THERYA NOTES 2022, Vol. 3 : 125-132 DOI: 10.12933/therya_notes-22-83 ISSN 2954-3614

Diet of *Lontra longicaudis* in La Sangría Lagoon, México

Dieta de *Lontra longicaudis* en la Laguna La Sangría, México

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There are records of Neotropical otters, *Lontra longicaudis* in Campeche, but ecological information is scarce. The diet of this species inhabiting La Sangría Lagoon, México, was analyzed to record feeding preferences over a year through the identification of undigested remains. Data were obtained from feces and feeders. Once per season (winter rainy season or *nortes* 2016, dry, and rainy 2017), 11.9 km of the shoreline was traveled. One hundred twenty-six feces and one feeder were collected in 52 sites. These samples were analyzed by assessing the percentage of occurrence (PO) and ecological niche width (Levin's index) through the identification of undigested remains to the finest taxonomic level possible. Seven major groups of prey were identified: fish, crustaceans, mollusks, mammals, birds, and others. From a total of 16 prey categories, fishes were the best represented with a higher PO and number of genera, including janitor fish (invasive species), followed by crustaceans and mollusks. There were no variations in the frequency of prey consumption by season, but there were statistical differences in the diversity of species consumed. Three native fish species and 4 potential new records of fish were confirmed as prey of Neotropical otters. Levin's index showed that La Sangría Lagoon has a niche width with a trend toward specialization for the otter (0.2078). Comparing the diet observed herein with literature reports for other localities confirms the trophic adaptability and highlights the ecological value of the Neotropical otter.

Key words: Campeche; feeding habits; janitor fish; Neotropical otter; Palizada River.

En Campeche hay registros de nutria neotropical, *Lontra longicaudis*, pero la información ecológica es escasa. Se analizó la dieta de esta especie que habita la laguna La Sangría para conocer las preferencias alimentarias a lo largo de un año identificando los restos encontrados en las heces. Los datos se obtuvieron de la revisión de heces y comederos. Una vez por temporada (*nortes* 2016, secas y lluvias 2017), se recorrieron 11.9 km de la ribera. Se analizaron 126 heces y un comedero colectados en 52 sitios, evaluando el porcentaje de aparición (PA) y amplitud de nicho ecológico (índice de Levins) identificando los restos hasta el máximo nivel taxonómico posible. Se identificaron 7 grupos principales de presas: peces, crustáceos, moluscos, mamíferos, aves, mamíferos y otros. De un total de 16 categorías de presas, los peces fueron los mejor representados al tener un mayor PA y número de géneros, incluida la presencia de pez diablo (especie invasora), seguida de crustáceos y moluscos. No existió variación en las frecuencias de consumo de las presas por temporada climática, pero sí hubo diferencia estadística en la diversidad de especies consumidas. Se confirmó la presencia de 3 especies nativas y 4 posibles nuevos registros de peces como presas. El índice de Levins indicó que la laguna La Sangría presenta una amplitud de nicho para la nutria que tendió a la especialización (0.2078). Al comparar esta dieta con la registrada por otros autores en otras localidades, se evidencia la adaptabilidad trófica de la nutria neotropical y se resalta su valor ecológico.

Palabras clave: Campeche; hábitos alimentarios; nutria neotropical; pez diablo; Río Palizada.

The Neotropical otter, *Lontra longicaudis*, inhabits from northwestern México to Uruguay, Paraguay, and northern Argentina (Larivière 1999; Gallo-Reynoso and Meiners 2018). In México, the subspecies *L. l. annectens* is distributed throughout the Sierra Madre and the Gulf of México (Gallo-Reynoso 1997; Sánchez and Gallo-Reynoso 2007; Hernández-Romero *et al.* 2018). There are various records of this species in the state of Campeche, but the ecological information is scarce (Vázquez-Maldonado *et al.* 2021). There were only 2 records of *L. l. annectens* for the Palizada River prior to this work. The first is a report by Gallo-Reynoso (1997), who found tracks and burrows. The second, 19 years later, is an otter skin donated to the Mastozoological Collection of the Center for Studies in Sustainable Development and Use of Wildlife (*Centro de Estudios en Desarrollo Sustentable y Aprovechamiento de la Vida Silvestre* CEDESU-UACAM, in Spanish) in 2016.

