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Feeding Habits of Two Sharks Species *Scyliorhinus canicula* (Linnaeus, 1758) and *Galeus melastomus* (Rafinesque, 1810) in the Western Algerian coasts

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ABSTRACT

The trophic relation of *Scyliorhinuscanicula* (Linnaeus, 1758) and *Galeusmelastomus* (Rafinesque,1810) was investigated by analyzing the stomach contents of 154 individuals of the Lesser-spotted Catshark and 220 individuals of the Blackmonth Catshark collected in the western Algerian coasts during six months. These Catshark species are the most abundant Selacians species on the Mediterranean coastlines. They are presents on the continental shelf on depth ranges partly overlap although and they occur in different habitats. Both of *S. canicula* and *G.melastomus*are characterized by an opportunistic scavengers and generalist feeding habit with a preference prey like Crustacean, followed by Fish, and Cephalopods classed as secondary prey. Their prey composition shows similarity observed primarily with individuals of 28-48 cm total length (Lt) where the Crustacean and Fish are the most important preys founded. While the Crustaceans are almost absent in the individuals of the Lesser-Spotted Catshark >48cm, they are significantly present in the Blackmonth Catshark. Lesser-spotted Catshark is a mostly benthic feeder and it feed on a greater diversity of prey than the Blackmouth Catshark which is more suprabenthic. The broad diets of these Catsharks species and their different prey composition may make them good indicators of theexploitation level and fishing-induced in the ecosystem fishing area.
KEYWORDS: Western Algerian coast, *Scyliorhinus canicula*, *Galeus melastomus*, Prey, Feeding habits.

INTRODUCTION

Scyliorhinus canicula (Linnaeus, 1758) and *Galeusmelastomus* (Rafinesque, 1810) are the two Elasmobranchs the mostabundant on the continental shelf in the Algerian occidental coasts (Sanchez andal. 2002). Lesserspotted Cat shark is found at depth from 50 to 500m especially between 100 and 300m (Sanchez, 1993) where Black month Catshark is commonly found between 200 and 500m, occasionally up to 55 and down to 1400m (Compagno, 1984; Carrasson andal. 1992) but *S.canicula* remains however the species the most abundant (Sanchez, 1993; Sanchez andal. 2002).These small Catshark species display daily vertical migration, males occupy the deeper areas during the day and in shallow areas at night while females congregate in the shallow area during the day and at night the deep waters (Sims andal. 2006).Although these species are abundant on our coasts, few data are available on landings of a low commercial value (Olaso andal. 1998; Rodriguez-Cabello andal. 2004). They are considered as accessory species that have characteristics suggesting that the changes that may affect their abundance and their diet may be good indicators of changes produced in the ecosystems. Some studies showed that trawling may change the benthos and so modify the abundance of their preferred prey, as well as increase the availability of their prey (Olaso andal. 1998; Rodriguez-Cabello andal. 2007; Olaso andal. 2002).Others works suggest that the feeding habit of the Blackmonth Catshark may change after the supply of energy from fishing discards. The assemblies analysis had shown the associated species on the spatiotemporal plan. The evolution of the assemblies linked to the changing environmental parameters can determine the permanent species in the area.
The main of this study of the feeding habits of these two small Catsharks species which represent accidental predator catch species reflect the characteristics of the state of the ecosystem, define their position in the trophic chain and could show some competition and sharing phenomena that take place in the middle (Berg, 1979 *in* Bouaziz, 1999; Cortes, 1999, Braccini andal. 2005; Domi andal. Demirhan and Seyhan, 2007).

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MATERIAL AND METHODS

During six months of sampling from January to June, 154 individuals of the Lesser-spotted Catshark and 220 individuals of Blackmouth Catshark are collected along the western Algerian coasts **(Fig.1)**, which allows to know the feeding habit of the species in their natural habitat and also their feeding behavior trophic migration that could explain the influence that may exist on their reproduction (Stregiou and Kapouzi, 2002).
In the laboratory the samples are weighed, measured and sexing, sexual maturity is determined macroscopically. The length at maturity for *S.canicula* is estimated at 36 cm and for *G.melastomus* is estimated at 48cm in the study area (TalebBendiab, 2010).

Stomach sampling

Stomach contents from both Lesser-spotted Catshark and Blackmouth Catshark are analyzed on laboratory. Total length (Lt), sex maturity and stomach fullness (Containing food or empty) were recorded for each predator specimen. The total volume of prey items was recorded for each stomach containing food. All prey items were counted and weighed.

