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Article

Feeding habits of *Mustelus henlei* on the western coast of Baja California Sur, México

Hábitos alimentarios de *Mustelus henlei* en la costa Occidental de Baja California Sur, México

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Resumen.- El tiburón musola parda *Mustelus henlei* forma parte de una importante pesquería comercial en la costa occidental de Baja California Sur, México. Sin embargo, se han realizado muy pocos trabajos sobre biología, reproducción y alimentación de esta especie. Nuestro estudio, es el primer trabajo que se realiza en esta especie en la plataforma continental (14 m a 250 m de profundidad) de B.C.S. Mediante un análisis taxonómico, se identificaron un total de 24 tipos de presas, de los cuales 15 fueron crustáceos, 6 peces y 3 cefalópodos. De acuerdo al índice de importancia relativa (IIR) la presa principal fue la langostilla *Pleuroncodes planipes* (81,4%), seguida de la materia orgánica no identificada (MONI) (15,7%), la macarela *Scomber japonicus* (0,94%) y los restos de peces (0,84%). En el análisis de importancia de presas por sexos, se encontró que tanto en hembras como en machos, la langostilla *P. planipens* fue la presa más importante, después MONI y *S. japonicus*. Las especies importantes en la dieta del tiburón que se encontraron en zonas más profundas (120 a 150 m) a bordo del crucero BIP XII, fueron similares a las encontradas en la localidad más somera (14-40 m) de Punta Lobos, siendo la presa dominante la langostilla y también el MONI. De acuerdo al Índice de Levin *M. henlei* es considerado un tiburón especialista. Se observó una superposición de dieta por sexo, área y talla. Con el análisis SIMPER se muestró una baja similitud entre las dietas, con valor de significancia reducida entre sexos, tallas y áreas. De acuerdo a la prueba ANOSIM no se encontraron diferencias significativas. El conocer que *M. henlei* presenta un comportamiento especialista puede ayudar no sólo a la conservación de la especie, sino de su hábitat y de los organismos que se encuentran en él y que son de vital importancia para el tiburón.

Palabras clave: Contenido estomacal, superposición de dieta, especialista, Punta Lobos, Baja California Sur, México

Abstract.- The Brown smooth-hound *Mustelus henlei* is part of an important commercial fishery on the western coast of Baja California Sur (BCS), Mexico. However, very few studies have been performed on the feeding and reproduction biology of these sharks in Mexico. Our study is the first work focusing on this species on the western shelf (14 m to 250 m in depth) of B.C.S. We identified a total of 24 types of prey contents in the stomachs of *M. henlei*: 15 crustaceans, 6 fish, and 3 cephalopods. According to the index of relative importance (IRI) the main prey items for *M. henlei* was the pelagic red crab *Pleuroncodes planipes* (81.4%), followed by unidentified organic material (UOM) (15.7%), the mackerel *Scomber japonicus* (0.94%), and fish remains (0.84%). Conducting a prey analysis considering sex of *M. henlei*, *P. planipes* was the most important prey in both females and males, followed by UOM, and *S. japonicus*. Sharks found in deeper areas (120-150 m) and those caught on board the exploration ship BIP XII had a similar dietary composition to those found in the shallow waters of Punta Lobos (14-40 m) where for both regions, the dominant prey items were the pelagic red crab and UOM. According to Levin's index, *M. henlei* may be a specialist feeder in this area. A diet overlap according to sex, area, and size was observed. The SIMPER analysis showed a low similarity in diet in relation to sex, size, and area. According to the ANOSIM test there were no significant differences. Knowing that *M. henlei* shows a specialist behavior could help research studies not only for species conservation but also for its habitat and the organisms that inhabit it, which are both of vital importance for this shark.

Key words: Stomach content, diet overlap, specialist, Punta Lobos, Baja California Sur, México

Introduction

In Mexican waters, about 80 shark species have been registered (Applegate *et al.* 1979); around 45 of those species inhabit the waters of the Gulf of California (Galván-Magaña *et al*. 1989). Baja California Sur has a strong tradition in shark fishing because of its long coastline with protected and deep sea waters as well as being a transition zone between temperate and tropical areas (Bonfil *et al.* 1990). However, scarce reliable biological information on sharks in this area is one of the main problems hindering decision-making on the resource management of commercial priority fisheries and of those resources that are not exploited (Castro-Aguirre *et al.* 1999).

Mustelus henlei Gill, 1863, from the family Triakidae, is an abundant specie in temperate and tropical waters and very common in closed and shallow bays with muddy and sandy bottoms. The species occurs from northern California, U.S.A. to the Gulf of California, Ecuador, and Peru and constitutes a commercial resource in Mexico**.** The specie is small; average size ranges from 50 cm to 70 cm; a maximum total length around 95 cm; viviparous, with a yolk sac-placenta; 3 to 5 pups per litter; size at birth from 19 cm to 21 cm; males and females reach sexual maturity at a size ranging from 51 cm and 63 cm (Fischer *et al*. 1995). Few studies on the diet of *M. henlei* have reported it feeds mainly on shrimp, crustaceans, fish (Russo 1975, Talent 1982, Gómez *et al.* 2003), and polychaetes (Haeseker & Czech 1993). It is classified as a tertiary predator or mesopredator (TL = 3.6) (Cortes 1999).