The Neotropical otter feeds mainly on the available species in its environment. Fish comprising a high species diversity are its main prey, including introduced species such as trout; crustaceans like shrimps, crabs, and prawns are also consumed. Additional prey types include invertebrates such as bivalve mollusks and insects and vertebrates, including amphibians (frogs and toads), reptiles (lizards, iguanas, snakes, and turtles), birds (including aquatic birds), and small rodents, in addition to vegetation such as leaves, fruits, and seeds (Gallo-Reynoso 1996; Macías-Sánchez and Aranda 1999; Arellanes-Licea and Briones-Salas 2003; Díaz-Gallardo *et al.* 2007; Gallo-Reynoso *et al.* 2008; Monroy-Vilchis and Mundo 2009; Briones-Salas *et al.* 2013; Duque-Ávila *et al.* 2013; Rangel-Aguilar and Gallo-Reynoso 2013; Santiago-Plata *et al.* 2013; Guerrero *et al.* 2018; Grajales-García *et al.* 2019; Lavariega *et al.* 2020; García-Silva *et al.* 2021).

Therefore, the Neotropical otter is recognized as a generalist and opportunistic carnivore and a top predator (Sánchez and Gallo-Reynoso 2007; Gallo-Reynoso *et al.* 2008; Rheingantz *et al.* 2017). Its feeding habits allow determining the diversity of otter prey in its local environment (Casariego-Madorell *et al.* 2008; Monroy-Vilchis and Mundo 2009; Rheingantz *et al.* 2017; García-Silva *et al.* 2021).

Assessing the niche width (Levin's index) to better understand the ecological role of the Neotropical otter in this fluvial-lagoon system, the objective of this study was to record the presence and percentage of occurrence (PO) of preys over a year through the identification of undigested remains collected from one feeder and feces.

La Sangría Lagoon is located in the state of Campeche (18° 26' 49.9", 18° 29' 19.3" N; 91° 47' 44.7", 91° 49' 10.34" W; Figure 1). The study area comprises approximately 2.41 km^2 and is adjacent to the Palizada River and the town of Boca Chica (to the west). The Palizada River is located southwest of Laguna de Términos, which is part of the Laguna de Términos Natural Wildlife Protected Area (APFFLT, for its acronym in Spanish; Ocaña and Lot 1996). This river is the first branch of the Usumacinta River Delta (Coll de Hurtado 1975). It is part of the Palizada–Del Este fluvial-lagoon system, with a mean salinity range of 0 ppm to 8 ppm, temperature between 22 ºC and 31 °C (Ayala-Pérez 1989), and water transparency of 1.0 ± 0.23 m (Muciño-Márquez *et al.* 2017). The surrounding vegetation is a well-developed mangrove forest with a tree height from 10 m to 25 m, dominated by black mangrove (*Avicennia germinans*), red mangrove (*Rhizophora mangle*), and, to a lesser extent, white mangrove (*Laguncularia racemosa*; Jardel *et al.* 1987).

Samples were collected in 3 different seasons of the year between 2016 and 2017: winter rainy season (*nortes* 2016), characterized by strong winds from the north and northeast and frequent rainfall from October to January; dry season (2017), with less frequent and intense rains from February to May; and rainy season (2017), characterized by heavy showers almost daily, particularly in the afternoon and night from June to September (Yáñez-Arancibia and Day 1982, 1988). We conducted 3 surveys for a total of 11.9 kilometers traveled along the lagoon shoreline. Since the study area is floodable and with dense vegetation, all surveys were made on board a 7.6 m long IMEMSA-type boat with a 60 HP outboard motor. We looked for indirect evidence (feeders, feces, tracks, latrines, vocalizations, genital secretions, and burrows) of the presence of Neotropical otters (Aranda-Sánchez 2012). Each evidence was georeferenced with a GPS (Garmin map 78s) and photographed with a digital camera (Ricoh WG-4 SR). Two kayaks were used when sailing with a boat was unfeasible. Surface temperature, water depth (Seahawk manual echo sounder), and salinity (ATAGO refractometer) were recorded in all the sites where feces and feeders were found (sites with food leftovers around burrows, logs protruding above the water surface, and latrines, along with other traces such as otter tracks; Spínola-Parallada and Vaughan-Dickhaut 1995).

