed that the major determinant of community structure is substrate type. The majority of the surveyed species had low axis 1 ordination scores indicating a strong association with a hard substrate. The step-wise linear regression models explained 45.3 % and 1 1.4% of the variation in the first and second axis survey ordination scores, respectively.

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INTRODUCTION

Approximately 30 years ago commercial development began along the coastlines of the Canary Islands, primarily on the islands of Tenerife and Gran Canaria. In order to meet the needs of the tourist industry, artificial harbors, beaches and hotels were constructed. Few environmental precautions were taken. For example, silt was dumped and massive alterations to the shoreline were made. The effect of these changes has been a serious decline in the economically important fisheries associated with the archipelago (BACALLADO et al. 1989). Basic knowledge of the ecology and well planned BACI (Before and After Control Impact) studies will prove important in assessing the effects of future development on the inshore fish. Most of the literature on the ecology of inshore fish deals with coral reefs and the debate over stochastic versus deterministic factors in the structuring of these communities (SALE et al. 1994) (AULT & JOHNSON 1998). Literature on non-coral reef fish communities has primarily been concentrated on the kelp forests of California (HOLBROOK et al. 1994) and New Zealand (CHOAT & AYLING 1987). The community ecology of the inshore fishes of the Canary Island Archipelago has received less attention.

The inshore fish community associated with the Canary Islands is unique in its composition (VAN TASSELL 1988; BRITO 1989, BRITO et al. 1995). Throughout the 1990's there has been an effort to quantify the inshore fish of the archipelago by BORTONE et al. (1991) and FALCON et al (1996). However, efforts to quantify the communities on Gran Canaria have been limited to smaller scale investigations (BORTONE et al. 1994; HAROUN et al. 1994). This study is part of a larger, long term temporal assessment (1991-1998) of the inshore fish of Gran Canaria. The goals here are to define the basic community structure, and examine spatial variations in this structure as well as the relation of environmental factors to community organization.

MATERIALS AND METHODS

Description of Study Area

The Canary Island Archipelago is located 70-450 km off the northwest shore of Africa (Fig. 1). Gran Canaria (1,531 km^2) is the third largest island and is inhabited by approximately 600,000 permanent residents (BACALLADO et al 1989). The shoreline consists of a basalt terrace dropping 10 - 15 meters before entering into sand. Each of the seven surveyed localities is referred to numerically. The surveyed localities are 1- Punta de la Cuesta de la Burra, 2- Punta Cruz de Piedra, 3- Punta de los Frailes, 4- Puerto Rico West, 5- Punta del Canario, 6- Punta del Canario Artificial Reef, and 7- Pasito Blanco Offshore Reef.

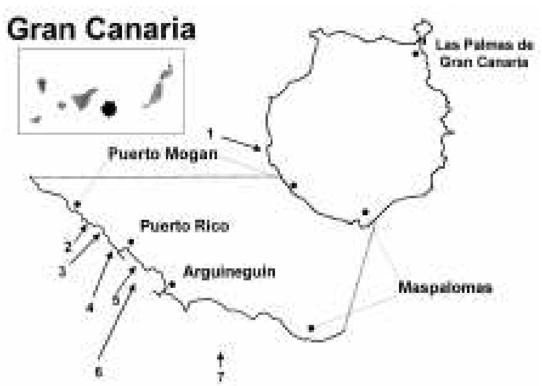

Fig. 1. Map of Gran Canaria with an inset showing its relation to the other islands of the Canary Island Archipelago. The surveyed localities are: 1, Punta de la Cuesta de la Burra; 2, Punta Cruz de Piedra; 3, Punta de los Frailes; 4, Puerto Rico West; 5, Punta del Canario; 6, Punta del Canario Artificial Reef and 7, Pasito Blanco Offshore Reef.