Up to date, there is no information on the feeding habits of *M. henlei* for the Mexican Pacific or the Gulf of California. Absence of information for these areas points out the need to improve knowledge of this species whose life strategy could be affected unfavorably by directed or incidental fishing emphasizing the value of planning marine conservation (Rojas 2006). Resource management planning must be based on research where there will be benefits for many countries according to their perspectives (Rodriguez-Romero *et al*. 2009).

Therefore, the aim of this study was to provide biological information about *M. henlei* for the western continental shelf of Baja California Sur, Mexico, to expand knowledge on its behavior, study size, sex, and geographical distribution and to determine its feeding strategies.

Materials and Methods

Study area

The western coast of Baja California Sur is directly exposed to the high-energy regime of the Pacific Ocean (Fig. 1). Constant wind direction is northeast from May to October and southeast from November to February. Along the peninsula, winds that come from the north and

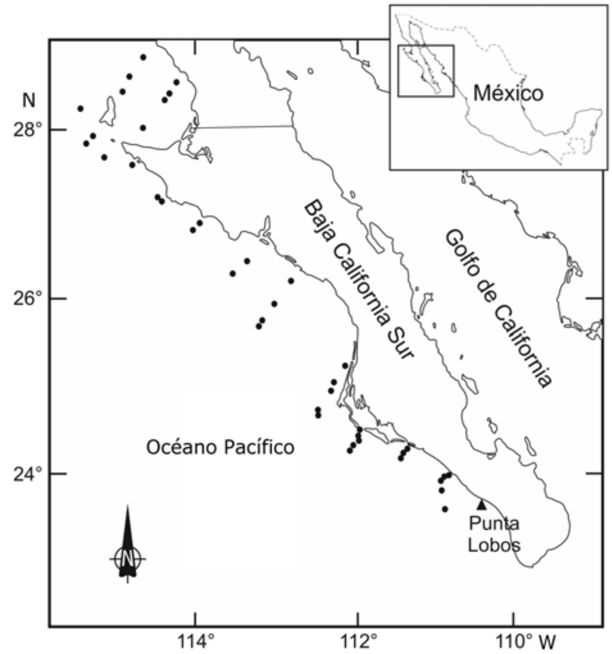

Figure 1. Sampling map for *Mustelus henlei* in the western coast of Baja California Sur, México. Black dots show the BIP XII exploration ship-sampling trajectory / Mapa de muestreo para *Mustelus henlei* en la costa Occidental de Baja California Sur, México. Los puntos negros señalan el trayecto de muestreo del barco BIP XII

northwest are vitally important to the ecosystem because they move the waters parallel to the coast, and together with the influence of the Earth's rotation, the wide cyclonic turns, surge fronts, and other effects provide nutrients to the superficial layer making it ideal for primary organic production (Rueda 1983).

Data collection

Samples were obtained from a scientific cruise and coastal fishing activities in Punta Lobos. The first sampling was performed with shrimp trawling nets from 11 March to 3 April 2005 on board the fisheries exploration ship BIP-XII (23°35'67"N, 110°24'44"W and 28°04'45"N, 114°45'34"W). 12 transects were established with a total of 55 hauls at an average depth of 30, 100, and a maximum depth of 300 m. Each trawl lasted from 15 to 20 min at a speed of approximately 2.5 knots h^{-1} (Fig. 1). Once *M. henlei* individuals were obtained, they were transferred to the Fisheries Ecology Laboratory at CIBNOR for stomach extraction and content analysis.

The second sampling was performed in Punta Lobos (23°25'N, 110°14'W) on 17 and 18 June 2005 applying the same methodology with respect to sample collection.

However, samples were captured with a 12.7-15.24 cm (5-6 in) monofilament mesh, which resulted in a more specific capture interval.

Total length (TL) was registered for each specimen captured using a conventional precision ichthyometer (1 m ± 1 cm). Likewise, sex was determined, and stomachs were extracted and transported to the Fisheries Ecology Laboratory at CIBNOR, and frozen at -25°C until they were analyzed. All the stomach samples were placed in 70% isopropyl alcohol, and the degree of gastric repletion was determined; then stomachs were grouped in 4 filling categories following Stillwell & Kohler (1982), where 0 = empty stomach: 1 = 25% filling; 2 = 50% filling; 3 = 75% filling; and 4 = 100% full.

From the stomach content, the different prey species were separated and classified according to their digestion stage. In the case of fish in a minimum digestion stage, identification keys were used according to Miller & Lea (1972), Eschmeyer *et al.* (1983), Allen & Robertson (1994), and Fischer *et al*. (1995); while for other fish in an advanced digestion stage, identification codes were used based on counting meristic characters (skeleton and vertebras) according to Clothier (1950) and Miller & Jorgensen (1973); crustaceans were identified by keys based on external characteristics (Brusca 1980). Cephalopods were identified with codes based on Iverson & Pinkas (1971); unidentified organic material (UOM) was also separated. Once different prey was separated, they were identified to the least possible taxon. Finally, the content was counted and weighed in an analytical balance (2000 ± 0.01 g).