The analysis and identification of remains undigested stomach found in the digestive tract is done either by taxonomic criteria when remains are digested either by the diagnostic parts as otholiths for fishes. The identification of prey was made using a set of references for several taxonomic groups (Fauvel, 1923; 1927; Corthers, 1983; Whitehead andal. 1986 et Hayward and Ryland, 1995).

Inventory is followed by a quantitative analysis allometric relationship for estimating lengths and weights of individual prey. Decapods, Crustacean, Fish and Cephalopods were usually identified to species level. These prey items were removed and preserved in a 10% buffered formalin solution for a later identification.

Analysis of diet composition

The diet breadth of both species determined to the lowest tax on comical level possible for each prey item was compared with different indices: ***IA, Q, IRI.***
Lauzanne index (1975) IA which use the occurrence index and the weight percent of prey item:

$$\mathbf{IA=F*}\boldsymbol{Cp}\mathbf{/100}$$

When:
IA≤10 the prey is considered as a secondary
10<IA≤25 sizeable prey
25<IA≤50 essential prey

IA>50 dominant prey

Hureau coefficient (1970) Q which use the number percent of prey item and occurrence frequency of the prey item.

$$Q= Cn*Cp$$

When:
Q>200 the preyis considered as a preferred prey
20<Q<200 secondary prey
Q>200 accessory prey

Index of relative importance of Pinkas andal. (1971) IRI which evaluate the relationship between the different prey items species diet, while considering the occurrence frequency, number percent and weight percent of each prey item.

$$IRI=F+(CN+CP)$$

In order to classify the prey items according to the IRI, the method developed is:
When:
200<IRI<20.000 the prey is considered as a main prey
20<IRI<200 secondary prey
IRI<20 accessory prey

The vacuity coefficient is also used which evaluate the relationship between the empty stomach percent (Nev) and the number of stomach studied (N).

$$Cv=Nev/N*100$$

RESULTS AND DISCUSSION

Comparative feeding ecology of *S.canicula* and *G.melastomus*

Previous studies have described feeding behavior in Catshark in the Atlantic Ocean and Mediterranean Sea (Mattson, 1981; Macpherson, 1981; Lyle, 1983; Carrassón and *al*. 1992), as well as in the Cantabrian Sea

(Olaso and Rodríguez-Marín, 1995a; Velasco and *al*. 1996; Olaso and *al*. 1998; Gutiérrez-Zabala and *al*. 2001). In the present study realized in the western Algrerian coasts, all the available data on the feeding of Lesser-spotted Catshark and Blackmouth Catshark during the sampling period have been integrated to compare their food habits and the influence of their habitats on diet.

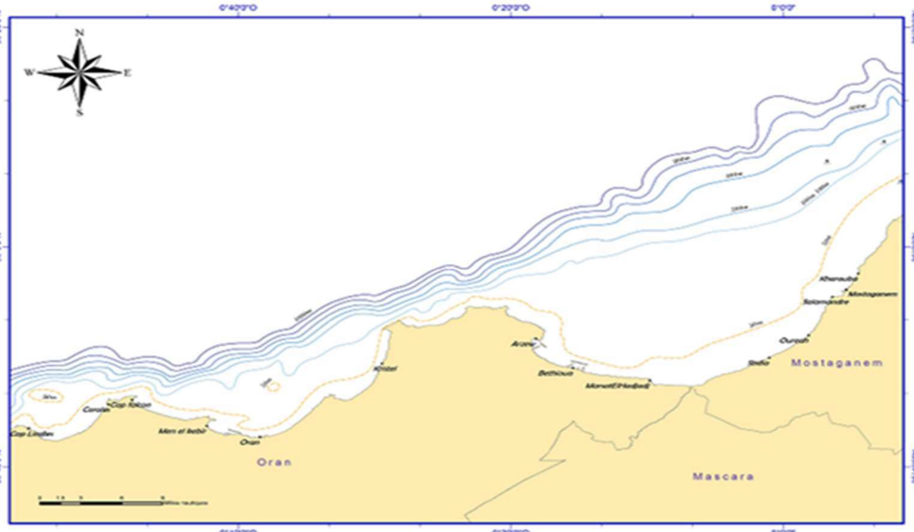

Figure 1: Localization of the sampling area (MapInfo Professional, Ver 12.0)

From a total of 145 stomachs of *S.canicula* analyzed with a total lengths ranged from 25 cm to 48 cm, 91 were full and 51 were empty. For *G.melastomus* 220 specimens were analyzed with total lengths ranged from 28 cm to 56 cm. From this sampling 61 stomachs were full of prey and 159 were empty. For both sampling were collected in the evening for a better quality and diversity of prey, knowing these species are nychtemeral, feeding at night.
In total, the vacuity y for *S.canicula* was 56,66% and for *G.melastomus* 72,95% **(Fig.2)**. The percentage by number of prey indicates that a sufficient number of stomachs were used to characterize the diet diversity of both *S.canicula* and *G.melastomus*.

