Trophic habitat of the Pacific sharpnose shark, *Rhizoprionodon longurio*, in the Mexican Pacific

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The Pacific sharpnose shark Rhizoprionodon longurio *is caught seasonally by inshore artisanal fisheries in the Mexican Pacific. Our study focuses on the feeding ecology of this shark species in the southern Gulf of California. The prey species obtained from stomach contents were identified and quantified, and variations between sexes and maturity stages were determined. A total of 98 stomachs were analysed during two periods (2000–2001 and 2003–2004); 64% of stomachs contained food. The trophic spectrum was composed of four cephalopod species, three crustacean species, and 13 pelagic and benthic fish species. According to the index of relative importance (%IRI), the fish* Echiophis brunneus *(IRI = 14.4%),* Opisthopterus dovii *(IRI = 12.2%) and* Scomber japonicus *(IRI = 9.6%) were the main prey items. Based on diversity values, IRI values and diet breadth,* R. longurio *is an opportunistic predator. The trophic position of* R. longurio *was above four in all categories, which indicates that this shark is a tertiary consumer.*

INTRODUCTION

The Pacific sharpnose shark *Rhizoprionodon longurio* (Jordan & Gilbert, 1842) is a small coastal species that lives over soft muddy and sandy bottoms of the continental shelf of the eastern tropical Pacific (from California, USA, through Central America, to Peru in South America). This shark can be found from the intertidal zone to at least 27 m depth (Compagno, 1990). The size at birth varies between 30 and 37 cm total length (TL); the maximum TL reported in Mexico is 120 cm (Márquez-Farías *et al.*, 2005). Males mature at 93 cm TL and females at 83 cm TL. Females produce between one and 12 embryos, with an average of 7.4 pups per litter (Springer, 1964; Compagno, 1984; Bizzarro *et al.*, 2000).

This species is caught in artisanal fisheries in the Mexican Pacific (Castillo-Géniz, 1990; Márquez-Farías *et al.*, 2005). It has been reported in the Gulf of California along the coasts of Sinaloa and Sonora during winter (January, February) and spring (March, April, May), and probably moves to deeper waters in the Gulf of California during summer and autumn (Kato & Hernández, 1967; Márquez-Farías *et al.*, 2005).

Rhizoprionodon longurio is one of the most abundant coastal sharks in the southern Gulf of California (Bizzarro *et al.*, 2000), where 91% of shark catches consist of *Mustelus*

henlei (Gill, 1863), *Sphyrna lewini* (Griffith & Smith, 1834) and *R. longurio* (Castillo-Géniz, 1992). In the Mazatlan area this shark species constitutes 45% of shark artisanal fisheries (Castillo-Géniz, 1992). However, there is evidence of declines in some artisanal fishery landings of this species, and further investigation is required to determine the impact of fisheries on this species throughout its distribution range (Smith *et al.*, 2009).

A moratorium on elasmobranch fishing permits in Mexico has been issued (NOM-029-PESC-2006); there is to be no increase in the total allowable catch of sharks and rays, protection of breeding and birthing areas in the Mexican Pacific, establishment of closed seasons, and special protection for shark species considered at risk (Castillo-Géniz, 1990). However, there is insufficient information available to include *R. longurio* in the IUCN (International Union for the Conservation of Nature) list of endangered species, since this species is classified as 'Data Deficient' at present (Smith *et al.*, 2009).

Diet analysis is one aspect of elasmobranch management that provides biological information that can help determine the interactions between species and their environment. The food types that comprise the diet can be determined directly from stomach content studies, and the amount, frequency and biomass of prey ingested by the consumer at different times of year (Escobar-Sanchez *et al.*, 2010), which can influence the abundance and distribution of sharks, can also be determined with these analyses (Castillo-Géniz, 1992).

Only one previous study was carried out on the diet of *R. longurio*; it was reported that the diet was dominated by

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fish (Clupeidae, Muraenidae, Triglidae, Sphyraenidae and Ophichthidae), and also included some cephalopods (e.g. *Loliolopsis diomedeae*) and crustaceans, representing an opportunistic feeding behaviour (Márquez-Farías *et al.*, 2005). This study, however, included a high number of unidentified fish, and no information was given on possible differences in prey consumed by sharks of different sex and maturity stages.

