Distribution of *Scyliorhinus canicula* in the circalittoral seabeds of Cabrera National Park

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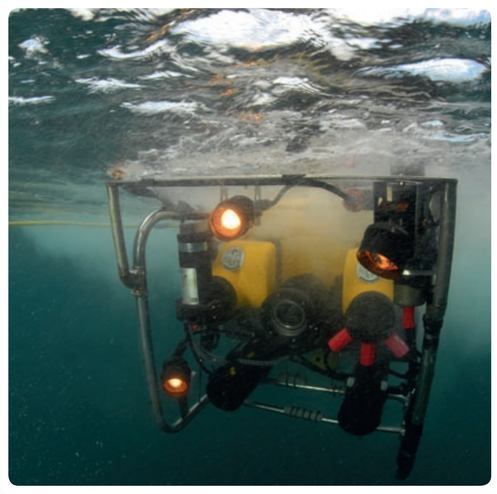


Abstract

The circalittoral seabeds of the Cabrera Archipelago National Park (Spain) and the surrounding areas are characterized by a combination of soft detritic bottoms scattered with coral or rock, which harbor a wide variety of Mediterranean flora and fauna, including several species of elasmobranchs.

In 2007, Oceana carried out bionomic investigations to survey the seabeds in and around Cabrera National Park, covering an area of 10,050 hectares. The small spotted catshark (*Scyliorhinus canicula*) was recorded during 53 observations for a total of 56 individuals among the three areas sampled. This species represented 91.7% of all elasmobranch sightings during the investigations. The other species seen were *Raja miraletus* (three individuals) and *Raja montagui* (two individuals), bringing the total to 61 elasmobranchs. The highest abundance of this species was seen in sampled areas below 100 metres depth. While mainly present on soft detrictic bottoms, *S. canicula* was also found on maërl beds and near kelp forests.

Our calculations demonstrate that the population of *S. canicula* in and around Cabrera National Park could be over 40,000 sharks, confirming that the biomass contribution of elasmobranchs in these areas is higher than in other areas of the Balearic Islands and even other areas of the Mediterranean Sea (see Moranta *et al.*, 2007 and Massutí and Moranta, 2003).

Introduction

Cabrera Archipelago National Park was created in 1991 and is composed of 19 islands in the Balearic Islands (Spain). The park covers 10,032 hectares, 8,703 of which are marine waters. The park has been declared a Special Protection Area (SPA) for birds and a Site of Community Importance (SCI), in accordance with European Union conservation directives. The park encompasses numerous types of habitats, including *Posidonia oceanica,* and to a lesser extent *Cymodocea nodosa,* seagrass meadows; maërl beds; coral, sandy and rocky bottoms; and *Cystoseria* forests.

Cabrera is an important area for elasmobranchs, and the following species are protected there: *Squatina* spp., *Scyliorhinus stellaris, Dasyatis centroura, Torpedo torpedo, Sphyrna* spp., and *Prionace glauca*. However, it is another species, the small spotted catshark, *Scyliorhinus canicula*, whose abundance in the park and its surrounding areas is most noteworthy.

S. canicula is a common species in the entire Mediterranean Sea, including the Black Sea (see Capapé *et al.*, 2008 and Serena, 2005). It is a benthic shark often found over gravelly, sandy or muddy bottoms from shallow waters down to 400 m depth, although its typical range is down to 110 m on the continental shelf and upper slopes (Compagno, 1984). *S. canicula* is one of only ten chondrichthyan species in the Mediterranean not considered to be under any threat of extinction now, or in the foreseeable future, by the International Union for the Conservation of Nature (Cavanagh and Gibson, 2007).

Remotely operated vehicles (ROVs) are useful tools for carrying out bionomic studies, allowing for in situ visual observation of fishes and habitats at deeper depths. The new insight gained on species distributions, behaviours and environmental conditions could ultimately lead to improved fisheries management and conservation programs.

Materials and methods

In July and September of 2007, Oceana carried out a bionomic investigation of the seabeds surrounding the Cabrera archipelago to identify potential areas for expansion of the national park and to study the deeper seabed communities within the limits of the protected areas.

To carry out the investigation, a ROV Phantom HD2+2 was used, equipped with a 750 resolution line camera with an F1.2 lens and a 1:12 zoom. The Oceana Ranger, a ketch catamaran, was used as a work station for the investigation. The vessel is 21 m long and 9.75 m wide, with a 13 person crew that included a captain, three sailors, a cook, four divers, two ROV technicians and two scientists.

Investigators carried out transects that were perpendicular or parallel to the coastline in areas to the north, east and south of the national park. While the transects were carried out, various data including depth, position, direction and time of day were recorded. At the same time, scientists on board made visual observations and recorded images for subsequent analysis. These recordings were later viewed three additional times to identify species, seabed types and other bionomic characteristics to the lowest taxonomic level possible.

