Cephalopod Biodiversity, Ecology and Evolution
Payne, A. I. L., Lipiński, M. R., Clarke, M. R. and M. A. C. Roeleveld (Eds). *S. Afr. J. mar. Sci. 20: 93–100*
1998

OCTOPUS VULGARIS AS A COMPONENT OF THE BENTHIC FAUNA OF THE NW AFRICAN COAST: A NOTE ON AN INVESTIGATION OF SPECIES COMMUNITY ORGANIZATION USING MULTIFACTORIAL ANALYSIS

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The common octopus *Octopus vulgaris* is very abundant off the coast of NW Africa, where it is exploited on such a large scale that it is the most valuable fishery product of Mauritania. Considering its economic value and because the stocks have been subjected to very high fishing pressure there since the 1970s, without any apparent long-term decrease in the landings, this study focuses on the species' spatio-temporal distribution compared to that of other species of the same benthic coastal community in order to provide some new information about its ecology. Multifactorial analysis of ecological data reveals that the common octopus dominates the benthic community off Mauritania and covers a broad range of habitats. Such characteristics may provide it with a considerable ecological advantage.

The common octopus *Octopus vulgaris* is one of the most important commercial species taken off NW Africa, specifically off Mauritania, Morocco and Senegal (F.A.O. 1997). In Mauritania, for example, it is the top fishery resource in terms of value (Dia *et al.* 1996) in a country where GDP is currently heavily reliant on fishing. In the light of its economic importance and given the fact that octopus stocks in the region have been intensively exploited since the 1970s without any obvious long-term decrease in catch (Jouffre and Inejih 1997), an attempt is made herein to provide information about its relative position within the benthic coastal community off NW Africa in terms of spatio-temporal distribution and species association.

Although several studies have dealt with the ecology of *O. vulgaris* in the area (Mangold 1983, Fernández-Núñez *et al.* 1996), most have focused on life history and reproductive biology. Few have looked at spatial distribution. Those studies that have (e.g. Hatanaka 1979, Guerra 1981, Dia 1988, Fernández-Núñez *et al.* 1996, Jouffre and Inejih 1996) tended to concentrate on *Octopus vulgaris* itself without comparing it with other species on the same grounds. Some are also based on commercial catches only, precluding interspecific comparisons such as that presented here.

More generally, Mangold (1983) noted, when reviewing worldwide knowledge of the ecology of the common octopus, that "There is a wealth of information from several areas, mainly provided by fishery surveys, but basic knowledge of many aspects as still lacking". A review of recent literature dealing with the ecology of this species neither contradicts Mangold's (1983) statement nor her belief that "The greatest handicap may be the absence of an overall survey ... in a given area". Consequently, one of the aims of the present study is to provide reference lists of species abundance over two full years on the basis of systematic scientific survey results. Both sampling effort and area were kept constant. Finally, to provide a better understanding of the dynamics of exploited octopus stocks, an attempt is made to put the main results into a general fisheries context.

MATERIAL AND METHODS

Data were derived from 24 experimental surveys made monthly in the Cap Blanc region of Mauritania between 1993 and 1995 aboard the Mauritanian R.V. *N'Diago*, each survey consisting of two sets of five stations along a double transect crossing the northern part of the Mauritanian continental shelf near Cap Blanc (Fig. 1). The transect ran from 10 to 100 m of water depth.