It has been reported that *R. longurio* segregates by sex and size in the Gulf of California (Castillo-Géniz, 1990), which could result in different prey being consumed by sharks of different sex and maturity stages. Differences in the diet of these different groups could be indicative of a disparate use of resources in different habitats (epipelagic, mesopelagic or bathypelagic), and could help detect feeding areas in the Mexican Pacific.

In this context, this study aimed to: (1) identify the diet of *R. longurio* from stomach content analysis; and (2) to detect possible intraspecific (sex and/or size) differences in diet between fishing periods, allowing us to determine the trophic relationships of this predator in the food chain of the Gulf of California, and provide basic biological information about an important shark species for Mexican artisanal fisheries.

MATERIALS AND METHODS

Sharks were sampled monthly from landings in the Mazatlan area (23°130′N 160°24′38″W; Figure 1). *Rhizoprionodon longurio* was sampled during two fishing periods: December 2000–February 2001 (period I), and October 2003–March 2004 (period II). Each shark was identified, the total body length in cm (TL) was measured, and sex was determined. Stomachs were removed and kept frozen (−20°C) until further analysis at the fish laboratory at the Centro Interdisciplinario de Ciencias Marinas (CICIMAR) in La Paz, Baja California Sur.

In the laboratory, stomachs were thawed and the percentage stomach fullness was determined according to Stillwell & Kohler (1982), where 0 = empty, 1 = 1–25% fullness, 2 = 26–50% fullness, 3 = 51–75% fullness, and 4 = 76–100%
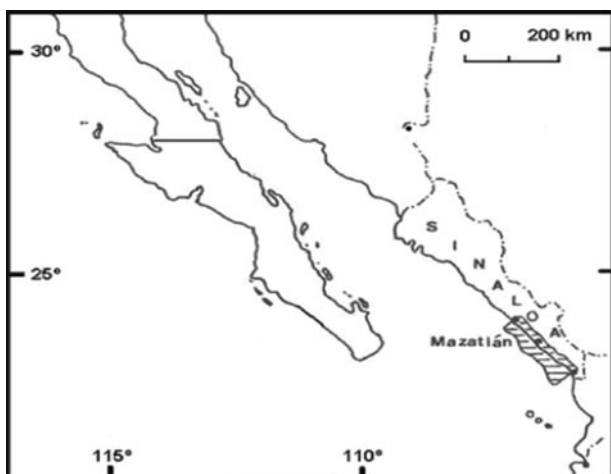

Fig. 1. Map showing the location of the study area. The hatched area indicates where the fishing fleet operates. It ranges from the coastline to 20 nautical miles seaward.

fullness. Four digestion states were identified according to Galván-Magaña (1988); prey items were identified to the lowest possible taxonomic level, and different identification keys were used for each digestion state.

Digestion state 1 included recently consumed items; keys by Allen & Robertson (1994) and Fischer *et al.* (1995) were used for prey identification. Digestion state 2 included food items with little to no skin remaining, but still containing muscle; digestion state 3 included fish skeletons. For digestion states 2 and 3, we used taxonomic keys based on vertebrae characteristics, such as number of vertebrae, position, and form (Clothier, 1950). We also compared diet items with complete skeletons of organisms captured in the area. Digestion state 4 was characterized by hard structures such as fish otoliths, crustacean remains, and cephalopod beaks; the keys by Brusca (1980), Wolff (1984), and Clarke (1986) were used for identification.

Once the stomach contents were identified, we determined whether the number of stomachs analysed was adequate to represent the trophic spectrum of *R. longurio*. Cumulative prey curves (Ferry & Cailliet, 1996) were created with the EstimateS program (Colwell, 2006). The coefficient of variation was calculated as an indicator of diet variability. For this study, if the coefficient of variation was below 0.05 the trophic spectrum was considered to be adequately represented (Steel & Torrie, 1992). Diversity was also plotted vs the number of stomachs analysed.