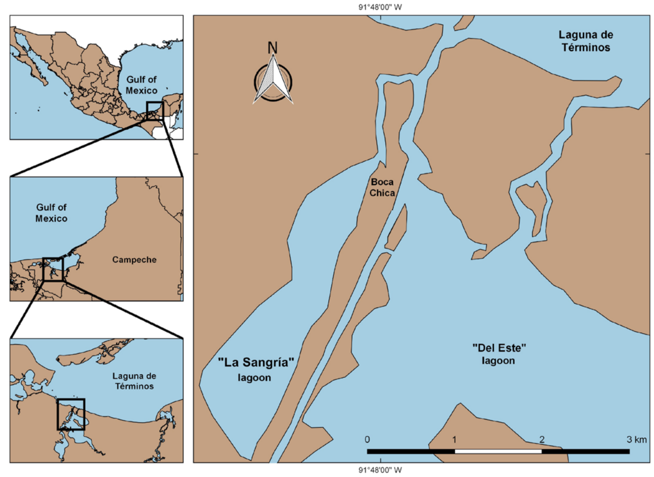

Figure 1. Location of the study area: La Sangría Lagoon, adjacent to the Palizada River, Campeche, México (Laguna de Términos Wildlife Protection Area).

Samples were collected manually and placed in properly labeled watertight bags stored in a fridge to be transported to the Laboratory 1 of the Faculty of Natural Sciences (FCN, for its acronym in Spanish) of the *Universidad Autónoma del Carmen* (UNACAR), where they were kept refrigerated until processing and analysis.

Feces samples and the materials collected from feeders were processed following the method by Santiago-Plata *et al.* (2013), with some modifications. Samples were washed with a 1:10 soap solution and left for 24 hours to remove any adhered fecal residues and decaying organic matter. Afterward, residues were washed in a constant flow of tap water using a sieve (0.5 mm mesh). Materials were placed on aluminum foil trays and stove-dried (Felisa FE - 292AD) at 61 °C. The materials were then placed in previously labeled manila paper envelopes. Any identifiable components and structures in each sample were sorted considering the zoological groups reported (to the finest taxonomic level possible), using a stereo microscope (Iroscope model Es - 24 PLIT) and tweezers (R - 1).

Small-sized components, such as scales, bones, hairs, feathers, teeth, and other fragments, were stored in properly labeled plastic vials. Larger structures such as partial fish skeletons, found mainly in feeders, were stored in paper envelopes.

One of the elements of greatest interest was otoliths; these were cleaned with a wet towel to remove adhered remains and determine whether their condition was suitable for identification. It is worth highlighting that the identification of each otolith in a pair (left and right) was conducted following the main characteristics mentioned by Ramírez-Pérez *et al.* (2019).

We identified species based on otoliths using three types of reference materials: 1) photographic catalogs from the *Formes d'Otòlits* database (AFORO BASE 2018, Catalan acronym; http://aforo.cmima.csic.es/index.jsp), *Sagitta* Otolith Catalog of Fishes of the Gulf of México (*Catálogo de otolitos* Sagitta *de peces del Golfo de México*) by Ramírez-Pérez *et al.* (2019), and Otoliths: A Way to Identify Fishes (*Otolitos:*

una manera de identificar a los peces) by Rosas Arevalo *et al.* (2021); 2) A list of fish species recorded for the Palizada–Del Este and Laguna de Términos system obtained from the Hydrological and Ichthyological Atlas of Laguna de Términos (*Atlas hidrológico e ictiológico de la Laguna de Términos*) by Ramos-Miranda *et al.* (2006) and Marine and Coastal Ichthyofauna of Campeche (*Ictiofauna Marina y Costera de Campeche*) by Ayala-Pérez *et al.* (2015), and 3) otoliths from the Otolith Collection of the Faculty of Natural Sciences at UNACAR. Once otoliths were identified to the finest taxonomic level possible, they were deposited following the Collection guidelines.

Ecological niche width was calculated through Levin's index (Levins 1968; Jaksic and Marone 2007), including the analysis of the remains of 98 samples of organisms identified to the finest taxonomic level possible:, where *B* is Levin's Index, and *Pi* is the relative frequency of the species using the resource *i*. The standardized Levin's index $B_{est} = (B - 1) / (n - 1)$ was used to express the niche width on a scale ranging from 0 (narrow niche) to 1 (wide niche; Krebs 1999).