The ROV moved along at less than a half metre above the sea floor, creating a field of vision 1.5-2 m wide. It moved at a velocity of 0.2-0.4 knots, permitting between approximately 700 and 850 square metres to be sampled per hour.

The sampling depths varied between 42 and 120 metres. The northernmost area was the shallowest (between 40 and 80 m depth), while the eastern and southern areas were deeper (between 65 and 100 m and 70-120 m depth, respectively). The southern area presented the widest bathymetric range.

Results

A total of 21 transects were completed (7 to the north of the park, 7 to the east and 7 to the south) covering a total of 44.06 nautical miles.

During the 21 transects executed, a total of 56 *Scyliorhinus canicula* individuals were documented: 31 to the north of the park (in 28 distinct observations; in three occasions two sharks were seen at one time), 8 to the east and 17 to the south.

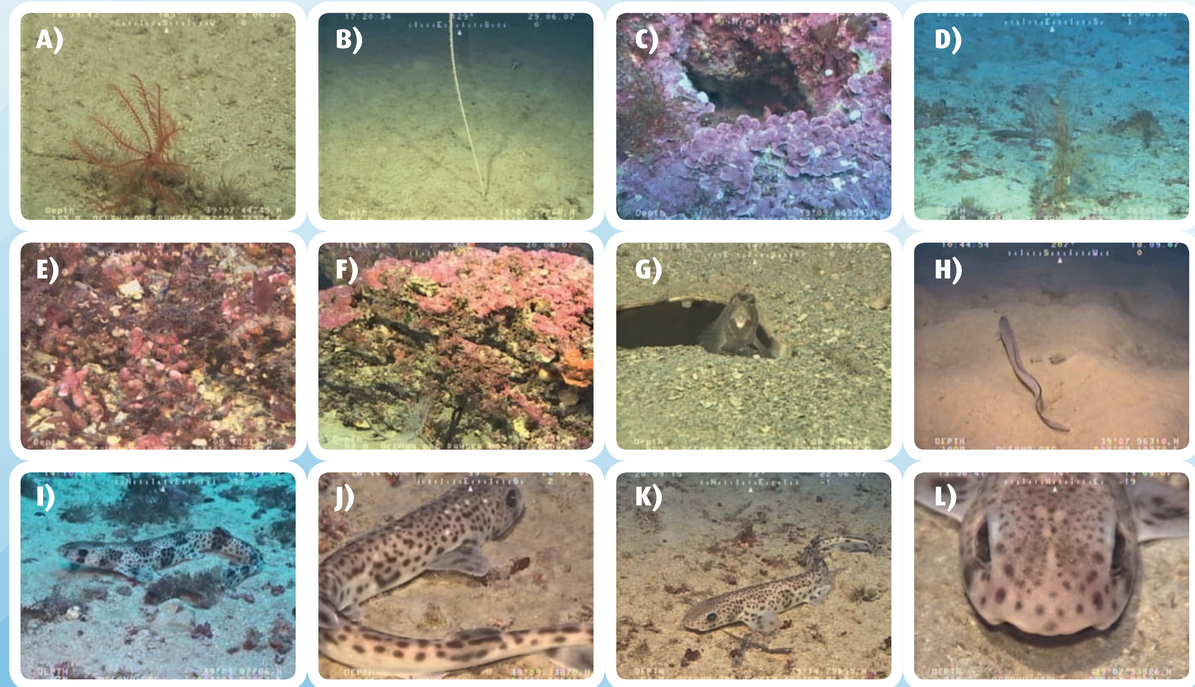
Most of the sightings were recorded between 50 and 100 m depth (44 of the 56 individuals), although most of the ROV effort was also carried out within this depth range. Indeed, 92.45% of the time spent surveying occurred within this bathymetric range. However, taking time spent surveying into account, the number of sharks observed clearly increased with depth, such that the density was more than 4 times higher in seabeds deeper than 100 m than in shallower areas.

Table 1. Sightings of *Scyliorhinus canicula* by depth.