Survey Technique

The survey was carried out in 1996. We used an underwater visual survey, the point-count (BORTONE et al. 1989) that is among the least disruptive of all survey techniques currently used to assess shallow aquatic communities (BARDACH 1959). An individual using SCUBA establishes an imaginary circle with a radius of 5.6 m (100 m^2), and horizontally counts all fish species up to 10 m above the substrate for a period of five minutes. If one fish of a school enters the survey area, the whole school is recorded as having entered (BROCK 1954). Fish that leave and reenter the survey area are counted only once. For some genera, species were not easily distinguishable and were recorded as genera only. For schooling species abundance was estimated in units of 50.

We recorded the following environmental data for each survey: time, date, depth, slope, substrate, and percentage of sand cover. Slope was estimated on a scale from 1(totally flat) to 4 (vertical). Substrate refers to vertical relief: 1 = no relief (e.g. a sandy surface), 2 = less than 0.5 m, 3 = 0.5 m to 3 m, and 4 = greater than 3 m. Biotic data for each survey included: the percentage of macroscopic algae above 1 cm covering the survey area, and the number of long spined sea urchins (*Diadema antillarium*). All data were recorded with pencil on roughened plastic slates and transferred to a computerized database for later analysis. For each sample, species abundance, number of species, number of individuals, and species diversity (H') according to the Shannon-Weaver Index (PIELOU 1966) were determined. All results from the analysis are expressed in units per 100 m^2.

Data Analysis

Detrended Correspondence Analysis (DCA) (HILL & GAUCH 1980) is an enhanced eigenvector ordination technique based on reciprocal averaging (RA) (HILL 1973). DCA was performed using PC-ORD (MCCUNE & MEFFORD 1997). PC-ORD uses a modified version of DECORANA (HILL 1979) with improvements in the rescaling algorithm suggested by OKSANEN &

MINCHIN (1997). Species abundances were $\log_{10}$ transformed in order to reduce the high variation present in the data set.

We constructed step-wise linear regression models to explain variation in the dependent variables (number of species, number of individuals per survey, species diversity (H'), sample ordination scores along the first axis, and sample ordination scores along the second axis). Five independent variables (slope, substrate, percentage of sand, percentage of algae, and number of sea urchins) were entered into each model. Variables were removed from the models if their $p > 0.05$.

Single classification ANOVA was performed on all independent and dependent variables to determine if statistical differences exist among surveyed localities. The dependent variables were also tested by ANOVA against slope and substrate type. Post-hoc tests were conducted using the T-method. Unless otherwise noted the significance level for a statistical test is $p < 0.05$. Data were analysed using programs written in Visual DBASE 7 (BORLAND 1997) and SYSTAT 7 (SPSS 1997).

RESULTS

Descriptive

The 48 species recorded in 211 visual surveys comprise 29 different families. Descriptive species statistics are listed in Table 1. The five most abundant species were *Chromis limbatus, Boops boops, Pomadasys incisus, Abudefduf luridus,* and *Thalassoma pavo* with respective mean abundances of 65.6, 37.4, 16.7, 8.7, and 4.5. Mean abundances and standard deviations by locality for each species are listed in Table 2. Sixteen species were represented by at most 1 or 2 individuals in a survey. The greatest number of individuals recorded for a single survey was 2500 *(Pomadasys incisus).* The five most frequently observed species were *Chromis limbatus, Abudefduf luridus, Canthigaster rostrata, Thalassoma pavo, and Diplodus vulgaris* with percent occurrences of 82.0, 76.8, 74.4, 72.0, and 51.7 respectively.

Community Structure

Surveys and species were ordinated along three axes using detrended correspondence analysis. The eigenvalues for each axis are 0.7224 for axis one, 0.3674 for axis two, and 0.2230 for axis three. The two-dimensional configurations for species and surveys are shown in Figures 2 and 3, respectively. Species that scored low along axis 1 are species which inhabit rocky areas of high substrate relief (e.g. *Triptergion delaisi*, *Mycteroperca rubra*, *Ophioblennius atlanticus*, *Scorpaena maderensis*). At the midpoint of axis one are *Stephanolepis hispidus*, *Diplodus sargus*, *Canthigaster rostrata*, and *Boops boops*, which inhabit the transition zone from hard substrate to sand. The highest scores along axis 1 are species solely associated with a sandy substrate (e.g. *Uranoscopus scaber*, *Heteroconger longissimus*, *Trachinus* spp., *Bothus podas*, and *Xyrichthys novacula*). The patterns of distribution along the second axis are less clear however. Species with high scores on the second axis tend to have less affinity for the substrate (e.g. *Belonidae* spp. and *Seriola* spp.), whereas lower scores indicate strong association with the substrate such as *Canthigaster rostrata* and *Apogon imberbis.* The low score of *Boop boops* does not fit the trend since it is a schooling species, nor does the high score of *Synodus saurus*, a benthic species.