Percentage of Occurrence was calculated with the formula: $PO = fi/ft \times 100$, where *fi* is the number of feces samples containing a prey category and *ft*, the total number of occurrences of all prey categories in the total number of feces samples (Macías-Sánchez and Aranda 1999). Finally, the Statistica Software version 7.0 (VinceStatSoft 2002-2007) was used to perform non-parametric Kruskal-Wallis tests and assess whether the consumption of prey groups (mollusks, crustaceans, fish, reptiles, birds, and mammals) varied significantly between the three seasons (Díaz-Gallardo *et al.* 2007).

We analyzed 126 samples of Neotropical otter feces and one feeder collected at 52 sites (Figure 2) in the three seasons. The dry season showed the highest abundance of feces (n = 71, 56.3 %), followed by the winter rainy season (n = 40, 31.7 %) and the rainy season (n = 15, 11.9 %). The latter record was likely the result of heavy rains prior to sampling, washing away the feces on some mangrove trunks.

Seven major groups were identified from feces. Fish showed the highest percentage of occurrence (59 %), followed by crustaceans (23 %), mollusks and mammals (5 % each), reptiles (4 %), birds (1 %), and others (3 %, including insects, polychaetes, and unidentified materials). Throughout the study, 4 types of indirect evidence were recorded: feces, latrines, vocalizations, and feeders (Figure 2A-C), with the winter rainy season (*nortes*) showing the greatest diversity of indirect evidence (Figure 2A). Only one feeder was recorded in the winter rainy season (*nortes*; Figure 2A). Bone remains were found in the feeder, allowing the identification of two fish genera: 1) *Pterygoplichthys* (janitor fish) and 2) *Cathorops* (dark sea catfish, *C. melanopus*; Table 1).

Of a total of 101 otoliths, only 29 (28. 7%) were identifiable due to their good state of conservation. Seven fish families were identified in feces: Ariidae, Batrachoididae, Gobiidae, Paralichthyidae, Cichlidae, Poeciliidae, and Loricariidae (Table 1). The genus *Pterygoplichthys* (janitor fish) was additionally identified using not only otoliths but also structures such as vertebrae, spines of pectoral and dor-

Table 1. Prey organisms identified in feeders and feces of the Neotropical otter in La Sangría Lagoon, Campeche. * Native species (Ramos-Miranda *et al.* 2006; Ayala-Pérez *et al.* 2015; Rosas Arevalo *et al.* 2021). ** Possible new records for the study area. + Taxonomic hierarchy according to Fishbase (Froese and Pauly 2022). ++ Taxonomic hierarchy according to the World Register of Marine Species (WoRMS 2021). FO = Frequency of Occurrence. PO = Percentage of Occurrence.

Phylum / Subphylum	Class	Order	Family	Genera	Species	FO	PO
Mollusca ++	Bivalvia	Ostreida	Ostreidae	*Crassostrea*	*Crassostrea* sp.	7	3.68
		Myida	Dreisseni-dae	*Mytilopsis*	*Mytilopsis* sp.	4	2.11
	Gastropoda		Unidentifiable			13	6.84
Arthropoda ++ / Crustacea	Malacostracea	Decapoda	Portunidae	*Callinectes*	*Callinectes* sp.	86	45.3
			Penaeidae	*Penaeus*	*Penaeus* sp.	21	11.1
	Hexanauplia	Balano-morpha	Balanidae	*Balanus*	*Balanus* sp.	1	0.53
Chordata / Vertebrata	Actinopterygii+	Batrachoi-diformes	Batrachoi-didae	*Opsanus*	*Opsanus beta* *	1	0.53
		Cicliformes	Cichlidae	*Cichlasoma*	*Cichlasoma urophthalmus* *	1	0.53
		Gobiifor-mes	Gobiidae	*Awaous*	*Awaous* sp. **	9	4.74
		Silurifor-mes	Loricarii-dae	*Pterygo-plichthys*	*Pterygo-plichthys* sp.**	19	10.0
			Ariidae	*Cathorops*	*Cathorops melanopus**	4	2.11
		Pleuronec-tiformes	Paralich-thyidae	*Cyclopsetta*	*Cyclopsetta chittendeni* **	1	0.53
		Cyprino-dontiformes	Poeciliidae	*Poecilia*	*Poecilia* sp. **	1	0.53
	Reptilia	Squamata Suborder: Serpentes		---		8	4.21
	Aves		Unidentifiable			1	0.53
	Mammalia	Rodentia		---		13	6.84
					TOTAL	190	100