The sampling gear was an Irish-type bottom trawl with metal Morgere-type panels (a complete description is given by Girardin 1990). The gear is similar to that used by local commercial fishermen[1], except that the latter often add heavy chains when targeting octopuses rather than fish. Each haul lasted 30 minutes and was made at a constant speed of 3,5 knots. Information on abundance, size of species, sex and maturity was collected from these experimental trawl catches (see

[1] In the same area there is also a small-scale shallow-water (<25 m) fishery for octopus using pots (Chaboud *et al.* 1988)

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Manuscript received: September 1997

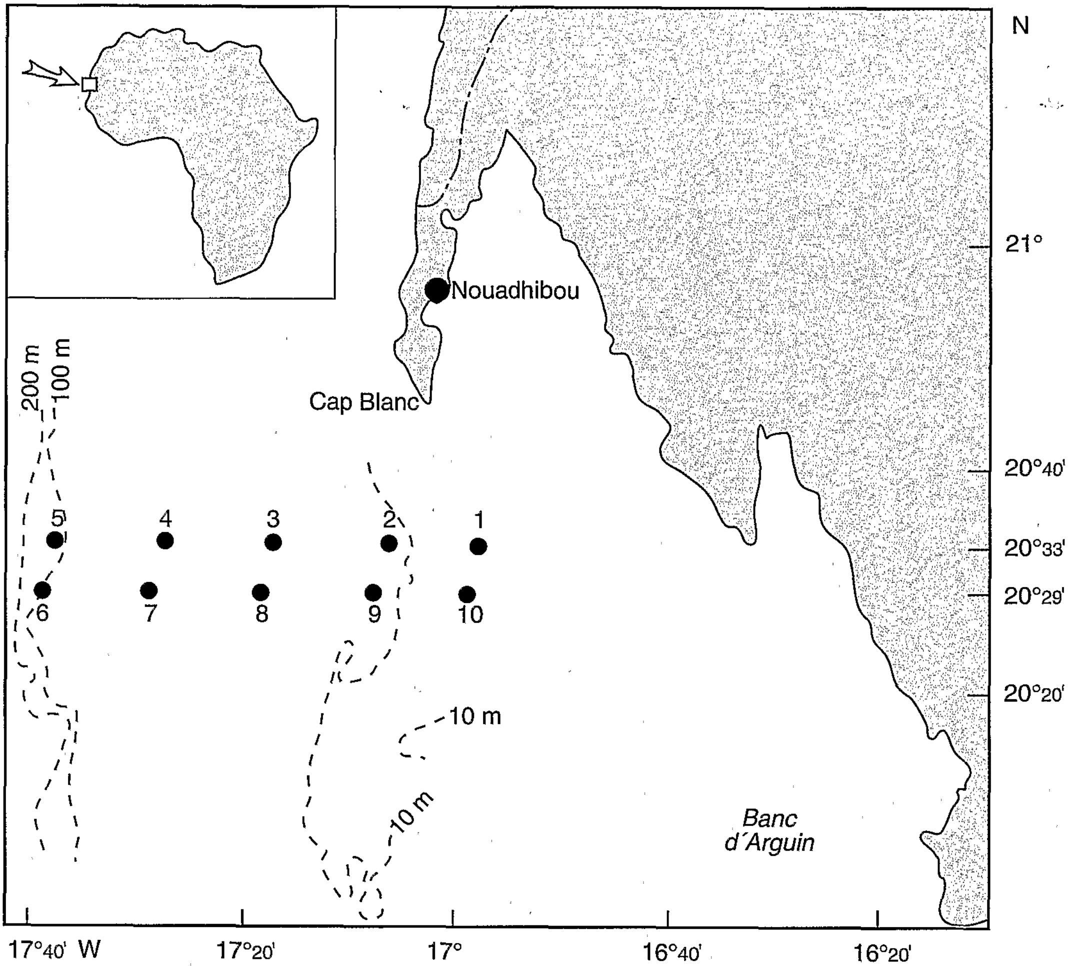

Fig. 1: Position of the sampling stations off Cap Blanc

Jouffre and Inejih 1996). For the current purpose, however, only numerical abundance of the main demersal species or groups is used.