The index of relative importance (IRI) was calculated with the formula IRI = (%N + %W) × (%F), where %N is the number and %W is the wet weight of each food item, expressed as the percentage of the total values of these variables found for all prey items in the stomach contents, and %F is the percentage frequency of occurrence of each food item (presence–absence) in all stomachs that contained food, as described by Pinkas *et al.* (1971), and subsequently modified as a percentage by Cortés (1997). To detect intraspecific variation, the data were sorted by sex and maturity stage (83 cm of TL for females and 93 cm of TL for males; Castillo-Géniz, 1990) during each fishing period.

An analysis of similarity was done to evaluate the differences within and between each category (sex, maturity stage and fishing period), using permutation-randomization methods (1000 permutations) in the similarity matrix (ANOSIM, PRIMER 6 v.6.1.6). The global rank dissimilarity R ($0 \leq R \leq 1$) is a useful comparative measure of degree of separation (it uses Bray–Curtis as a measure of similarity). When R is near zero, H_o cannot be rejected; i.e. there is no separation between groups. The ANOSIM values between 0.2 and 1 indicate that the null hypothesis can be rejected, and organisms probably do not have the exact same diet (Clarke & Warwick, 2001). The *P* value tests the significance of the R value. Essentially the samples are randomly assigned to groups 1000 times, and R is calculated for each permutation. The observed value of R is then compared against the random distribution to determine if it is significantly different from that which could occur at random. If the value of R is significant, we can conclude that there is evidence that the samples within groups are more similar than would be expected by random chance (Clarke & Warwick, 2001).

The Shannon–Wiener diversity index, based on the abundance of all prey items, was used to calculate diversity (Pielou, 1975). To evaluate the diet breadth of *R. longurio* we used Levin's standardized index, '*Bi*' (Krebs, 1999), which ranges

from 0 to 1, with low values (<0.6) indicating a diet dominated by few prey items (specialist predator), and higher values (>0.6) indicating a generalist predator (Labropoulou & Eleftheriou, 1997). We also calculated the trophic position (TP) based on stomach contents, with the equation proposed by Christensen & Pauly (1992), then calculated the mean and standard deviation (SD) to represent the variability of those individual values as:

$$TP = 1 + (\sum_{i=1}^{n} DC_{ji})(TP_i)$$

where DC_{ji} is the diet composition in weight, in terms of prey proportion (*i*) in the predator's diet (*j*), *TP* is the trophic position of the prey species (*i*) and *n* is the number of prey groups in the diet.

The *TP* for fish prey species were obtained from FishBase (Froese & Pauly, 2003), and those for cephalopods and crustaceans were obtained from Cortés (1999).

RESULTS

A total of 98 organisms were sampled, ranging from 47 to 170 cm TL, with a mean size of 92.1 cm (22.4 SD). Females measured 61 to 170 cm TL with a mean size of 96.2 cm (22.7 SD); whereas males ranged from 47 to 160 cm (TL), with a mean size of 88.7 cm (SD = 21.6). Of the total *Rhizoprionodon longurio* samples (40 during fishing period I and 58 during fishing period II), 63 stomachs (64%) contained food and 35 (36%) were empty. In both periods, the largest number of samples was obtained in February (24 with food, 15 empty) and December (15 with food, 7 empty).

Fifty-five per cent of stomachs were in stomach-fullness category 1; 28% were in category 2; 6% were in category 3; and 10% were in category 4 (Figure 2A). Seven prey items were in digestion state 1; 21 prey items were in state 2; 39 prey items were in state 3, and 44 prey items were in state 4 (Figure 2B). In general, the prey species accumulation curve showed that a sufficient number of stomachs was analysed to adequately characterize the diet of *R. longurio* (Figure 3). The coefficient of variation (CV) in all categories for both fishing periods was <0.05 (Table 1).

The trophic spectrum was composed of four cephalopod species belonging to four families, three crustacean species from three families, and 13 fish species from ten families. According to the index of relative importance (%IRI), *Echiophis brunneus* (Castro-Aguirre & Suárez de los Cobos, 1983) (14.4%), *Opisthopterus dovii* (Günther, 1868) (12.2%), *Scomber japonicus* (Houttuyn, 1782) (9.6%) and *Achirus mazatlanus* (Steindachner, 1869) (7.1%) were the most important components in the diet (Table 2).