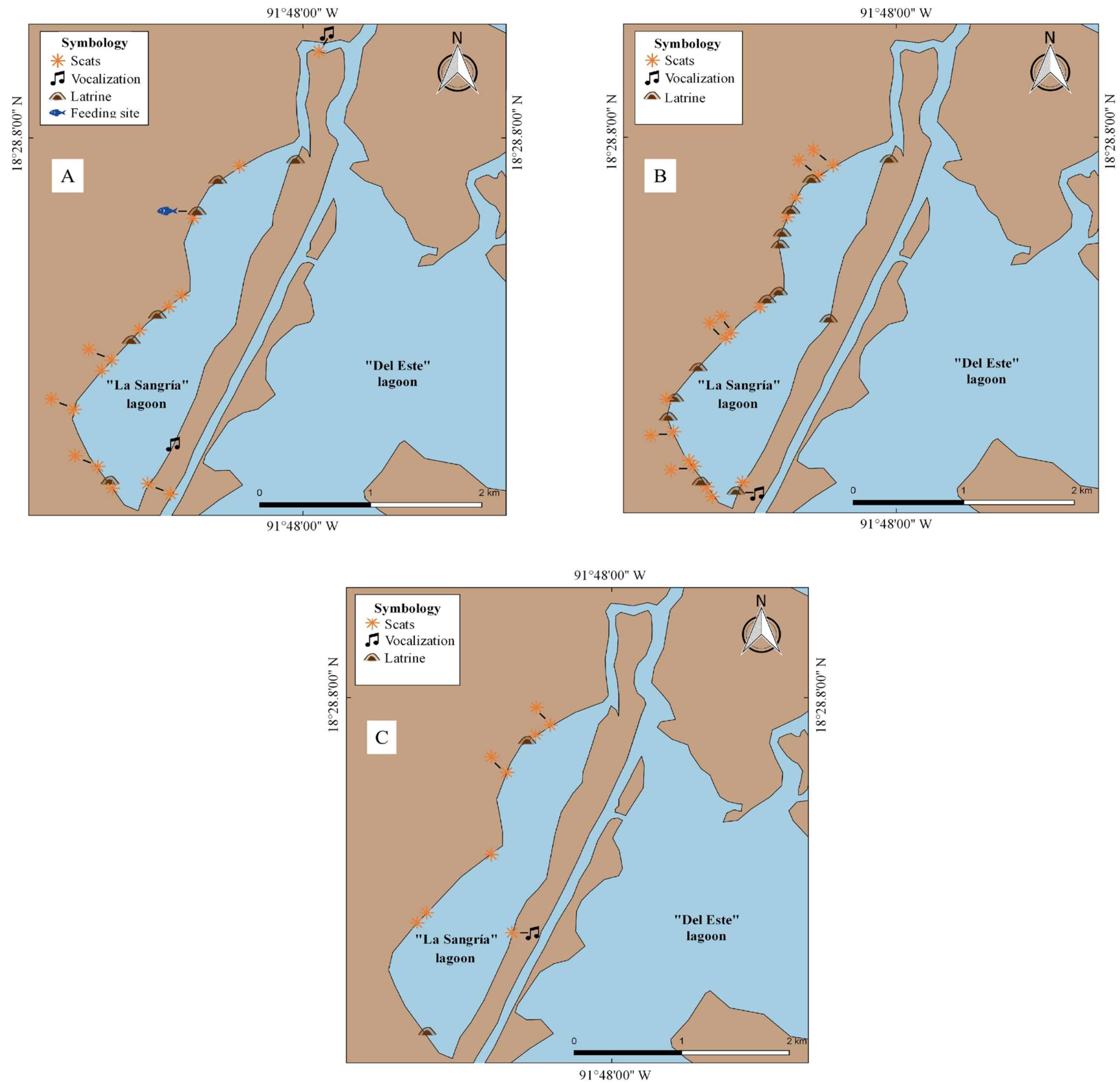

Figure 2. Spatio-temporal distribution of indirect evidence of Neotropical otter in La Sangría Lagoon, Palizada, Campeche, México. A) Winter rainy season (*nortes* 2016). B) Dry season (2017). C) Rainy season (2017).

sal fins, and, particularly, dermal plates. The janitor fish showed a total percentage of occurrence of 14.28 % during the sampling period, with the highest percentage in the rainy season (26.70 %), followed by the winter rainy season (*nortes*; 15 %) and the dry season (11.30 %).