The ordination of the surveys along the first axis follows a pattern similar to the species. The surveys with the lowest scores are composed of species such as *Apogon imberbis, Thalassoma pavo* and *Sparisoma cretense* which inhabit rocky areas. The highest score surveys are primarily composed of sand associated species (e.g. *Bothus podas* and *Xyrichthys novacula).* Along the second axis, the surveys with the top-ranking scores are composed of free swimming species such as *Trachinotus ovatus* and *Belonidae* spp., whereas lower scores are associated with high abundances of *Xyrichthys novacula* and *Boops boops.* The first axis in the ordination separates both species and survey by their association with substrate type (e.g. rocky versus sand). The gradient the second axis represents is less clear; however, it appears to be loosely linked to the degree of species vagility.

Table 1

Descriptive species statistics listed by family. For each of the 48 species the mean abundance per survey, (SD) standard deviation, maximum number of individuals in a survey, and percent of occurrence is listed.

Family	Species	Mean	SD	Maximum	Percent Occurence
Apogonidae	*Apogon imberbis*	2.65	9.11	60	15.17
Atherinidae	*Atherina presbyter*	0.47	6.88	100	0.47
Aulostomatidae	*Aulostomus strigosus*	0.02	0.18	2	1.90
Balistidae	*Balistes carolinensis*	0.02	0.18	2	1.90
Belonidae	*Belonidae* spp.	0.13	1.42	20	1.90
Blenniidae	*Ophioblennius atlanticus*	0.09	0.38	3	7.11
Bothidae	*Bothus podas*	0.17	0.62	6	9.95
Carangidae	*Pseudocaranx dentex*	0.93	10.44	150	4.27
	Seriola spp.	0.06	0.38	3	2.84
	Trachinotus ovatus	0.04	0.39	4	1.42
Congridae	*Heteroconger longissimus*	0.73	7.47	100	1.42
Haemulidae	*Pomadasys incisus*	16.69	175.90	2500	12.32
Kyphosidae	*Kyphosus sectatrix*	0.01	0.10	1	0.95
Labridae	*Centrolabrus trutta*	0.11	0.57	7	7.58
	Coris julis	0.09	0.35	3	7.58
	Thalassoma pavo	4.51	7.09	60	72.04
	Xyrichthys novacula	0.36	1.25	10	10.90
Labrisomidae	*Labrisomus nuchipinnis*	0.01	0.07	1	0.47
Monacanthidae	*Stephanolepis hispidus*	0.11	0.42	3	8.06
Mullidae	*Mullus surmuletus*	0.32	2.65	34	4.74
Muraenidae	*Muraena augusti*	0.04	0.19	1	3.79
Myliobatidae	*Myliobatis aquila*	0.01	0.07	1	0.47
Pomacentridae	*Abudefduf luridus*	8.65	8.81	44	76.78
	Chromis limbatus	65.58	79.58	450	81.99
Priacanthidae	*Heteropriacanthus cruentatus*	0.06	0.33	2	3.79
Scaridae	*Sparisoma cretense*	1.02	2.08	17	36.97
Scorpaenidae	*Scorpaena maderensis*	0.12	0.43	3	9.48
Serranidae	*Mycteroperca rubra*	0.01	0.10	1	0.95
	Serranus atricauda	0.27	0.57	3	21.80
	Serranus cabrilla	0.23	0.51	2	19.43
	Serranus scriba	0.07	0.27	2	6.16
Sparidae	*Boops boops*	37.37	100.70	800	35.55
	Diplodus cervinus	0.09	0.37	3	7.58
	Diplodus sargus	1.32	3.66	30	24.17
	Diplodus vulgaris	1.66	2.96	22	51.66
	Lithognathus mormyrus	0.07	0.54	7	2.84
	Oblada melanura	1.32	8.97	100	8.53
	Pagrus auriga	0.36	0.68	4	27.01
	Sarpa salpa	0.54	2.70	25	11.37
	Sparus aurata	0.01	0.07	1	0.47
Sphyraenidae	*Sphyraena viridensis*	0.36	3.44	40	2.37
Synodontidae	*Synodus saurus*	0.01	0.07	1	0.47
	Synodus synodus	0.07	0.30	3	5.69
Tetraodontidae	*Canthigaster rostrata*	2.46	2.61	17	74.41
	Sphoeroides spengleri	0.08	0.29	2	7.58
Trachinidae	*Trachinus* spp.	0.04	0.24	2	2.84
Tripterygiidae	*Tripterygion delaisi*	0.01	0.10	1	0.95
Uranoscopidae	*Uranoscopus scaber*	0.01	0.07	1	0.47