Quantitative diet composition

For the quantitative analysis of the stomach contents, percentage methods were utilized, such as numeric (%N), gravimetric (%W), and frequency of occurrence (%FO) according to Hyslop (1980), as well as the index of relative importance (%IRI= (%N+%W) x %FO) proposed by Cortés (1997).

Ecological index

Diet niche breadth was determined using Levin's standardized index (Krebs 1989), following the technique proposed by Labropoulou & Eleftheriou (1997) using the following formula:

$$Bi = 1/n - 1\{(1/\sum jPij^2) - 1\}$$

Where Bi = Levin's index for predator j; Pij^2 proportion of predator's diet i on prey j, and n = number of prey categories. These index values fluctuate from 0 to 1; under 0.6 indicates a diet dominated by few prey; thus, we are dealing with a specialist predator; values larger than 0.6 reveal diets of a generalist (Krebs 1989).

To analyze trophic overlap between areas (Punta Lobos and on board the exploration ship BIP XII), sizes (juveniles and adults) and sex, the Morisita-Horn index (Hyslop 1980) was used with the following equation:

$$\underset{i=l}{\overset{n}{C}}\lambda = 2\sum (Pxi \times Pyi)/(Pxi + \sum_{i=l}^{n} Pyi)$$

Values $C\lambda$ ranged from 0 to 1. We used Langton's (1982) scale, which defines that values 0-0.29 indicate a low overlap; 0.30-0.59 average overlap: and higher than 0.6 indicate a high overlap. When values of 1 are obtained, it means that all the elements in the diet are shared, indicating a total overlap.

Statistical analysis

A completely at random design was used with a sample size of 166 organisms. For the stomach content analysis, one-way similarity test ANOSIM ($P < 0.05$) was utilized to determine differences by sex, size, and area. The test implies a global statistical calculus (R) that contrasts similarity variance within and among groups, considering values R > 0.75 imply a defined separation; R > 0.50 a clear differentiation; R > 0.25 a reduced separation; and R~0 a small or null separation (Clarke 1993, Clarke & Warwick 2001). The last step was the application of a similarity percentage (SIMPER) test to determine which species contributed more to defining diet composition. These analyses were performed by using PRIMER V6.0 (Plymouth Routines in Marine Research Programs) (Clarke & Warwick 2001).

Results

Diet composition of *Mustelus henlei*

Of the 166 individuals analyzed, 66% showed stomach content. The TL of *Mustelus henlei* specimens fluctuated from 36 cm to 106 cm. Following the filling proportion values: 45% of the stomachs were found within category 1 (0-25% full); 12% within category 2 (26-50% full); 22% in category 3 (51-75% full); and 21% in category 4 (76-100% full). A total of 24 types of prey were identified through a taxonomical analysis, of which 15 were

Table 1. Percentages in numeric (%N), gravimetric (%W), frequency of occurrence (%FO), and index of relative importance (%IRI) methods of the general trophic spectrum of *Mustelus henlei* in the western portion of Baja California Sur / Porcentaje del espectro trófico general del tiburón *Mustelus henlei* en la porción Occidental de la Península de Baja California, en los métodos de porcentaje numérico (%N), gravimétrico (%P), frecuencia de Ocurrencia (%FO), e índice de importancia relativa (%IIR)

Prey species	%N	%W	%FO	%IRI	Categories
Crustaceans					
Galatheidae	65.4	52.5	44.7	81.5	Main
Stomatopoda	3.2	0.1	12.8	0.2	Secondary
Brachyura	2.6	2.7	13.2	1.60	Secondary
Calappidae	0.2	0.3	0.8	0.01	Occasionally
Portunidae	1.4	7.2	34.4	0.60	Occasionally
Anomura	1.2	0.01	3.25	0.05	Occasionally
Crustacean remains	3.6	0.63	8.0	0.38	Secondary
Mollusca					
Cephalopoda	3.0	1.14	4.0	0.10	Occasionally
Octopodidae	0.24	0.27	0.88	0.004	Occasionally
Osteichthyes					
Scombridae	3.12	7.5	8.8	0.94	Main
Scorpaenidae	0.24	0.57	0.88	0.01	Occasionally
Serranidae	0.24	1.01	0.88	0.01	Occasionally
Paralichthyidae	0.24	1.69	0.88	0.02	Occasionally
Uranoscopidae	0.72	0.64	2.63	0.04	Occasionally
Rest Fish	3.12	4.8	10.5	0.84	Main
UOM	11.03	27.5	40.4	16.0	Main
Benthic material	0.72	0.06	2.6	0.02	Occasionally

crustaceans, 6 fish, and 3 cephalopods besides UOM (Table 1). According to %IRI, crustaceans were the most important prey, where the pelagic red crab *Pleuroncodes planipes,* was the main prey, followed by UOM, *Scomber japonicus*, and fish remains.