The ANOSIM test indicated that diet composition was similar between male and female juveniles (R = 0.04, P = 0.01), and between male and female adults (R = 0.01, P = 0.01). These categories were therefore combined to compare the diet similarity between adults and juveniles. The ANOSIM showed high similarity between adults and juveniles (R = 0.02, P = 0.02), and differences between the two fishing periods (R = 0.23, P = 0.01; Figure 4).

Diversity values (H') of juvenile males were lower during fishing period I and increased during fishing period II, other
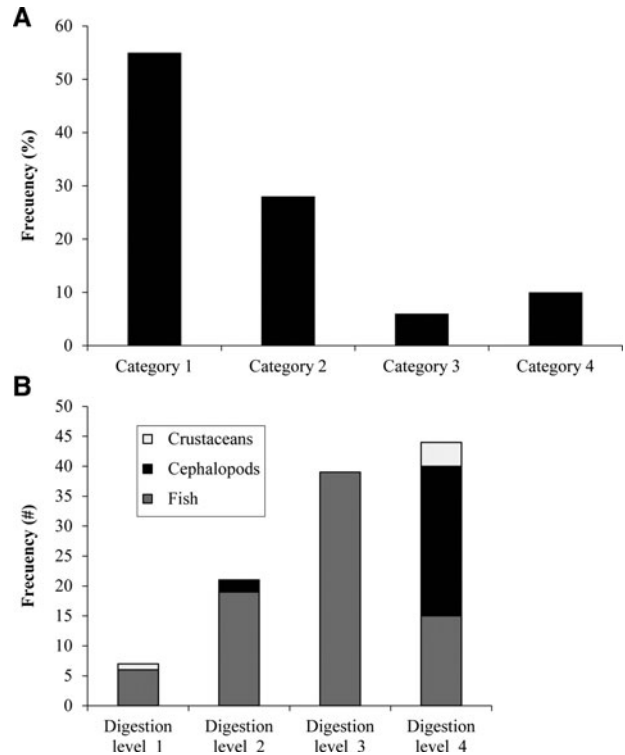

Fig. 2. Precentage of fullness (A) and digestion level (B) observed in the stomachs of *Rhizoprionodon longurio* in the Mexican Pacific.

shark categories had high H' values during both fishing periods. Diet breadth values (*Bi*) were >0.6 for all shark categories during fishing period I, while during fishing period II, adult females and juvenile males had *Bi* values <0.6. Adult females had a lower trophic position (TP) during fishing period I, which increased during fishing period II; the other categories showed similar TP values during both fishing periods (Table 3).

DISCUSSION

The minimum size (47 cm TL) of *Rhizoprionodon longurio* recorded in this study was similar to the size at birth, which
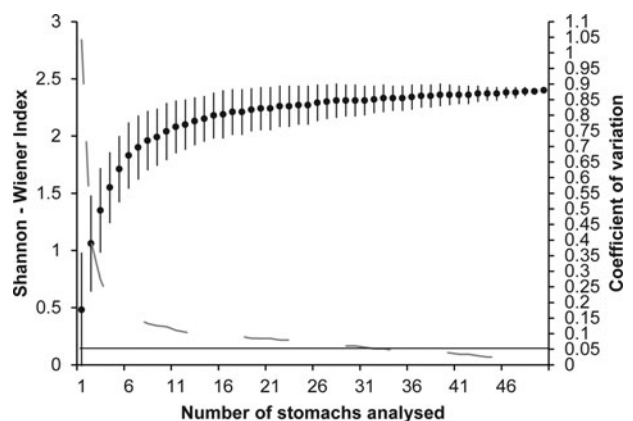

Fig. 3. Cumulative curve of prey species for *Rhizoprionodon longurio* caputured off Mazatlan, Mexico (black line, Shannon diversity with SD, grey line, coeffcient of variation).

Table 1. Summary description of *Rhizoprionodon longurio* for stomach contents analysis (*R. longurio* females length-classes: juvenile (J) <83 cm total length (TL); adult (A) ≥83 cm TL; *R. longurio* males length-classes: J < 93 cm TL; A ≥ 93 cm TL), CV, coefficient of variation, SWC, stomachs with content.