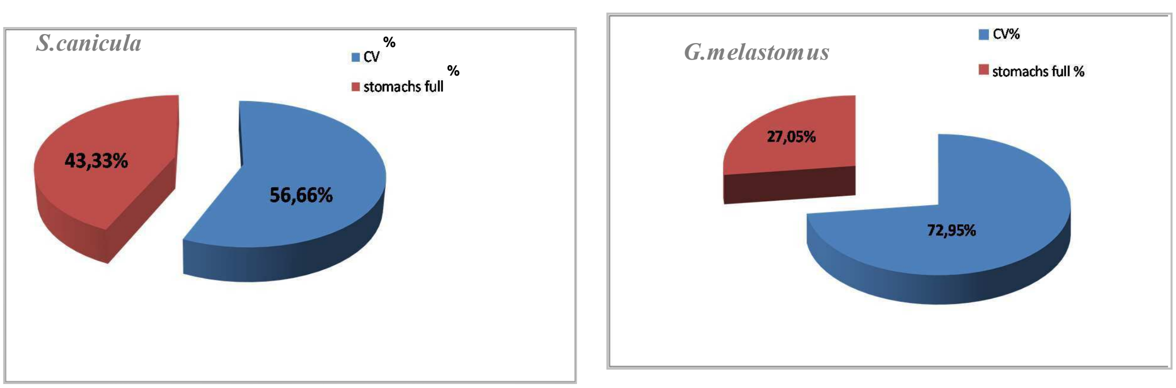

Figure 2: Vacuity indices of both species

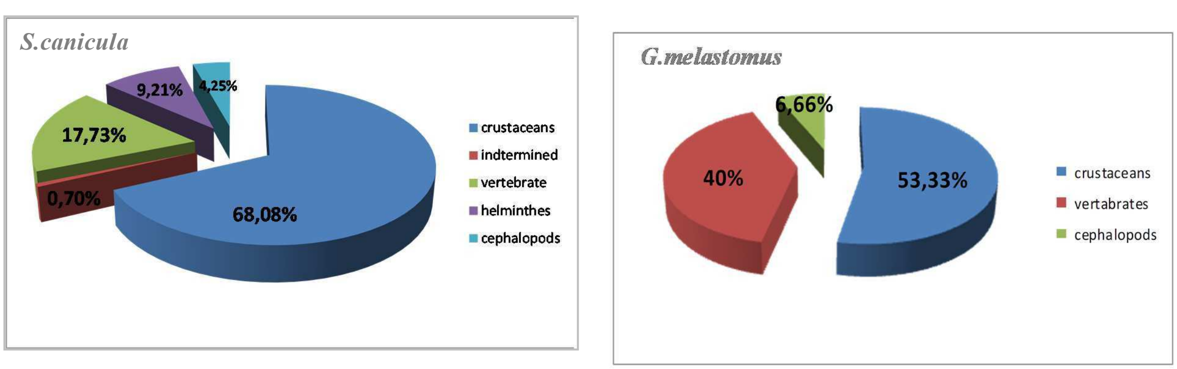

Figure 3: Frequency occurrence of the prey of both species

Syliorhinus canicula (Linnaeus, 1758) and *Galeus melastomus* (Rafinesque, 1910) exhibit the same diverse diet, composed of 151 and 116 prey, part of three branch Arthropods, Cephalopods and Vertebrates represented by small fishes. Crustaceans were by far the most abundant group in their diet according to the occurrence indices, with value of 68,08 % and 53,33% respectively. The second and third prey for both species were small fishes *Micromesistius poutassou* and *Trachurus trachurus* and Cephalopods *Octopus vulgaris* and *Loligo vulgaris* **(Tab.1)**.