According to the numeric method, a total of 417 prey organisms were counted, where crustaceans contributed 77.6%, UOM 11.03%, fish 7.6%, and mollusks 2.8% (Table 1). The most numerous type of prey was *P. planipes,* followed by crustacean remains and the mackerel *S. japonicus*. Prey total weight was 1330.6 kg, with the contribution of crustaceans, UOM, fish, and mollusks. The rest of the prey did not have an important contribution, all together contributing less than 14%.

Feeding habits and ecological index

The total length recorded for females ranged from 36 cm to 102 cm. The total number of stomachs analyzed for females was 103 (29 empty), where 18 prey species were found in their diet. On the other hand, males recorded a total length of 37 cm to 107 cm. The total number of stomachs analyzed for males was 63 (23 empty). Their diet was composed of 14 types of prey. The most important prey content was *P. planipes* and UOM (Fig. 2). When determining trophic breadth by sex, a difference in values was observed, 0.06 for females and 0.09 for males (Fig. 5).

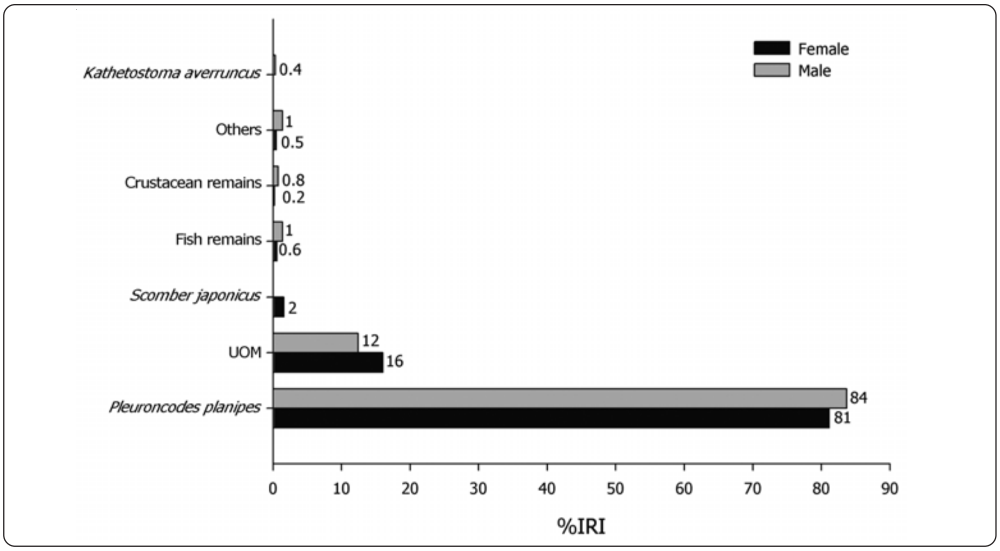

Figure 2. Index of relative importance (%IRI) of the main prey for males and females of the shark *Mustelus henlei* in the western portion of Baja California Sur, México / Índice de importancia relativa (%IIR), de las presas principales de machos y hembras del tiburón *Mustelus henlei*, en la porción Occidental de la Península de Baja California Sur, México