Table 2

Mean abundances for the 48 species by locality. The standard deviation is listed under each mean.

Species	1	2	3	4	5	6	7
Abudefduf luridus	10.54 9.41	11.43 12.32	8.56 6.60	11.77 10.69	6.52 5.00	4.51 4.14	7.96 7.36
Apogon imberbis	0.12 0.43	0.03 0.16	0.37 0.84	----------	0.09 0.42	10.78 16.46	3.61 10.40
Atherina presbyter	3.85 19.61	----------	----------	----------	----------	----------	----------
Aulostomus strigosus	0.04 0.20	----------	----------	----------	----------	----------	0.14 0.45
Balistes carolinensis	0.04 0.20	----------	0.07 0.38	0.08 0.27	----------	----------	----------
Belonidae spp.	----------	0.03 0.16	----------	0.96 4.00	0.04 0.21	----------	----------
Boops boops	52.85 107.83	16.15 26.15	9.11 20.22	0.12 0.33	0.65 3.13	55.76 98.53	118.39 202.08
Bothus podas	0.50 1.33	0.23 0.66	0.04 0.19	0.12 0.43	0.09 0.29	0.02 0.16	0.21 0.50
Canthigaster rostrata	2.85 2.77	1.77 2.14	4.67 4.60	2.42 1.68	2.39 1.44	2.39 1.66	1.14 1.72
Centrolabrus trutta	0.38 1.39	0.12 0.33	0.00 0.00	0.31 0.62	0.04 0.21	----------	----------
Chromis limbatus	60.12 88.72	42.45 51.04	45.81 40.83	73.73 85.78	51.91 69.15	105.90 107.41	67.39 69.95
Coris julis	0.19 0.63	0.17 0.45	----------	0.04 0.20	0.13 0.34	0.07 0.26	----------
Diplodus cervinus	0.04 0.20	0.03 0.16	----------	----------	----------	----------	0.64 0.78
Diplodus sargus	0.12 0.43	0.23 0.53	----------	1.81 5.97	0.26 0.54	0.17 0.63	7.36 4.91
Diplodus vulgaris	2.46 4.50	0.97 1.76	0.59 1.19	3.38 4.40	1.30 2.12	2.32 2.90	0.64 1.52
Heteroconger longissimus	5.96 20.88	----------	----------	----------	----------	----------	----------
Heteropriacanthus cruentatus	----------	----------	----------	----------	----------	----------	0.46 0.79
Kyphosus sectatrix	0.08 0.27	----------	----------	----------	----------	----------	----------
Labrisomus nuchipinnis	0.04 0.20	----------	----------	----------	----------	----------	----------
Lithognathus mormyrus	----------	----------	----------	----------	0.35 1.47	0.10 0.49	0.07 0.26
Mullus surmuletus	----------	0.03 0.16	----------	0.04 0.20	----------	0.05 0.22	2.25 7.06
Muraena augusti	0.04 0.20	0.00	----------	----------	----------	----------	0.25 0.44
Mycteroperca rubra	----------	----------	----------	0.08 0.27	----------	----------	----------
Myliobatis aquila	----------	----------	----------	----------	----------	----------	0.04 0.19
Oblada melanura	0.38 1.24	----------	----------	4.77 19.82	0.35 1.30	----------	4.86 15.02

Table 2 (cont.)