Depth	Sightings north quadrant Av^n (% of total)	Sightings south quadrant Av^n (% of total)	Sightings east quadrant Av^n (% of total)	Sightings park total Av^n (% of total)	Time surveying (min)	Proportion of time surveying	Average sightings per hour (Av^n h^{-1})
<50	1 (3.23%)	0	0	1 (1.79%)	191	2.17%	0.314
50-100	30 (96.77%)	6 (35.30)	8 (100%)	44 (78.57)	8148	92.45%	0.324
>100	0	11 (64.70)	0	11 (19.64)	474	5.38%	1.392

Soft seabeds composed of detritic sand was the predominant habitat type observed in and around the park. However, maërl beds, coral beds, kelp forests, gorgonian gardens and algae communities, among other habitat types, were also documented. We have divided the seabed types in the following manner, depending on the substrate and most characteristic flora or fauna communities present:

- Soft bottoms are those with detritic sand with or without sparse algae communities;
- Maërl beds are those where rhodoliths covered 20-80% of the seafloor;
- Hard bottoms are rocky areas, normally made up of coralligenous beds.



A-C: soft bottoms, **D-E:** Maërl beds, **F-H:** Hard bottoms, **I-L:** *S. canicula.*

The average density of *Scyliorhinus canicula* in the areas surveyed was 3.921 individuals per hectare, with an average of 1.270 sharks for every nautical mile covered. Geographic distribution, however, was not uniform, and the majority of sightings occurred in the northern quadrant.

Table 2. *Scyliorhinus canicula* distribution and density by area surveyed.

Quadrant	Total quadrant surface area	Nautical miles (nm) covered	M^2 observed	Total sightings (AV-n)	AV^n nm^{-1}	AV^n m^{-2}	AV^n ha^{-1}	Relative density	Total weighted density
North	4984 ha	20.60	66785.20	31	1.505	0.000464	4.642	23136	
South	2465 ha	10.36	33581.15	17	1.640	0.000506	5.062	12478	40514
East	2602 ha	13.10	42463.17	8	0.611	0.000188	1.883	4900	
TOTAL Average	10050 ha	44.06	142829.52	56	1.270	0.000392	3.921	39406	

Taking seabed types into consideration, the majority of *S. canicula* sightings occurred over soft seabeds of detritic sand, where this fish shared living quarters with echinoderms, bivalves, cnidarians, etc. In fact, higher abundances of *S. canicula* corresponds to the areas in the north and south quadrants where soft bottoms were most prevalent. *S. canicula* was also found on maërl beds and near kelp forests.

With these points in mind, we have estimated the density of *S. canicula* for the circalittoral seabeds of Cabrera National Park, providing us with the following numbers:

Table 3. *Scyliorhinus canicula* distribution and density by bottom type.

Quadrant	Total quadrant surface area (ha)	Sightings per per seabed type	AV^n mn^{-1}	AV^n ha^{-1}	Time spent surveying (min)	Density	Total density	Total weighted density
SB	3323	25	2.216	3.839	2256	2276		
North MB	1638	6	0.656	2.023	1.830	3314	26040	
HB	23	0	0.000	0.000	35	0		
SB	2358	17	1.758	5.426	1933	12794		
South MB	14	0	0.000	0.000	23	0	12794	43961
HB	93	0	0.000	0.000	116	0		
SB	1056	6	1.152	3.551	1043	3750		
East MB	834	2	0.535	1.651	747	1377	5127	
HB	712	0	0.000	0.000	830	0		
TOTAL	6737	48	1.835	5.662	5232	38145		
Average	2486	8	0.615	1.898	2600	4718	42863	
	828	0	0.000	0.000	981	0		

SB: Soft Bottoms, **MB:** Maërl Bed, **HB:** Hard Bottom.

Conclusions

While we clearly found greater densities of *Scyliorhinus canicula* below 100 m depth, the entire bathymetric range for this species is wider than what was surveyed in this study (Compagno, 1984). We noted that infralittoral and shallow circalittoral soft bottoms can also be suitable habitats for *S. canicula.*

Soft bottoms, with or without algae cover, is the preferred seabed type for *Scyliorhinus canicula* in the areas surrounding the Cabrera archipelago. The abundance of this species over this seabed type is 3 times higher than that over maërl beds, and no individuals were found over hard bottoms. Soft bottoms of detritic sand may be a favoured habitat type for *S. canicula* because it is best camouflaged here. This species' colouring, with small dark, and occasional light, spots and saddle markings over a lighter coloured body, blends in well with the brown and sandy tones of the detritic sandy seabeds.

A factor kept in mind during our analysis was the possibility of repeating observation counts for individuals that were swimming back and forth across the ROV camera's field of vision. Likewise, there was a possibility of not recording individuals that might have fled the oncoming ROV and were thus not seen. The authors have tried to be as accurate as possible in their documentation, both during initial real-time observations and in subsequent reviews of video tapes.

We have estimated the population of *S. canicula* in and around Cabrera National Park to be over 40,000 sharks. Other elasmobranches were also seen in the sampling areas, specifically three individuals of *Raja miraletus* (seen in the southern quadrant) and two of *Raja montagui* (seen in the southern and eastern quadrants).

Acknowledgements

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