Two families of crustaceans were identified (Portunidae: *Callinectes*; and Penaeidae: *Penaeus*). Regarding mollusks, 2 classes were recorded: Gasteropoda and Bivalvia, the latter with two genera (*Crassostrea* and *Mytilopsis*), both representative of the area (García-Cubas and Reguero 2007). Only the Order Rodentia was identified for mammals, while the reptiles identified belong to the Order Squamata, particularly the Suborder Serpentes. Finally, birds could only be identified to class (Table 1).

Considering the organisms identified in Table 1, the standardized Levin's index showed that the niche width of *L. l. annectens* tends to specialization in La Sangría Lagoon (B_{est} = 0.2078; Krebs 1999). The statistical analysis of the feeding habits by season revealed no variation in the consumption frequency of prey groups (H = 5.421, *d.f.* = 2, $P >$ 0.05; Table 1). However, there were statistically significant differences in the diversity of species consumed (H = 46.3, *d.f.* = 2, $P < 0.01$).

Fish were the main prey group in the three seasons (53 % rainy, 50 % winter rainy, and 71 % dry). The rank of percentages for the main prey groups were fish > crustaceans > mollusks = mammals, with fish > crustaceans in the three seasons.

The food resources of the Neotropical otter recorded in the feeder and feces comprised diverse groups (7 in total: fish, crustaceans, mollusks, mammals, reptiles, birds, and others). However, the low standardized Levin's index value (0.2078) in La Sangría Lagoon may suggest that the Neotropical otter presents a niche width with a specialist tendency. This work confirms that species with a wide distribution, such as the Neotropical otter (Ramírez-Bravo 2010), will shift their trophic condition from generalist to specialist, depending on the site where preys are located (Monroy-Vilchis and Mundo 2009) or exposure to intense disturbances (Briones-Salas *et al.* 2013), feeding preferentially on the most abundant and available resource, in this case, fish, including the janitor fish (*Pterygoplichtys* spp.). Briones-Salas *et al.* (2013) mentioned that classifying the Neotropical otter as a specialist should not depend solely on the Levin's index value; its ability to consume a wide range of food items and its plasticity to adapt to new conditions should be assessed too. Therefore, further studies should address the abundance, frequency, and other ecological aspects of prey species in the study area.

Several authors have described *L. longicaudis* as an opportunistic carnivorous species that can consume prey according to their availability (Gallo-Reynoso 1996; Macías-Sánchez and Aranda 1999; Arellanes-Licea and Briones-Salas 2003; Díaz-Gallardo *et al.* 2007; Casariego-Madorell *et al.* 2008; Santiago-Plata *et al.* 2013; Rheingantz *et al.* 2017; Grajales-García *et al.* 2019; García-Silva *et al.* 2021). The hypothesis that diet analysis is a key factor in classifying the Neotropical otter as an opportunistic species (defined as a species that has greater adaptability by not specializing in any particular food) is not consistent with the results of this work. However, all the studies on the subject should be considered, and some authors report that the Neotropical otter is an opportunistic species with a flexible diet (Chanin 1985; Briones-Salas *et al.* 2013; Rheingantz *et al.* 2017).