Mean abundances for the 48 species by locality. The standard deviation is listed under each mean.

Species	1	2	3	4	5	6	7
Ophioblennius atlanticus	0.12 0.33	0.28 0.64	0.04 0.19	0.08 0.39	0.09 0.42	----------	0.04 0.19
Pagrus auriga	0.12 0.59	0.03 0.16	0.22 0.58	0.23 0.43	0.39 0.58	0.93 0.98	0.43 0.50
Pomadasys incisus	29.04 103.81	1.27 2.88	0.56 1.25	----------	----------	0.02 0.16	96.43 471.56
Pseudocaranx dentex	0.08 0.27	4.20 23.73	----------	0.81 3.92	0.17 0.83	----------	0.04 0.19
Sarpa salpa	----------	1.20 4.69	0.04 0.19	0.42 1.24	0.13 0.63	0.88 3.15	0.54 2.65
Scorpaena maderensis	0.19 0.49	0.05 0.22	0.04 0.19	0.08 0.27	----------	0.29 0.64	0.14 0.59
Seriola spp.	----------	----------	----------	----------	0.09 0.42	0.05 0.31	0.32 0.86
Serranus atricauda	0.85 0.92	0.07 0.35	0.19 0.48	0.46 0.58	----------	0.24 0.49	0.21 0.42
Serranus cabrilla	0.04 0.20	0.05 0.22	0.37 0.56	0.27 0.60	0.04 0.21	0.54 0.71	0.21 0.42
Serranus scriba	0.19 0.40	0.12 0.40	0.04 0.19	----------	----------	0.07 0.26	----------
Sparisoma cretense	1.08 1.62	1.20 1.90	0.41 1.25	2.96 4.30	0.30 0.70	0.61 1.00	0.71 0.81
Sparus aurata	----------	----------	----------	----------	----------	0.02 0.16	----------
Sphoeroides spengleri	----------	0.03 0.16	0.07 0.27	0.15 0.37	0.09 0.29	0.05 0.22	0.21 0.50
Sphyraena viridensis	----------	----------	----------	----------	----------	----------	2.71 9.25
Stephanolepis hispidus	----------	----------	----------	----------	----------	----------	0.86 0.85
Synodus saurus	----------	----------	----------	----------	----------	----------	0.04 0.19
Synodus synodus	0.08 0.27	----------	0.04 0.19	0.04 0.20	0.04 0.21	0.07 0.26	0.21 0.63
Thalassoma pavo	10.88 15.07	3.38 3.81	4.67 3.76	3.88 4.84	3.30 5.11	1.95 2.06	5.36 6.58
Trachinotus ovatus	----------	0.20 0.88	----------	----------	0.04 0.21	----------	----------
Trachinus spp.	0.15 0.54	0.03 0.16	----------	----------	----------	----------	0.11 0.31
Tripterygion delaisi	0.00	0.03 0.16	----------	----------	----------	0.02 0.16	0.00
Uranoscopus scaber	0.04 0.20	----------	----------	----------	----------	----------	----------
Xyrichthys novacula	0.46 1.27	1.00 2.18	0.11 0.58	0.62 1.27	0.04 0.21	----------	0.18 0.94