There were two steps to the treatment of data. The first step was to select the dominant species of the Cap Blanc region and to rank them according to abundance and frequency of occurrence. To be selected, a species had to be one of the 40 most frequently encountered, one of the 10 most numerous in the catches or one of the 10 that contributed most to the total catch mass. For comparison, the same selection procedure was applied to a second set of data from 28 surveys held in the same area with the same research vessel, gear and catch methodology. Those surveys (the demersal surveys of the Mauritanian Oceanographic and Fishery Research Centre between 1982 and 1994) each covered the whole Mauritanian shelf, so providing a reference list of species for a larger area than just off Cap Blanc.

The second step of data treatment (for the Cap Blanc data only) was to analyse them statistically with the ADE software of Chessel and Dolédec (1993). The basic calculations are derived from the correspondence analysis of Hirschfeld (1935) and Hill (1973) and applied to the abundance data (crossing 240 samples × 40 species) from Cap Blanc. A new statistical approach allowed reciprocal scaling of species tolerance and sample diversity, as proposed by Thioulouse and Chessel (1992).

Table I: The 40 main species from the sampling transects off Cap Blanc, 1993–1995, and their rank according to different abundance criteria

Rank	Species identification tag for Fig. 2	Species	Ranking		
			Frequency of occurrence	Number	Total mass
1	O. vulg	*Octopus vulgaris*	1	19	3
2	Pag. be	*Pagellus bellotti*	2	4	4
3	Lo. vulg	*Loligo vulgaris*	3	10	8
4	S. off	*Sepia hierredda*	4	23	11
5	Ci. li	*Citharus lingatula*	5	5	9
6	Tr. tr	*Trachurus trecae*	6	8	13
7	Z. fa	*Zeus faber*	7	50	16
8	Lep. sp	*Lepidotrigla* sp.	8	13	31
9	Ura. sp	*Uranoscopus* sp.	9	60	24
10	Tra. dr	*Trachinus draco*	10	35	48
11	Dip. be	*Diplodus bellottii*	11	3	2
12	Arn. i	*Arnoglossus imperialis*	12	22	52
13	Sol. vu	*Solea vulgaris*	13	26	34
14	Bot. po	*Bothus podas*	14	56	82
15	Den. mar	*Dentex maroccanus*	15	41	73
16	Sco. ste	*Scorpaena stephanica*	16	46	53
17	Halo. di	*Halobatrachus didactylus*	17	58	22
18	Dec. rh	*Decapterus rhonchus*	18	16	17
19	Mic. the	*Microchirus theophila*	19	36	62
20	Sco. ja	*Scomber japonicus*	20	40	42
21	Den. ca	*Dentex canariensis*	21	37	33
22	S. bert	*Sepia bertheloti*	22	53	30
23	Mon. mi	*Monolene microstoma*	23	29	60
24	Sol. se	*Solea senegalensis*	24	63	27
25	Chel. ga	*Chelidonichthys gabonensis*	25	54	77
26	Scy. ca	*Scyliorhinus canicula*	26	47	15
27	Ser. ca	*Serranus cabrilla*	27	71	68
28	Munid.	Munidae	28	1	6
29	Spo. ca	*Spondyliosoma cantharus*	29	49	35
30	Den. an	*Dentex angolensis*	30	68	46
31	B. bps	*Boops boops*	31	15	51
32	Mu. mu	*Mustelus mustelus*	32	24	5
33	Ser. af	*Serranus africana*	33	62	86
34	Ra. mir	*Raja miraletus*	34	77	38
35	Mic. bos	*Microchirus boscanion*	35	27	81
36	Port.	Portunidae	36	9	45
37	Ra. sp	*Raja* sp.	48	70	10
38	Heli. da	*Helicolenus dactylopterus*	58	2	1
39	Coel. sp	*Coelorhincus* sp.	91	6	7
40	Ples. he	*Plesionika heterocarpus*	96	7	72

RESULTS

The 40 main species of the Cap Blanc community are ranked in Table I. *Octopus vulgaris* was first in terms of frequency of occurrence, 19th by numerical abundance and 3rd in terms of total mass. In an important commercial fishing area for octopus, therefore, the species dominates the benthic community.