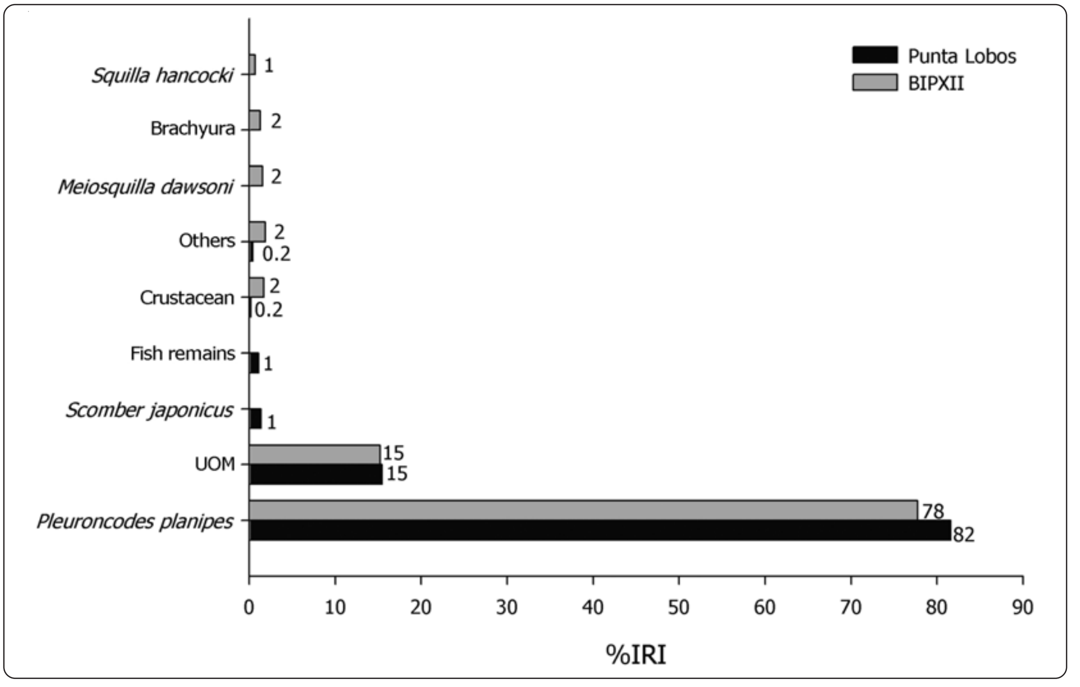

Figure 3. Index of relative importance (%IRI) of the shark *Mustelus henlei* feeding habits in the coastal area of Punta Lobos and the deepest western portion of the Baja California Sur, México (Ship BIPXII) / Índice de importancia relativa (%IIR), de los hábitos alimenticios del tiburón *Mustelus henlei* en la zona de Punta Lobos y en la zona más profunda de la porción Occidental de la Península de Baja California Sur, México (Barco BIPXII)

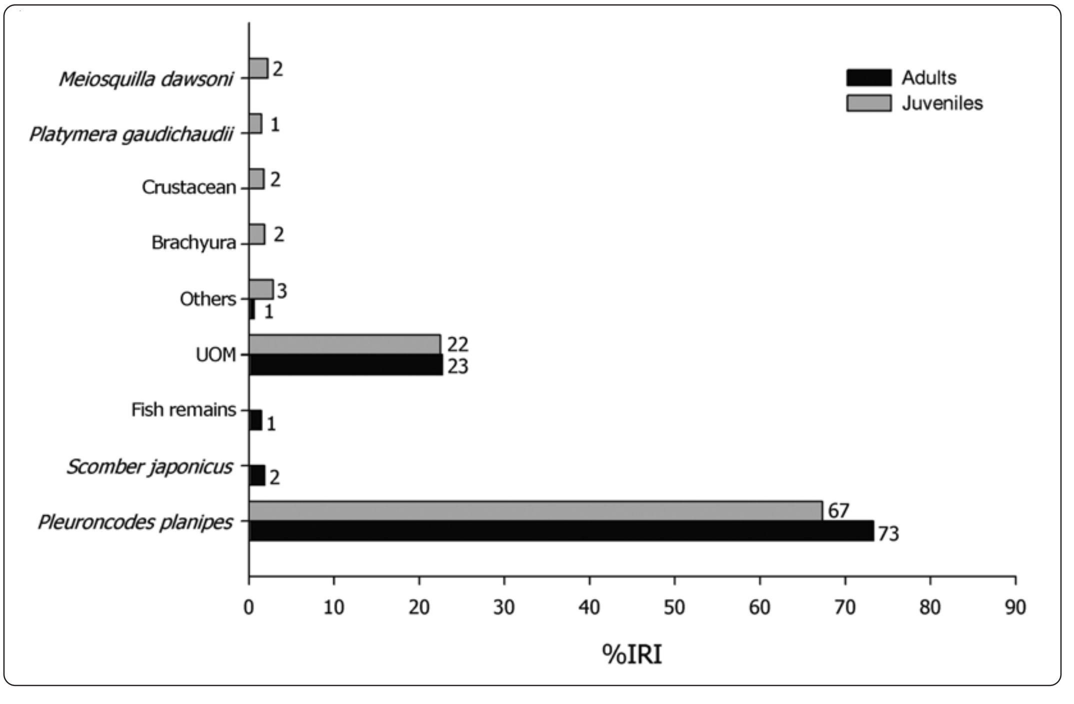

Figure 4. Index of relative importance (%IRI) of the main prey for juveniles and adults of the shark *Mustelus henlei* in the western portion of Baja California Sur, México / Índice de importancia relativa (%IIR), de las presas principales de juveniles y adultos del tiburón *Mustelus henlei*, en la porción Occidental de la Península de Baja California Sur, México

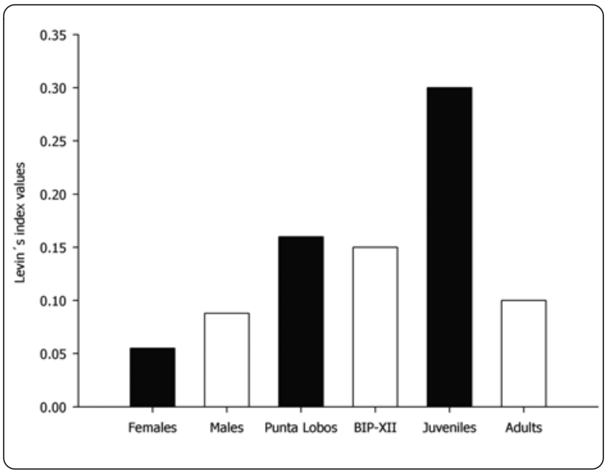

Figure 5. Trophic scope of the shark *Mustelus henlei* according to sex, sizes and sampling area in the western portion of Baja California Sur, México / Amplitud trófica del tiburón *Mustelus henlei* de acuerdo al sexo, talla y zona de muestreo en la porción Occidental de la Península de Baja California Sur, México

In Punta Lobos, a total of 101 *M. henlei* specimens (68 and 33 females and males (2:1), respectively) with lengths ranging from 58 cm to 106 cm were captured, of which 78 stomachs contained food. Through taxonomic analysis 19 types of prey were identified where the main ones were *P. planipes*, *S. japonicus*, and UOM (Fig. 3).