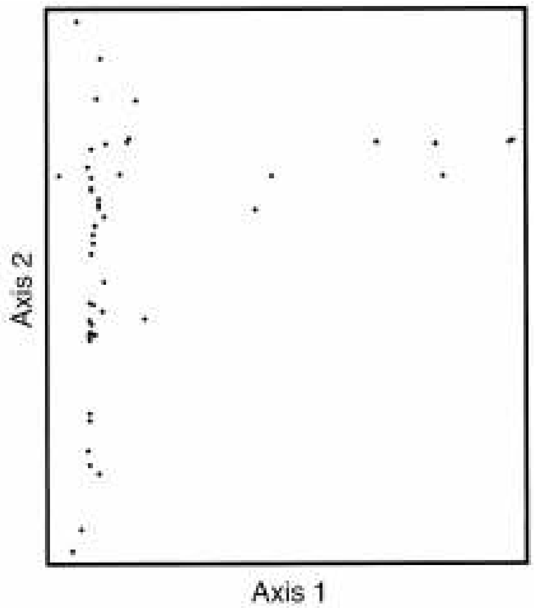

Fig. 2. Scatter diagram of the 48 species ordination scores along the first and second Detrended Correspondence Analysis (DCA) axes.

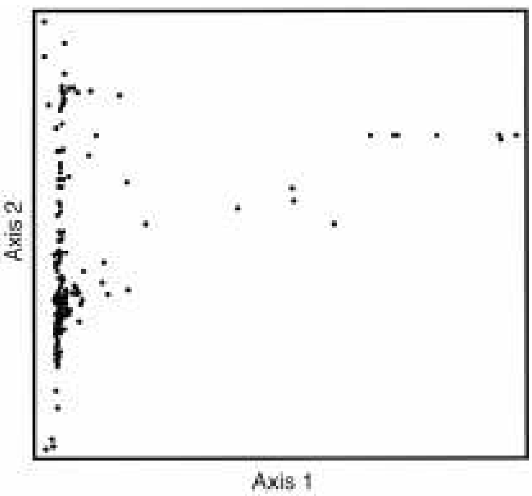

Fig. 3. Scatter diagram of the 211 surveys ordination scores along the first and second Detrended Correspondence Analysis (DCA) axes.

Step-Wise Regression Models

The percentage of variation explained in the dependent variables by the linear models ranged from 9.4% for number of individuals in a survey to 53.3% for number of species per survey. In the model of number of species, depth, substrate, sand, algae and urchins were significant. The linear model explained 27.6% of the variation in species diversity (H'). For the survey ordination scores along the first axis the linear model explained 45.3% of the variation with depth, substrate, and percent of sand significant. In the model of the second axis scores 11.4% of the variation was explained while only percentage of sand was significant in the model. When the seven localities coded as dummy variables were added to the step-wise models the percent of variation explained increased to 63. 1 % for the number of species, 16.9% for the number of individuals, 33.9% for species diversity, 55.4% for DCA axis 1, and 17.8% for DCA axis 2.

Analysis of Variance

See Table 3 for means of environmental and biotic variables and their significance in the ANOVA. The number of species recorded at Pasito Blanco differed statistically from the other 6 sites means, this result is due Pasito Blanco being an offshore reef. The means for the number of species, number of individuals, and species diversity were significant with regard to substrate type. Substrate 1 was significantly lower than substrate 2, 3, and 4 for number of species and H'. For slope, number of species and species diversity were significant. Slope one means were significantly lower than slope two means for number of species and H'.

DISCUSSION

BORTONE et al. (1994), in a more limited survey off Gran Canaria, recorded 37 species using the point-count method, seven of which were not recorded in the present study. Three of them from the family Gobiidae, are cryptic in color and were probably overlooked in the present study because the underwater visual survey technique does not provide an accurate assessment of cryptic species (BROCK 1982). FALCON et al. (1996) in a comparable and more thorough study

Table 3

Summary of environmental and community variables by locality and for the total number of surveys. The surveyed localities are: 1- Punta de la Cuesta de la Burra, 2-Punta Cruz de Piedra, 3-Punta de los Frailes, 4-Puerto Rico West, 5-Punta del Canario, 6-Punta del Canario Artificial Reef, and 7-Pasito Blanco Offshore Reef. The standard deviation is listed below each mean. Significance among the overall means (ANOVA) are indicated by: * = p < 0.05 and ** = p < 0.01.