Category	Group	Number of organisms obtained		Number of stomach to reach a CV ≤ 0.05	Total average length (cm)
		Fishing period I (SWC)	**Fishing period II (SWC)**		
Males	J	4 (2)	22 (13)	11 (CV = 0.04)	72.2
	A	16 (6)	11 (10)	10 (CV = 0.04)	104.8
Females	J	2 (1)	10 (10)	7 (CV = 0.03)	65.5
	A	18 (9)	15 (12)	18 (CV = 0.04)	106.6

is reported to be between 30 and 37 cm TL (Compagno, 1984; Bizzarro *et al.*, 2000; Márquez-Farias *et al.*, 2005). We found pregnant females, which have been previously reported for the Central Mexican Pacific (Nayarit coast) and upper Gulf of California (Pérez-Jiménez *et al.*, 2005). Therefore, the Mazatlan coast seems to be an important pupping area, similarly to the northern Gulf of California and Sonora coast, which also have been considered important pupping areas for the Mexican Pacific population of *R. longurio* (Bizzarro *et al.*, 2000).

The average size of sharks caught in this study corresponded to adult organisms (females: 96.2 cm TL, males: 88.7 cm TL), while juveniles and adults dominated the catches in Sinaloa (Márquez-Farias *et al.*, 2005). Some organisms had maximum sizes of 170 cm (TL), similar to those reported for Peru and Colombia (Franke & Acero, 1991).

Castillo-Géniz (1990) and Márquez-Farias *et al.* (2005) reported that trends in *R. longurio* landings from Sinaloa and the Gulf of California, Mexico indicate marked seasonal movement patterns, with *R. longurio* being a primary component of artisanal elasmobranch fisheries during winter and spring (Kato & Hernandez, 1967; Márquez-Farias *et al.*, 2005). Despite the low number of organisms sampled in this study (*N* = 98), sharks were caught in December and February (winter) during both fishing periods, which coincides with that reported by these authors.

The presence of empty stomachs (35 of 98 stomachs), and the high number of stomachs included in stomach fullness category 1 (<25% full) may be related to two factors: (1) the type of fishing gear used; and (2) prey digestion state. In Mazatlan, *R. longurio* is caught using gill-nets and longlines; these two gear types cause high stress in shark species at the time of capture, resulting in regurgitation of stomach contents, which may explain the high number of empty stomachs. However, although this behaviour has been observed in other species (e.g. *Sphyrna lewini*, Torres-Rojas *et al.*, 2009), the occurrence of different categories of stomach fullness leads us to take into consideration the digestion state of prey species.

It has been reported that some shark species do not feed again until they have digested the last prey they ingested; this has been seen in *Negaprion brevirostris* (Poey, 1868), *Squalus acanthias* (Linnaeus, 1758) and *Carcharhinus plumbeus* (Nardo, 1827) (Jones & Geen, 1977; Medved *et al.*, 1988; Cortés & Gruber, 1990). We found that cephalopods were mostly at an advanced level of digestion, which is explained by the fact that the soft tissue of squid has been

Table 2. Summary of food categories in stomachs of *Rhizoprionodon longurio* captured off Mazatlan, Mexico, expressed as percentages by number (%N), weight (%W), frequency of occurrence (%F) and the index of relative importance (IRI).

Prey item			%N	%W	%F	%IRI
Cephalopoda	Loliginidae	*Lolliguncula (Loliolopsis) diomedeae*	12.42	0.05	20.63	1.32
	Ommastrephidae	*Dosidicus gigas*	0.65	0.01	1.59	0.06
	Onychoteuthidae	*Onychoteuthis banksii*	3.27	1.17	7.94	1.24
	Argonautidae	*Argonauta* spp.	26.80	0.02	12.70	2.66
Crustacea	Squillidae	*Squilla biformis*	0.65	0.01	1.59	0.06
	Galatheidae	*Pleuroncodes planipes*	1.31	0.91	3.17	0.41
	Rest of crustacean	Crustaceans	1.31	1.19	3.17	0.50
Teleostei	Ophichthidae	*Echiophis brunneus*	7.84	8.01	17.46	14.50
	Pristigasteridae	*Opisthopterus dovii*	9.80	5.59	20.63	12.29
	Serranidae	Serranids	4.58	1.00	9.52	1.39
	Carangidae	*Chloroscombrus orqueta*	2.61	3.60	6.35	2.50
		Decapterus spp.	4.58	1.44	9.52	1.79
	Sciaenidae	*Cynoscion parvipinnis*	1.31	3.10	3.17	1.09
	Mugilidae	*Mugil cephalus*	1.31	6.91	3.17	2.28
	Scombridae	*Auxis* spp.	1.31	10.13	1.59	1.71
		Euthynnus lineatus	0.65	0.10	1.59	0.08
		Scomber japonicus	2.61	20.13	4.76	9.67
		Scomberomorus sierra	0.65	10.30	1.59	1.67
	Achiridae	*Achirus mazatlanus*	7.84	4.55	14.29	7.16
	Tetraodontidae	*Lagocephalus lagocephalus*	1.31	0.37	1.59	0.19
	Unidentified teleosts	Fish	7.19	21.41	17.46	37.42