Table II provides the same listing for the whole Mauritanian shelf over the longer period (1982–1994). More than half the species were also on the Cap Blanc list. Again, *O. vulgaris* was the most frequently encountered species, even though most stations were occupied outside the main fishing areas for octopus. In terms of numerical abundance, *O. vulgaris* only ranked 45th, but by mass, it was second only to the very common sparid *Pagellus bellotti*.

Figure 2 gives the results of the first factorial ordination of the Cap Blanc data. The plot takes the form of an arch (the horseshoe or Guttman effect), a well known feature of correspondence analysis (Chessel and Dolédec 1993). The arch reveals the presence of a gradient in the data, a strong, single-axis organization of the community. *Octopus vulgaris* is also projected to be central, meaning that it occupies an intermediate

Table II: The 40 main species deduced from trawl survey covering the whole Mauritanian EEZ, 1982–1994, and their rank according to different abundance criteria

Rank	Species identification tag for Fig. 2	Species	Ranking		
			Frequency of occurrence	Number	Total mass
1	O. vulg	*Octopus vulgaris**	1	45	2
2	Pag. be	*Pagellus bellotti**	2	2	1
3	S. off	*Sepia hierredda**	3	54	25
4	Ra. mir	*Raja miraletus**	4	49	18
5	Tr. tr	*Trachurus trecae**	5	6	8
6	Z. fa	*Zeus faber**	6	41	21
7	Ci li	*Citharus lingatula**	7	5	16
8	Ps. pra	*Pseudupeneus prayensis*	8	20	17
9	Dec. rh	*Decapterus rhonchus**	9	17	19
10	Den. ca	*Dentex canariensis**	10	32	29
11	Sy. mi	*Syacium micrurum*	11	50	50
12	Ep. ae	*Epinephelus aeneus*	12	99	24
13	Po. in	*Pomadasys incisus*	13	13	3
14	Den. an	*Dentex angolensis**	14	14	5
15	Lo. vulg	*Loligo vulgaris**	15	31	40
16	Spa. c	*Sparus caeruleostictus*	16	40	15
17	Den mar	*Dentex maroccanus**	17	11	23
18	Bra. a	*Brachydeuterus auritus*	18	10	11
19	Umb. c	*Umbrina canariensis*	19	21	4
20	Pan. n	*Panaeus notialis*	20	51	119
21	T. div	Miscellaneius teleost fish of minor economic importance	21	16	9
22	Chel. ga	*Chelidonichthys gabonensis*	22	35	49
23	Lep. sp	*Lepidotrigla* sp.*	23	9	20
24	To. to	*Torpedo torpedo*	24	106	64
25	De. mac	*Dentex macrophthalmus*	25	12	14
26	Pl. me	*Plectorhyncus mediterraneus*	26	26	6
27	Mu. mu	*Mustelus mustelus**	27	75	12
28	Sco. ste	*Scorpaena stephanica**	28	48	46
29	Me. se	*Merluccius senegalensis*	29	23	27
30	Bro. ba	*Brotula barbata*	30	67	30
31	S. bert	*Sepia bertheloti**	31	85	129
32	Mic. the	*Microchirus theophila**	32	77	76
33	Ra. str	*Raja straeleni*	33	126	41
34	Sol. se	*Solea senegalensis**	34	121	75
35	Arn. i	*Arnoglossus imperialis**	35	47	123
36	Dip. be	*Diplodus bellottii**	47	3	7
37	Syn. m	*Synagrops microlepis*	77	7	52
38	Cap. ap	*Capros aper*	85	8	38
39	Munid.	Munidae*	109	1	34
40	Heli. da	*Helicolenus dactylopterus**	118	4	10

* Species/taxa occurring in the Cap Blanc dataset

position according to a demersal community gradient. Using reciprocal averaging of the correspondence analysis, projection of the 240 samples on the same first factorial plan (Fig. 3) provides a pattern directly related to the previous positions of the species (as shown in Fig. 2), so allowing ecological interpretation of the previous gradient. For this factorial projection (Fig. 3), a star representation is used as a way of grouping all the samples made at the same depth range. It is very clear that the community gradient is essentially related to depth.