Number of surveys		Total	1	2	3	4	5	6	7
		211.00	26.00	40.00	27.00	26.00	23.00	41.00	28.00
Number of species	**	6.99	7.12	5.72	5.41	7.00	5.87	7.85	9.82
		2.97	3.17	3.25	2.23	2.99	1.03	2.09	2.59
Species diversity (H')		0.99	0.95	0.97	1.01	1.00	1.08	0.93	1.07
		0.47	0.48	0.58	0.48	0.48	0.45	0.37	0.40
Number of individuals		149.36	183.88	86.75	76.00	109.62	68.87	187.83	324.18
		246.53	177.50	70.91	48.14	90.60	67.83	151.42	568.26
Depth (m)	**	12.32	8.68	8.40	10.17	10.22	10.44	19.28	16.66
		4.60	1.91	1.13	2.23	2.81	1.79	0.73	1.78
Slope of substrate	**	1.28	1.46	1.45	1.37	1.65	1.04	1.00	1.04
		0.53	0.57	0.67	0.48	0.68	0.20	0.00	0.19
Substrate type	*	2.19	2.08	2.10	2.15	2.42	2.43	2.17	2.07
		0.89	0.83	0.94	0.76	1.04	1.06	0.62	0.96
Percent sand		36.00	35.96	41.12	27.04	39.81	42.39	28.90	38.93
		39.21	42.22	45.27	41.16	40.27	35.72	29.58	35.94
Percent algae	**	16.60	49.81	24.32	2.96	39.81	3.87	0.37	0.54
		29.29	38.09	30.93	15.11	31.36	7.34	1.71	1.94
Urchins	**	31.70	2.88	20.12	38.33	3.73	44.35	34.80	79.64
		48.78	7.05	43.78	33.47	7.68	43.37	25.79	85.53

of the inshore fauna of the Canary archipelago recorded 76 species. However DOOLEY & VAN TASSELL (1985) consider 217 species to be part of the regular inshore fauna of the archipelago. Since there are inter-faunal differences between islands, and we surveyed only a limited section of the Gran Canaria coastline, the 49 species in 29 families in our study represent a considerable portion of the island's fish community.

Spatial scale is an important consideration in any ecological study (LEVIN 1992), and we found high habitat heterogeneity across the seven localities. For the majority of environmental variables and for the number of species per survey the ANOVA models showed significant differences among localities. On a finer scale, looking within habitat types the ANOVA models revealed significant differences among number of species, species diversity, and number of individuals. A substrate of 1 tested significantly lower than the other substrates. An explanation for this is that the community associated with this substrate is sand specific. This community is less diverse and usually less abundant than its rocky counterpart. Part of this is likely due to the high territoriality exhibited by the dominant species *(Bothus podas* and *Xyrichthys novacula)* of the community.

The patterns of community structure revealed in the ANOVA models are supported by the ordination. The first axis in the DCA ordination is strongly associated with substrate type, a finding supported by the species scores and the significant variables (depth, substrate. and percent of sand) in the regression model of the axis scores. A large number of species are clustered along the initial part of the axis. These species, representing a considerable portion of those surveyed are primarily associated with a hard substrate. BORTONE et al. (1991) found a similar pattern on El Hierro in the DCA ordination along the first axis. Since the sandy substrate is relatively absent from El Hierro the effect of clustering was even more pronounced. Further, on El Hierro, BORTONE et al. (1991) found the second axis scores to represent affinity for the substrate. Overall we found a similar pattern for the second axis scores but on finer examination there are a considerable number of exceptions. Most of the anomalies are of rare species, less than 1% overall occurrences in the study. Occurrence of a rare species is more an event of chance than an ecological phenomenon and therefore may obscure ordination results (GAUCH 1982).

It appears that substrate type is important in the spatial structuring of the community of inshore fish into two different assemblages. This conclusion has important consequences for development along the shore. The basalt terrace extending from most of the coastline is rather narrow between 50 and 100 meters. Since a considerable portion of the species are associated with the hard substrate, disruption of the shelf by filling with sand and sediment from harbour and artificial beach construction will have a negative impact on this community.

ACKNOWLEDGEMENTS

We would like to give special thanks to G. Oulton for her continual support throughout this research and to “Top Diving”, Puerto Rico, Gran Canaria for material support. Also thanks go to Professor William T. Maple of Bard College for his comments on the manuscript.

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