Fishing period I
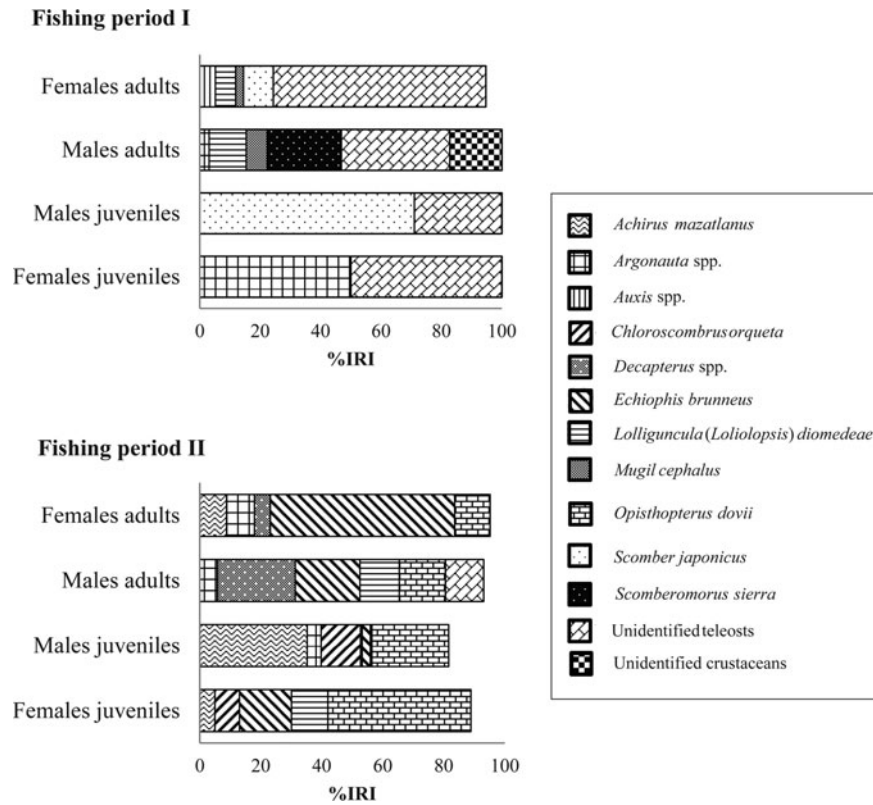

Fishing period II

Fig. 4. Variation in the index of relative importance (IRI) between sex and maturity stage in each fishing period in *Rhizoprionodon longurio* captured off Mazatlan, Mexico.

estimated to pass through the digestive tract over a period of 5 – 10 h (Olson & Boggs, 1986).

Tricas (1979) made prey digestion tests in *Prionace glauca* (Linnaeus, 1758), and he observed that after 24 h of consuming a fish, only vertebrae, otoliths and small sections of muscle remained. Moreover, Preti *et al.* (2001) classified the digestion states of prey species of *Alopias vulpinus* (Bonnaterra, 1788), finding that prey species were in an advanced digestion state due to the effective time of the fishing haul, which lasted more than 10 h.

In this study, prey were at intermediate or advanced digestion states. Considering that stomachs were collected at dawn, once the artisanal boats picked up the gear left overnight at sea (about 10 h) (Torres Rojas *et al.*, 2009), there should have been sufficient time for the gastric juices of the shark stomachs to act. Therefore it can be inferred that prey in digestion states 3 and 4 were consumed by *R. longurio* at least one day before the sharks were captured, demonstrating that this shark has a high feeding activity at a certain time of day (probably overnight).