In order to take this one-axis community organization a step further and to provide a more complete, ecologically applicable result, the Thioulouse and Chessel (1992) method was applied. Those authors showed that the use of a Gaussian inertia ellipse in reciprocal scaling on a species × samples table is a way to access a representation of niche width and to quantify or compare species tolerance. Figure 4 presents just that analysis for the Cap Blanc dataset. On such a projection, the larger the ellipse the greater the range of habitat. *Octopus vulgaris* has the greatest range.

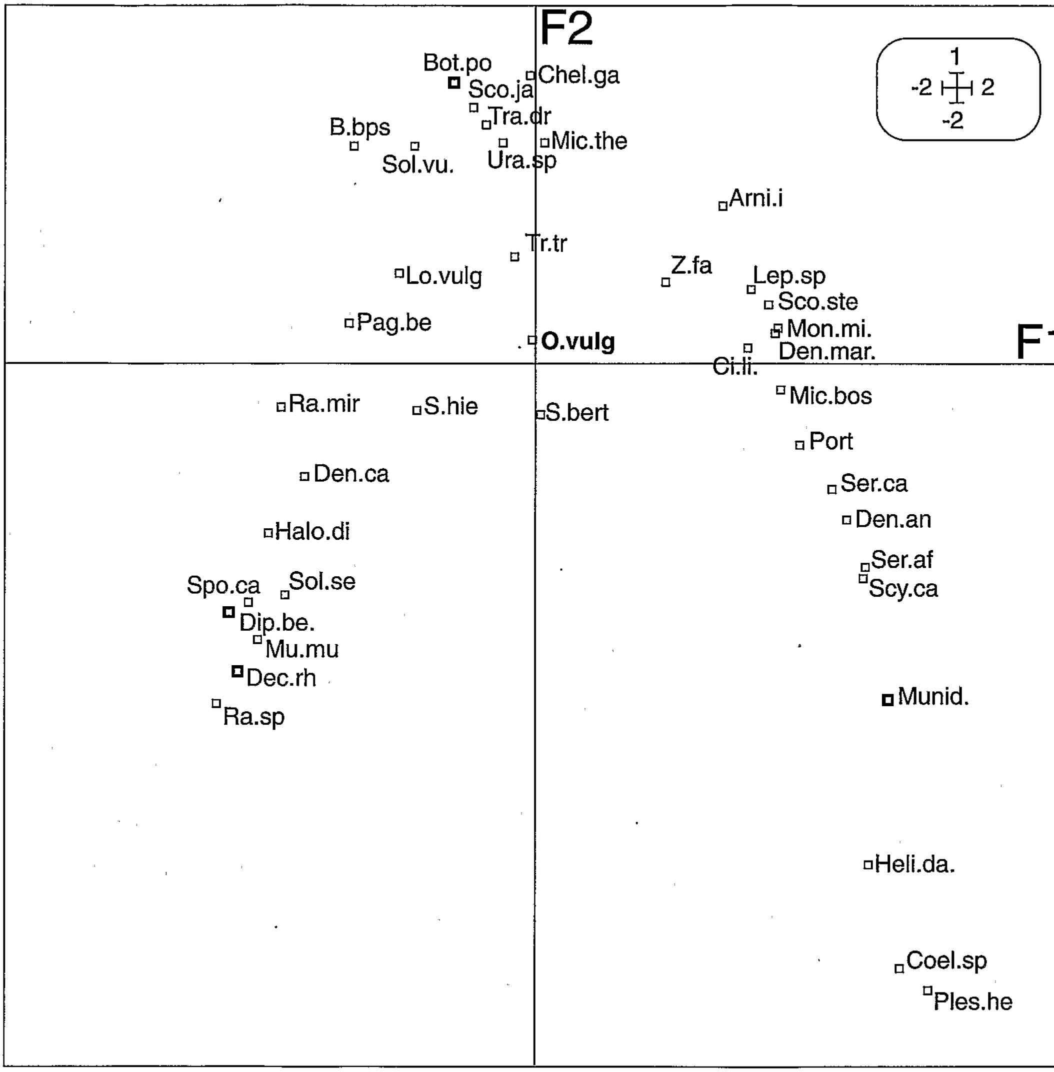

Fig. 2: Projection of the 40 species according to the first factorial ordination of the Cap Blanc data (240 samples × 40 species)

DISCUSSION

The substratum off Cap Blanc is mainly sandy or muddy, similar to that on other parts of the Mauritanian shelf (Domain 1980, Dubrovin *et al.* 1991). It is therefore largely devoid of natural dens or holes in which octopuses can hide. Discarded pots (especially those dumped by trawlers that have snagged artisanal gear) are, however, common, especially in the proximity of the harbour of Nouadhibou. Octopuses may also hide in cylindrical holes they dig in sand or muddy sand, as observed by Scuba divers working in the bay of Dakar (Sénégal).

In addition to substratum preference, octopus distribution can also be related to the biotic environment in which they live. In terms of food availability, several authors (e.g. Nigmatullin and Ostapenko 1976, Guerra