In the western portion off the Baja California Peninsula on board the exploration ship BIP XII, a total of 65 (31 females and 34 males) specimens with a length of 36-90 cm were collected of which only 36 had food in their stomachs. According to the %IRI, 16 types of prey were identified through taxonomical analysis, of which the main types were *P. planipes*, crustacean remains, brachyurans, and UOM (Fig. 3). As to areas, we observed *Bi* values of 0.16 in Punta Lobos and *Bi* values of 0.15 on board BIP-XII, considering the species as a specialist predator (Fig. 5).

For juveniles, TL was 36-61.5 cm. The total number of stomachs analyzed was 62 (29 empty). The %IRI showed preferences for *P. planipes*, *Platymera gaudichaudii, Meiosquilla dawsoni,* Brachyura, crustacean remains, and UOM.

For adults 104 stomachs were analyzed (22 empty); TL of these specimens ranged from 64 to 106 cm. The most important prey in their diet was *P. planipes, S. japonicus*, fish remains, and UOM (Fig. 4). Levin's index showed juveniles (*Bi* = 0.3) and adults (*Bi* = 0.1) both having a specialist behavior (Fig. 5).

Diet breadth and overlap of *Mustelus henlei*

Trophic breadth of *Mustelus henlei* in the western section of Baja California Sur was low (*Bi* = 0.05), showing a strong preference for some types of food; in this specific case the red pelagic crab (*P. planipes*) and the mackerel (*S. japonicus*). Thus, *M. henlei* may be considered as a specialist predator.

When comparing samples taken from deep to shallow water (BIP XII and Punta Lobos, respectively) we observed a high overlap of Cl = 0.992 between sexes and of Cl = 0.949 between areas according to Morisita-Horn's index. There was an evident overlap of Cl = 0.862 in juveniles and adults, indicating they have common prey and share a specific area of Pacific Ocean coast line.

Statistical analysis

By the SIMPER statistical analysis for females and males, we found that diets had a low similarity value (24%) due to the variation in prey contribution percentage that mostly characterize their spectrum; likewise for juveniles and adults (21%), as well as for Punta Lobos and on board BIP XII (22%), which infers a reduced number of prey constitutes their diet (Table 2).

When applying the ANOSIM test by sex we did not find significant statistical differences (R_{global} = 0.065; P = 0.2), only an overlap. Between juveniles and adults, we observed a reduced significant value (R_{global} = 0.177; P = 1.0), likewise for the areas of Punta Lobos and on board BIP XII (R_{global} = 0.20; P = 0.1).

Discussion

In Mexico, the paternoster-line, hand line, and nets are the most used methods for commercial shark capture (Applegate *et al*. 1979). Coastal elasmobranchs, such as batoids and small sharks (cat sharks) are captured mainly with nets (Ramírez-Amaro 2011). When the shark is captured, the food ingested continues the digestive process and shows a high percentage of non-specific categories (items) as UOM, and fish and crustacean remains.

For *M. henlei* a small number of empty stomachs was found, as it has been reported in other studies where the percentage of empty stomachs in the species of the genus *Mustelus* is very low in general: 3.1% in *M. griseus* (Kamura & Hashimoto 2004); 0.8% in *M. palumbes* (Smale & Compagno 1997); 2.47% in *M. schmitti* (Belleggia *et al.* 2012); 8.7-11.7% in *M. mustelus* (Smale & Compagno 1997,

Table 2. Results of the SIMPER analysis (percentage similarities) by sexes, sizes, and areas for *Mustelus henlei* in the western coast of Baja California Sur, México / Resultados del analisis de SIMPER (porcentaje de similaridad) por sexos, tallas y areas para *Mustelus henlei* en la porcion Occidental de la Península de Baja California Sur, México

	Group Female	Group Male	Dissimilarity	Contribution	Cumulative
	Abundance (mean)	Abundance (mean)	(mean)	(%)	(%)
Pleuroncodes planipes	1.82	1.43	26.4	34.77	34.77
UOM	1.22	0.64	19.92	26.23	61.0
Scomber japonicus	0.32	0.06	4.20	5.53	66.52
Rests Fish	0.18	0.24	4.06	5.34	71.87
Brachyura	0.02	0.16	3.59	4.73	76.6
Crustacean	0.06	0.08	2.75	3.62	80.22
Platymera gaudichaudii	0.05	0.07	2.01	2.64	82.86
Kathetostoma averruncus	0.00	0.11	1.81	2.39	85.25
Clibanarius panamensis	0.01	0.11	1.42	1.88	87.13
Solenocera florea	0.02	0.03	1.22	1.61	88.73
Meiosquilla dawsoni	0.02	0.04	1.16	1.53	90.26
Groups Females & Males					
Mean Similarity= 24%					