Table 1: Diversity of ingested prey by both species

Phylum	sub-phylum	Classe	Sub-classe	super-odre	Odre	Famille	genre	espèce
							Pasiphaea	*sivado*
					Decapoda	Pasophaidea	*Pasiphaea*	*multidentata*
Arthropode	Crustacea	Malcostraca	Enmalacostraca	Encarida	Decapoda	Nephropeidea	*Nephrops*	*norvegicus*
						Penaeidae	*Parapenaus*	*longirostris*
							Goneplax	*nipponensis*
					Mysidacea	goneplacidea	*Goneplax*	*rhomboide*
Annelida		polychaeta	Ind	Ind	Ind	Ind	*Ind*	*Ind*
Chordata	Vertebrata	actinopterygii			Gadiforme	Gadidea	*Micromesistius*	*poutassou*
Chordata	Vertebrata	actinipterygi	Neopterygii	achantopterygi	Perciforme	Carangidea	*Trachurus*	*trachurus*
Helminthes		Nematoda	Secermantea	ascariodoidea	Ascaridida	Anisakidea	*Hysterothylacium*	*Ind*
Cephalopodes	Mollusca	cephalopoda	Coleoidea	octobranchia	Octopoda	Octopodidea	*Octopus*	*Vulgaris*
Cephalopodes	Mollusca	cephalopoda	Coleidea	decabranchia	Teuthida	Loliginidea	*Loligo*	*Vulgaris*

The same observations are noted, analyzing frequency and evolution of the number of prey with length classes. For both *S.canicula* and *G.melastomus* length class present the three groups with length ranged from 36-48 cm and 28-48 cm respectively, where the Crustaceans represent the dominant prey and Vertebrate and Cephalopods played more a secondary role in the diet of the two species.

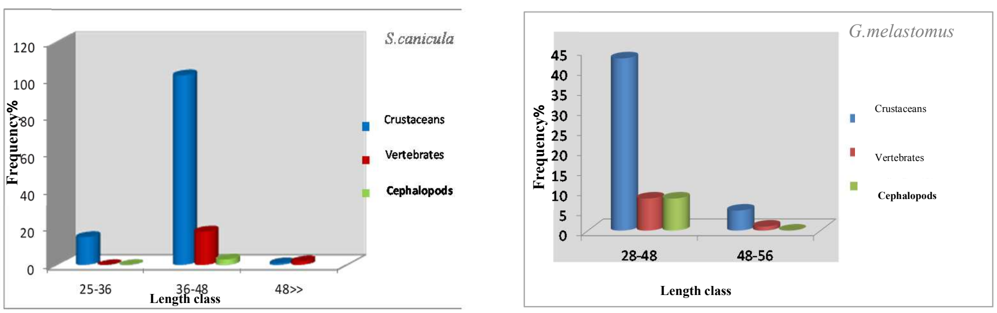

Figure 4: Frequency and evolution of the number of prey with length classes for both species

The maturity index OSI and sex related variability in the diet of *S.canicula* and *G.melastomus*

The study of the OSI index with *G.melastomus* was not significant. In contrast, the analyze of the vacuity and OSI of *S.canicula* showed a reverse trend. These results are according with the studies of Rodriguez-Cabello andal. 2008. We can observe the maximal vacuity values of *S.canicula* are noted in January and May corresponding to the lowest values of OSI which can be explained by the trends to feed before the spawning period to provide sufficient energy for gonads development (INRH, 2002).

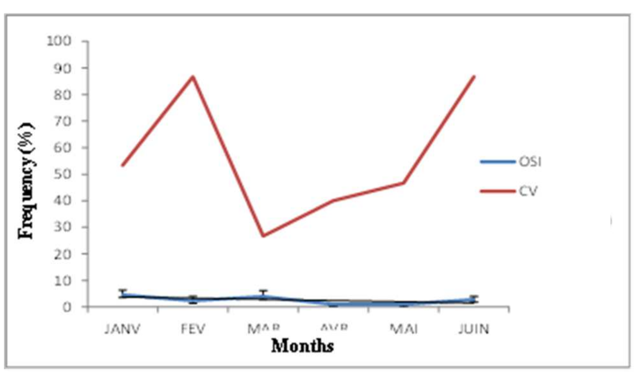

Figure 5: Variability of the OSI and CV of *S.canicula*

From the calculation Q, IRI and IA following the **Hureau, 1970, Lauzanne, 1975 and Pinkas andal. 1971 methods (Tab.2 and 3)** *S.canicula* and *G.melastomus* present frequencies of prey are not different, with Crustaceans as essential prey and Vertebrates and Cephalopods as secondary or accessory prey for both sexes**(Tab.4)**.