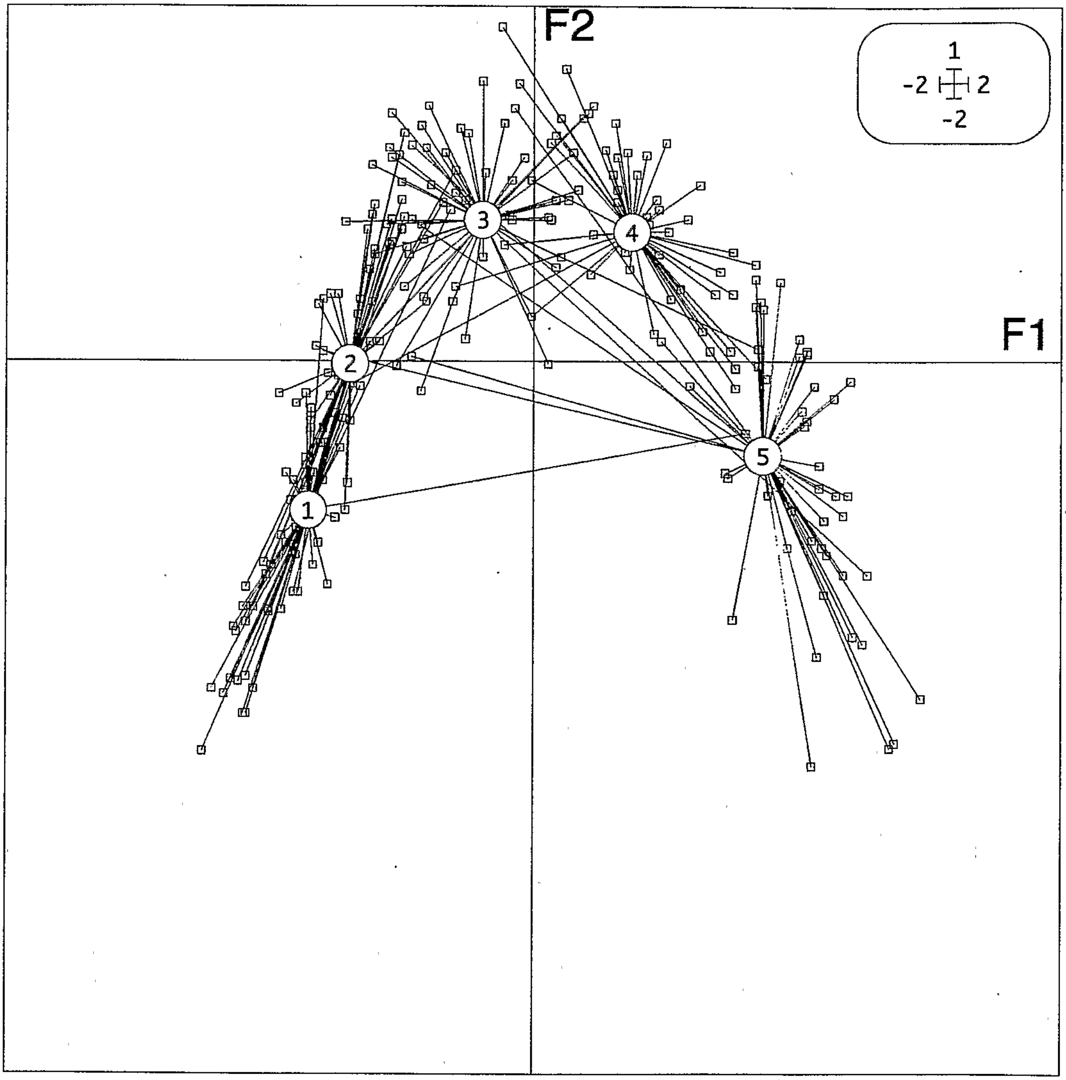

Fig. 3: Projection of the 240 samples according to the first factorial ordination (cf. Fig. 2) with star representation grouping pairs of samples according to increasing depth, from Class 1 (10 – 20 m) to Class 5 (80 – 100 m)

1978, Hatanaka 1979) have documented the wide spectrum of octopus prey (e.g. crabs, bivalves, cephalopods, fish) in the area. Octopuses also associate or co-occur with prey species, predators and competitors. Those species positioned in Figure 4 close to *O. vulgaris* are those that statistically are closest to octopus in terms of abundance at the same station or have the greatest extent of co-occurrence at the different stations, showing the use of multifactorial analysis in elucidating species proximity.

The results and analyses have shown that common octopuses off Mauritania have one of the highest ecological tolerances and certainly the broadest habitat range in that demersal community. This statement is particularly notable if it is considered that, in an ecological context, the demersal ichthyological community off Sénégal and Mauritania has been described by Domain (1980) as intermediate between