Fish were the most important prey in terms of abundance and richness, followed by cephalopods and crustaceans. Castillo-Géniz (1990) and Márquez-Farías *et al.* (2005) mentioned that the diet of this shark species is dominated by teleosts and includes some cephalopods and crustaceans. It has also been observed that another species of the same genus (*Rhizoprionodon taylori* Ogilby, 1915) in Australia has a diet consisting mainly of fish (Salini *et al.*, 1998).

The fish consumed by *R. longurio* were benthic (e.g. *Echiophis brunneus*) and coastal pelagic species (e.g. *Opisthopterus dovii*) (Table 2), implying that *R. longurio* probably makes vertical migrations in the water column. It has been observed that *R. longurio* can feed on benthic prey, such as members of the Ophichthidae family, as well as on pelagic prey belonging to the Carangidae family over sandy bottoms (less than 27 m depth) in the Mazatlan area (Manjarrez-Acosta *et al.*, 1983; Castillo-Géniz, 1992). It should be noted that we found sand in some stomachs, which gives support to the finding that *R. longurio* feed on benthic prey.

Table 3. Diversity index values (H′), diet breadth values (Bi) and trophic position (TP) of *Rhizoprionodon longurio* captured off Mazatlan, Mexico (x, no data; J, juvenile; A, adult; *, only one piece of data).

Category	Group	H′		Bi		TP	
		Fishing period I	Fishing period II	Fishing period I	Fishing period II	Fishing period I	Fishing period II
Males	J	1.50	2.99	1	0.06	4.14	4.54
	A	2.44	2.86	0.80	0.81	4.47	4.28
Females	J	1.00*	2.89	1*	0.86	4.24*	4.99
	A	2.97	2.29	0.75	0.27	4.48	4.90

Other species from the same genus such as *R. taylori* also feed on pelagic fish of the Clupeidae, Teraponidae and Engraulidae families (Salini *et al.*, 1998; Simpfendorfer, 1998). We can conclude that *R. longurio* has a preference for benthic habitats, where it consumes fish such as *E. brunneus,* but can also migrate to the pelagic zone and consume pelagic prey, such as *O. dovii.*

There were no differences in the diet between sexes and sizes; however, the importance of prey (%IRI) varied in the diet. During fishing period II (Figure 3), *E. brunneus* and *Decapterus* spp. were found in all adults, but adult females consumed a higher amount of the benthic species *E. brunneus* (Froese & Pauly, 2011), while males consumed a higher amount of the epipelagic fish *Decapterus* spp. (which has a depth range of 30–70 m; Froese & Pauly, 2011). Juvenile male sharks consumed mostly the benthic species *Achirus mazatlanus* (which has a depth range of 1–20 m; Froese & Pauly, 2011), while juvenile females consumed mostly the epipelagic species *O. dovii* (which has a depth range of 0–50 m; Froese & Pauly, 2011). These results coincide with the report of segregation between sexes and sizes in the area (Castillo-Géniz, 1990).

Previous studies have reported changes in diet depending on sex and maturity stage (Klimley, 1983; Galván-Magaña *et al.*, 1989). Lowe *et al.* (1996) noted a change in diet with growth in *Galeocerdo cuvier* (Péron & Lesueur, 1822) due to several factors: (a) larger sharks may feed on large prey, because they have access to different habitats; (b) sharks at different stages of development occupy different areas and are segregated by size and sex; and (c) as shark size increases, the prey capture efficiency increases, as the senses are fully developed, and sharks are able to capture larger and faster prey.

Although we did not find significant differences in diet composition (ANOSIM), the importance of prey species from different habitats differed among sexes and sizes, which could indicate dietary changes based on maturity stage, with adult females and juvenile males feeding in the benthic zone (higher consumption of *E. brunneus* and *Achirus mazatlanus* respectively), and adult males and juvenile females feeding in epipelagic areas (*Decapterus* spp. and *O. dovii*, respectively).