Table 2: Classification of prey ingested by *S.canicula* using three methods

Prey	Effec/prey	Cn	Cp	Q	IA	IRI
Crustaceans	97	125,620491	104,861538	9145,74038	44,9107493	9375,49459
Fish	28	20,1930014	44,1854383	1163,32297	10,1543379	1521,511331
Cephalopods	7	15,0595238	32,8073027	0	9,19074727	0

Table 3: Classification of preys ingested by *G.melastomus* using three methods

Prey	Effec/prey	Cn	Cp	Q	IA	IRI
Crustaceans	107	92.2413793	39.5096198	3644.42182	183.980495	597.41
Fish	10	8.62068966	41.2824367	355.883075	20.7691939	100.21
Cephalopods	9	7.75862069	19.2079436	149.027148	16.1730885	111.17

Table 4: The importance of the different prey ingested by both of *S.canicula* and *G.melastomus*

Method used	Importance	Prey
Hureau (1970)	Preferential prey Q > 200	Crustacean
	Preferential prey 20 < Q < 200	Vertebrate
	Accessory prey Q < 20	
Lauzanne (1975)	IA > 50 : dominants prey	
	25 < IA ≤ 50 : essential prey	Crustacean
	10 < IA ≤ 25 : sizeable prey	
	IA ≤ 10: secondary prey.	Vertebrate, Cephalopods
Pinkas (1971)	Preferential prey 200<IRI<20000	Crustacean, Vertebrate
	Secondary prey 20<IRI<200	
	Accessory prey IRI<20	Cephalopods

This study has shown broad diet spectrum of *S.canicula* and *G.melastmus* wich is in agreement with several published studies of these species (Capape and al. 1974; Olaso and al. 1998; Bozzano and al. 2001; Olaso and al. 2002; Domi and al. 2005; Olaso and al. 2005 Cabello-Rodriguez and al. 2008; Morthino and al. 2012).The main dietary of both of *Scyliorhinus canicula* (Linnaeus, 1758) and *Galeus melastomus* (Rafinesque, 1910) have a similarly feeding habit with a dominance of the Crustacean, monitoring of Vertebrates and Cephalopods. This diversity of prey shows a generalist and opportunistic scavenger feeding habit (Ellis and al.1997; Serrano and al. 2003) for the Lesser-spotted Catshark andirrespective of length-class. The diet of Blackmouth Catshark was less diverse than that of the Lesser-spotted Catshark. The Blackmouth Catshark is apparently less opportunistic and selects less varied prey than Lesser-spotted Catshark (Olaso, 1990; Sánchez, 1993), referring to the results of the studies carried at the Norwegian area by Mattson (1981) and Carrassón and al. (1992) in the Catalonian Northwestern Mediterranean, we also observe that all size classes had a more diverse diet than those in shallower water where their prey were more abundant compared to the large prey which are are less abundant than small prey. This opportunistic character of the Lesser-spotted Catshark has been also observed in the studies of Cabello- Rodriguez (2008) in all length classes, especially with length ≥ 30 cm corresponding to one year old and more (Lyle, 1983; Olaso and al. 1998).The most abundant Crustaceans belonged to order decapods were *Parapeneaus longirostris*, we also found *Goneplax rhomboide* and *Goneplax nipponensis* as prey, indicating the ability of *S.canicula* and *G.melastomus* to forage in benthic habitats. They have been described as active benthic feeders that use a range of active senses for finding prey (Olaso and al. 2005; Kimber and al. 2009). According to the study realized in the Bay of Biscay, high prey diversity enabled its classification as a generalist feeding species (Serrano and al. 2003). These species have also been considered opportunistic scavengers, taking advantage of the discards from local trawling fisheries (Olaso and al. 1998; 2005).

The presence of pelagic vertebrate prey as *Micromesistius poutassou* and *Trachurus trachurus* in the stomach contents of *S.canicula* and *G.melastomus* is also evidence of this species as a pelagic predator *S.canicula* meets different organism suprabenthic and some demersals fishes in different depths (Maucheline and Gordon, 1984; Maucheline and Gordon, 1991; Gordon and al. 1996, Merett and Haedrich, 1997). Although it has a nocturnal feeding (Pals and al. 1982; Carrasson and al. 1992; Bello, 1995) it diet is diversified with essentially benthic prey communities and also pelagic species (Lyle, 1983; Olaso and al. 2005).