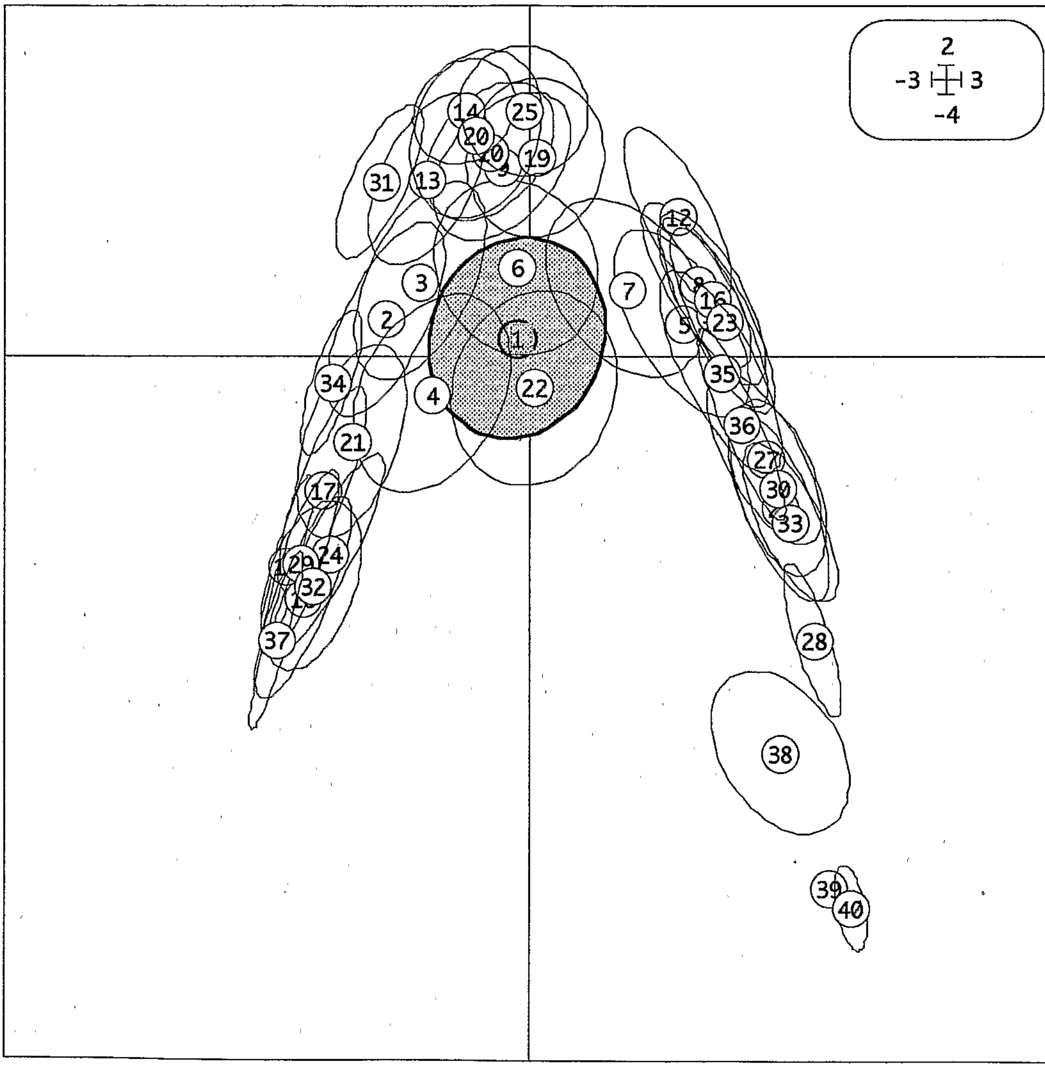

Fig. 4: Species projection according to the first factorial ordination, with a Gaussian inertia ellipse as a representation of the species tolerance or the range of habitat of the 40 main species of the demersal community off Cap Blanc (numbers = species rank according to Table I; stippled area = *Octopus vulgaris*)

two greater communities, namely cold-water species of Saharan and Mediterranean affinity and warm water of Guinean affinity. Theoretically, therefore, the community studied here consists of species and populations of relatively high ecological tolerance.

In conclusion, the common octopus appears to be a major ecological component of the benthic community off Mauritania in terms of both numbers and mass. However, what is probably more ecologically significant than its total abundance is its very large range of habitat (compared to that revealed by the global community analysis for other species). Ability to colonize and occupy a wide range of depth and substratum all year round may represent an ecological advantage for the species. In addition to its other biological characteristics (see Caddy 1983, Mangold 1983, Amaratunga 1987, Jouffre and Inejih 1997, Inejih and Jouffre in press, Jouffre *et al.* in press), this advantage is probably one reason why the common octopus seems to tolerate overfishing better than other species (Jouffre and Inejih 1997). It may also explain how the species can maintain such a great abundance when so highly exploited or even why it seems to have supplanted other species, e.g. sparids, that have greatly decreased in the same area as a result of overfishing (Pereiro and Bravo de Laguna 1980, Caddy 1983).

ACKNOWLEDGEMENTS

The study was supported by a cooperative programme between the Centre National de Recherches Océanographiques et des Pêches (CNROP) and the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM). I thank CNROP's Director for providing facilities and the R.V. *N'Diago* for the study and other CNROP officials for their hospitality and help during the surveys.

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