The differences found in the feeding habits of *R. longurio* between fishing periods are probably associated with prey–predator relationships (Wootton, 1990; Abrams, 2000). In this study *R. longurio* fed mainly on highly migratory prey (e.g. *Opisthopterus dovii, Scomber japonicus*). Simpfendorfer *et al.* (2001) reported that the diet of tiger sharks (*Galeocerdo cuvier*) is associated with the spatial distribution of their prey. Results obtained in this study indicate that differences found could be attributed to variations in the population dynamics of prey, keeping in mind that the seasonal relative abundance of prey is determined by competition, predation, reproduction and environmental variables (Krebs, 1985; Abrams, 2000).

Temporal changes in the diet of different shark species have been documented in different parts of the world, and have been attributed to feeding behaviour (Stillwell & Kohler, 1982; Cortés, 1997; Torres-Rojas *et al.*, 2009). In this study, some categories of *R. longurio* behaved as specialists, according to Levin's index (adult females and juvenile males during fishing period II). However, this specialist behaviour was not seen during both fishing periods; during fishing period II an opportunistic behaviour was evident.

The specialist behaviour of *R. longurio* could be due to this shark feeding on species that form large schools (e.g. *O. dovii*), which results in large amounts of this species being found in the shark stomachs, and a low value of Levin's index. However, high diversity values were observed for all shark categories, even the ones with a specialist behaviour (Table 3), indicating that sharks consumed different kinds of prey during both fishing periods. The feeding behaviour of *R. longurio* has been previously classified as opportunistic (Márquez-Farias *et al.*, 2005). We compared two indices (Levin's and Shannon's), which indicated that *R. longurio* is an opportunistic predator, as was reported by Márquez-Farias *et al.* (2005).

Most sharks are apex predators that occupy tertiary trophic positions (TP) (Cortés, 1999). The trophic positions estimated in this study (Table 3) agree well with values reported by Cortés (1999) for *R. longurio* (TP = 4.2), so this shark may be considered a tertiary carnivore. One of the limitations of stomach content analysis is that it only represents the last meal, and often small prey species from low trophic positions are not detected. In this study, however, we found similar trophic positions to those reported by other authors.

We observed higher TP values for females than males during fishing period II (Table 3), due to females having consumed prey at higher trophic positions during this period. Females consumed a higher biomass of *E. brunneus* and *O. dovii,* which have a TP of 4.2 (Froese & Pauly, 2011). Males consumed prey at lower trophic levels, such as *Achirus mazatlanus* (TP = 3.2; Froese & Pauly, 2011) and *Decapterus* spp. (TP = 3.4; Froese & Pauly, 2011), which resulted in the trophic differences observed between the two sexes. The TP obtained for *R. longurio* was high (>4). Pauly (1998) suggested that the high trophic positions of sharks mean that the overall yield from fisheries should be low and not sustainable at high exploitation levels. Therefore, recent attempts to regulate fisheries in Central America should greatly improve the conservation of *R. longurio*.

The preference of *R. longurio* for prey with coastal distributions, along with high exploitation of this species by artisanal fisheries, could result in an imbalance of the ecosystem, as has happened in the Mediterranean Sea, where sharks in coastal areas have decreased (Ferretti *et al.*, 2008), contrary to what has happened with species of oceanic habitats (e.g. *Sphyrna zygaena*). The decline of *R. longurio* could induce increases in midlevel consumers, shifts in species interactions, and trophic cascades (Estes *et al.*, 1998; Pace *et al.*, 1999; Worm & Myers, 2003; Frank *et al.*, 2005), because predators with high TP such as *R. longurio* can play an important role in structuring communities by controlling prey populations and preventing ecological dominance (Paine, 1984; Heithaus *et al.*, 2008).

The loss of a predator such as *R. longurio* could cause an imbalance in the Mexican Pacific, as has been seen for other shark species in the Gulf of Mexico (Baum & Myers, 2004; Shepherd & Myers, 2005), in the coastal north-western Atlantic and possibly the Caribbean (Bascompte *et al.*, 2005; Myers *et al.*, 2007).

This study provides information of the prey consumed by the Pacific sharpnose shark, the habitat where it consumes its prey, and the important role that it plays in the area of Mazatlan, Mexico; this information could provide the basis for resource conservation measures.

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