In some works the increased abundance of the Scyliorhinide is related to the decline of some commercial species (Fogary and Murawsky, 1998; Rogers and Ellis, 2000). This study also provides important information regarding to the potential for the resource competition given the high level of diet overlap between both species and the diversity of the ecosystem of the area.

Competition and predation are important, that why it is important to know how competition and predation could influence the distribution of Elasmobranchs fishes (Papastamatiou and al. 2006), and it is also important to determine the preferential prey items and feeding habits of these species in order to assess resource partitioning and competitive segregation among species that coexist in similar area.

Both species were captured in the same area their trophic behavior confirms that both species use these habitats throughout their whole life-cycle are in competition, this competing with a high diet similarly between tow Scyliorhinidea has been observed in the Cantabrian Sea (Spain) in the study of Olaso and al. (2005). The present study shows that although the different bathymetric distribution *S.canicula* and *G.melastomus* have the same dietary composition in the study area. Both of species feed mostly on Crustaceans and teleost prey, the behaviour of both species allows them to feed on prey from the benthic communities and from mid-water depths. However, the feeding habits of Lesser-spotted Catshark are mostly benthic (Lyle, 1983; Olaso and Rodríguez-Marín, 1995a, 1995b) and Blackmouth Catshark are benthopelagic (Bozzano and al. 2001).

In the Mediterranean Sea, Catshark eyes are of considerable importance for detecting their prey and their retinas adapt to the depth at which they occur (Bozzano and al. 2001). Lesser-spotted Catshark adapt to the more variable light intensity in their coastal habita. The prey of Blackmouth Catshark in the Mediterranean Sea make extensive vertical migrations (Bello, 1995) and at least a fraction of the population ascends to the bottom of the near-surface mixed layer (Cartes and al. 1993; Bergstad and al. 1996). The adaptation of their eyes to depth is highly related to the distribution range of each species.

We note that the Catsharks change their habita as they grow from juveniles to adults, with older Lesser-spotted Catshark moving closer to the shore and older Blackmouth Catshark moving further offshore. As Catsharks grow the frequency of the fish capture increases as it has been described in other areas (Relini and Wurtz., 1975; Macpherson, 1980; Olaso and al. 2005). The consumption of the mesopelagic fish *M. poutassou* is particularly important for both species, and so is the increase of the catch of Cephalopods for Lesser-spotted Catshark.

Olaso and al. (2004) discribe an Morphological characteristics of the eyes and olfactory lobes of both species probably result in differences in their search and capture of prey, and noted that better sight and poorer smell of the Blackmouth Catshark favours the hunting and capture of prey that are found in the water column. The poorer sight and better smell of the Lesser-spotted Catshark suggests that this species is better adapted to consume benthic prey (Bozzanoand al. 2001; Kaiser and Spencer, 1994; Olaso and al. 1998 and 2002) .

Lesser spotted Catshark and the Blackmouth Catshark represent the most abundant species in the Mediterranean sea, their slow growth and late reproduction make them very susceptible to overfishing (Graham and al. 2001; Baum and al. 2003).

In the case of these Catsharks, trawling in study area may have made them more available because fishing activity would supplemented their food with offal and discards. Previous studies have postponed similar increases in abundance of these small sharks that have accompanied the decline of commercial species (Fogarty and Murawsky, 1998; Rogers and Ellis, 2000). In most cases, the reasons for these increases are unknown. The increased abundance of Lesser-spotted Catshark probably results from scavenging on macrofauna, such as Crustaceans and errant polychaetes (Serrano and al. 2003a, 2003b) which benefit from disturbed sediments and organic matter generated by trawls and discards (Collie and al. 1997; Kaiser and al. 1998) including fish (Olaso and al. 1998).

Knowing that these species do not represent the target species and therefore having no specific fishing it is impossible to establish a study on exploitation, indirect way, taking into account their migratory characteristics and trophic changes in the availability and diets of these two species of Catshark may be good indicators of broadscale changes caused by increasing exploitation in their ecosystem.

Further work should also include continued interseasonal and interannual sampling, in order to detect the possible influence of fishing activities on benthic organisms and the diet composition of top predators such as Elasmobranchs as well as other life-history parameters such as age and length structure age at maturity and ultimately stock identification. Abundance changes of the feeding habits of these tows Sclyiorhinidea could be an excellent indicator of the state of the ecosystem which they belong.

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