	Group Juvenil	Group Adult	Dissimilarity	Contribution	Cumulative
	Abundance (mean)	Abundance (mean)	(mean)	(%)	(%)
Pleuroncodes planipes	0.85	2.0	28.04	35.37	35.37
UOM	0.38	1.25	20.57	25.95	61.32
Scomber japonicus	0.00	0.31	4.0	5.05	66.37
Brachyura	0.13	0.06	3.73	4.71	71.08
Crustacean	0.12	0.05	3.38	4.26	75.34
Fish remains	0.00	0.28	3.17	4.0	79.34
Platymera gaudichaudii	0.20	0.0	2.98	3.76	83.1
Kathetostoma averruncus	0.08	0.03	1.76	2.22	85.32
Meiosquilla dawsoni	0.11	0.0	1.71	2.16	87.48
Squilla hancocki	0.07	0.0	1.4	1.77	89.24
Groups Juvenile & Adult					
Mean Similarity= 21%					

	Group Pta. Lobos	Group BIP XII	Dissimilarity	Contribution	Cumulative
	Abundance (mean)	Abundance (mean)	(mean)	(%)	(%)
Pleuroncodes planipes	2.12	0.87	29.12	37.23	37.23
UOM	1.29	0.48	20.93	26.76	63.98
Scomber japonicus	0.36	0.00	4.57	5.84	69.83
Fish remains	0.28	0.03	3.39	4.33	74.16
Crustacean	0.05	0.11	3.09	3.95	78.11
Brachyura	0.00	0.14	2.91	3.73	81.84
Meiosquilla dawsoni	0.02	0.07	1.57	2.01	83.85
Portunus xantussi	0.00	0.11	1.53	1.96	85.81
Kathetostoma averruncus	0.02	0.06	1.24	1.59	87.4
Stomatopoda	0.01	0.04	0.91	1.17	90.03
Groups Pta. Lobos & BIP XII					
Mean Similarity= 22 %					

Saïdi *et al.* 2009a); 8% in *M. antarticus* (Yick *et al.* 2012); 13.7-14.28% in *M. punculatus* (Jardas *et al.* 2007, Saïdi et al. 2009b, Lipej *et al.* 2011); 6% in *M. californicus* (Talent 1982) and *M. lunulatus* (Navia *et al.* 2006); 5.5-14% in *M. henlei* (Talent 1982, Haesker & Czech 1993).

The occurrence of the high proportion of empty stomachs in other studies may be related to the use of long lines to capture animals (Wetherbee & Cortés 2004), which may attract more animals with empty stomachs, such as 51.3% in *M. canis* (Vianna *et al.* 2000), 53.2% in *M. henlei*, and 52.4% in *M. lunulatus* (Gómez *et al.* 2003), and 38.22% in *M. dorsalis* (Rojas 2006).

The main food components found in *M. henlei*'s trophic spectrum were *P. planipes*, a dominant pelagic species of great abundance and permanence on the continental shelf of Baja California Sur, which is associated with the California current system and distributes vertically along the water column (Boyd 1967); and secondly *S. japonicus*, an abundant fish in the pelagic coastal area, occasionally in the epipelagic area (Fischer *et al*. 1995). The majority of benthic organisms were stomatopods (*Eurysquilla* spp., *Meiosquilla dawsoni*, and *Squilla hancoki*) and brachyuran crabs. Demersal species defined as those that are closely related with the sea bottom either for reproduction or food, such as *Kathetostoma averruncus* were also registered.

In the central Seto Inland Sea of Japan, Kamura & Hashimoto (2004) observed *Mustelus griseus* showing a preference for crabs living on sandy or muddy bottoms; *Mustelus manazo* prefers crustaceans and polychaets. In the Gulf of Nicoya, Costa Rica, *Mustelus dorsalis* is classified as a polyphagus opportunist predator for that area (Rojas 2006). Russo (1975) analyzed *M. henlei* finding it feeds mainly on the shrimps *Upogebia pugettensis*, *Crago franciscorum* and on crabs of the genus *Cancer* and *Hemigrapsus oregonensis*, species which establish intertidal feeding. He also found fish *Cymatogaster aggregata, Engraulis mordax*, and *Citharicthys* spp. in the guts. Talent (1982) concluded *M. henlei* feeds mainly on crustaceans, which are its most important feeding item; fish is the second most important prey for the largest sharks, and crustaceans are the most eaten in coastal shallow waters. Haesker & Czech (1993) found *M. henlei* consumed more slender crabs and fish but fewer yellow shore crabs and polychaete worms than those near Indian Beach. Gómez *et al.* (2003) performed a study on the feeding habits of *M. lunulatus* and *M. henlei* in Gorgona National Natural Park in the Colombian Pacific, reporting these species generally predate on crustaceans, mainly *Portunus iridiscens, Squilla panamensis* and *Hipoconcha panamensis*, followed by mollusks of the family Loliginidae, and fish in less proportions.

The amplitude of the trophic niche in *M. henlei* necessarily implies a specialist food conduct; besides, pelagic, demersal, and benthic prey records suggest this organism performs vertical and horizontal migrations to make use of these types of prey (*S. japonicus* and *P. planipes*). *M. henlei*'s movements have been associated to tides, and this behavior could be explained by its feeding ecology, mainly that of an active forager on marshes (Campos *et al*. 2009). It remains in bays throughout the year but may leave them during winter as the waters cool and rains reduce salinity (Love 1996, Hopkins & Cech 2003). At low tide Brown smooth hounds have generally retreated to deeper water where they may await their next foraging opportunity while digesting their last meal, thus exhibiting slower movement rates. They show a significant increase in movement during the night in relation to daytime (Campos *et al.* 2009), It could explain the high presence in their diet of *P. planipes,* which migrate vertically in the water column rising to the surface at dusk to feed and avoid predation (light intensity is less) and remain in this area during the night (Boyd 1967).

The presence of an important number of food components within the trophic spectrum of *M. henlei* makes its predation capacity evident. However, in spite of having a considerable number of prey, the trophic spectrum of this shark was very reduced, which is why it could be considered as a prey specialist by showing major consumption of only a few types of prey. Zayas-Álvarez (1998) mentioned that in elasmobranchs it is common to find a wider trophic spectrum in females than in males although there are no important differences. In our study females in general showed a low trophic spectrum (0.06), the same as for males. It highlights a narrow trophic spectrum, mainly due to the fact that both sexes feed on *P. planipes* and *S. japonicus*. The SIMPER analysis showed a low similarity percentage between prey percentages. According to the ANOSIM test there were no significant differences by sex that could have shown a diet overlay. The presence of common prey with different IRI percentages indicates there is no segregation by maturity stages; the results observed in females' diet could suggest they spend most of the time in the coastal area, feeding from benthic organisms (stomatopods and crustaceans) but frequently migrating toward the ocean area where pelagic red crab and mackerel can be observed.

They are likely subjected to food availability in deeper waters. Males showed they feed on demersal and pelagic fish. Rojas (2006) points out that *M. dorsalis* could form ontogenic aggregations where females and males of similar sizes coincide spatially and temporally in feeding reserves very close to the bottom and near the coast. Regarding food site selection as reported by Pittenger (1984) regarding food site selection, these shark species could share space when finding sites where food is abundant and available.

The sharks found in the western section off the Baja California Peninsula on board (BIP-XII) and in Punta Lobos showed a specialist behavior, a high overlap between the diets, a low similarity of species abundance, and a significantly reduced difference. These results might be due to the high percentage of *P. planipes* consumption and the presence of UOM, which was difficult to separate and locate within the identified taxa because of their high degree of digestion. However, the sharks also showed other types of prey such as *S. japonicus,* crustacean remains, and brachyurans, which make a slight variation in *M. henlei*'s diet according to area

Most of the juvenile sharks were found in deep waters (120-150 m), inferring they move between the ocean and coastal areas to feed on benthic organisms (brachyurans and squillas), as well as pelagic prey (*P. planipes*). The majority of the adults were captured in Punta Lobos (15-40 m), most of them females, suggesting they move to coastal areas for reproductive purposes. Silva-Santos (2012) in his reproduction study on *M. henlei* on the western coast off Baja California Sur reports more adult females in the captures from the same area, possibly due to the breeding and birth season. Likewise with *M. schmitti,* the adults of both sexes were recorded in the coastal area because they prefer the warmer waters of spring and summer during breeding and birth (Oddone *et al*. 2007). The lesser proportion of juveniles in the adult capture sites confirms an ontogenic spatial separation. Embryos, newborn, and juveniles possibly occur in different growth areas, a condition that from the evolutionary viewpoint could be an advantage, as suggested by Branstetter (1990), who adds this separation reduces predation risk. The trophic width by size classifies *M. henlei* as a specialist, with a high overlay and a low similarity in diet, and a reduced significant difference likely linked to the consumption of *P. planipes* and UOM in a greater proportion. Fish and invertebrates were the most outstanding where the invertebrate *P.planipes* accounted for the difference in the abundance of *M. henlei* for some areas, justifying the importance these resources have to sustain different species by providing large benefits from the ecological and fishing point of view.

Fisheries have also made these species a target, which is why some shark populations have collapsed or have decreased in a short period of time (Anderson 1990). The combination of late maturity, low fecundity, and slow growth in most shark species has made them especially vulnerable to over-exploitation, and shark populations around the world are declining at a rapid rate due to overfishing (Musick 1999).

It is important to highlight that our study provides new information on *M. henlei*'s diet as a benthic species dependent on the bento-pelagic habitat for feeding; it is a polyphagus organism that shows a strong preference for a small group of prey along the coasts of Baja California Sur. Knowledge on *M. henlei*'s feeding habits and behavior as a specialist predator in this area will direct us toward better management of this species and its habitat.

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