Of the 7 groups of prey identified in feces, fish was the main group in most cases. The presence and consumption of *Pterygoplichtys* spp. were recorded in the three climatic seasons, suggesting that the Neotropical otter may play a role in regulating janitor fish populations, as reported by Amador del Ángel *et al.* (2014) and Vázquez-Maldonado *et al.* (2018). In this work, it was not possible to identify janitor fish species with otoliths. Two species are reported in the region, *P. pardalis* and *P. disjunctivus*, and hybridization between both species also has been documented (Li-Wei *et al.* 2011; Amador del Ángel *et al.* 2014). It is worth highlighting that the lowest percentage of occurrence (11.3 %) for *Pterygoplichtys* spp. was recorded in the dry season when the highest salinity values were observed with a maximum concentration of 5 ppm (parts per million). It has been reported that specimens of *P. pardalis* kept at a salinity level of 0.2 PSU (practical salinity units) can survive a sudden (acute) exposure to salinities up to 10 PSU for 10 days (experimental evaluation criterion of 240 hr; Capps *et al.* 2011) with low mortality. La Sangría Lagoon is under the hydrological influence of Laguna de Términos. The latter is characterized by brackish to marine water masses, and salinity values above 0 ppm prevail in the dry season, given the lack of inputs of fluvial and pluvial fresh water (Ayala-Pérez 1989). It has been mentioned that the hybridization between *P. pardalis* and *P. disjunctivus* has given rise to hybrid superiority, so hybrid specimens are more adaptable when they invade new habitats (Jumawan *et al.* 2011). Further studies are required to understand its resistance and abundance (*i.e.*, higher salinity values are associated with a lower percentage of occurrence of janitor fish in feces, likely due to lower consumption from lower prey abundance).

The identification of fish to species based on otoliths was complex. It is worth mentioning that some otoliths also did not allow identification to family, mainly for three reasons: 1) otoliths were highly degraded due to the digestion process, 2) they were not the *Sagitta* otoliths commonly used for fish identification, and 3) they were only small fragments that did not allow observing morphological structures essential for proper identification. Since species identification directly impact Levin's index, the presence of potential prey, including fish and other taxa, should be addressed in future studies. This issue is not unique to this study but affects any results reporting that otoliths remained and passed through the digestive tract, as in the case of common bottlenose dolphins (*Tursiops truncatus*; Naranjo Ruíz *et al.* 2019). However, this index gives insights into understanding niche width, which should not depend solely on the Levin's index value for the area, as suggested by Briones-Salas *et al.* (2013).

Three of the prey fish species identified are native to the area (*Cathorops melanopus, Opsanus beta*, and *Cichlasoma urophthalmus*), according to Ramos-Miranda *et al.* (2006), Ayala-Pérez *et al.* (2015), and Rosas Arevalo *et al.* (2021). Four likely new fish records for the area were also obtained (*Awaous* sp., *Cyclopsetta chittendeni*, *Poecilia* sp., and *Pterygoplichthys* sp.). Nonetheless, more detailed analyses should be performed since no reference catalog of otoliths is currently available for the region or the genera inhabiting the study area.

Regarding the ranking of the percentages of the main prey groups recorded in this study (fish > crustaceans > mollusks and mammals), a new relationship emerged versus studies from other regions of México, even relative to those where fish are highlighted as the main prey of otters (Table 2).

Our results in La Sangría Lagoon showed that the consumption percentages are related to prey availability each season. This is consistent with the reports by authors such as Chemes *et al.* (2010) and Santiago-Plata *et al.* (2013), the latter for a locality (La Veleta) very close to our study area in Laguna de Términos region, Campeche.

The Neotropical otter plays an important role in the ecosystems where it thrives. When its feeding habits in La Sangría Lagoon are compared with those recorded elsewhere, its trophic adaptability and ecological value are evidenced. Accordingly, otters are considered umbrella species (Bifolchi and Lodé 2005) and top predators, highlighting their potential to maintain the functioning of aquatic environments (Sánchez and Gallo-Reynoso 2007; Gallo-Reynoso *et al.* 2008; Grajales-García *et al.* 2019; García-Silva *et al.* 2021), particularly through the consumption of exotic and invasive species, such as the janitor fish (Capps *et al.* 2011; Amador del Ángel *et al.* 2014).

The fact that otters use logs of different mangrove species illustrates the functional links of this species with other components in the same ecosystem, as previously described by Bifolchi and Lodé (2005), confirming that the Neotropical otter is a key umbrella species in its ecosystem.

Table 2. Percentage of occurrence of the main prey groups in feces of *Lontra longicaudis annectens* in México. *Insects, arachnids, diplopods, and gastropods. **Laguna de Términos Wildlife Protection Area.

Order	Location	Citation
Crustaceans > fishes > insects	Ríos Ayuta, Copalita and Zimatán, costa de Oaxaca	Casariego-Madorell *et al.* 2006
		Casariego-Madorell *et al.* 2008
	Río Zimatán, costa de Oaxaca	Briones-Salas *et al.* 2013
*Invertebrates > fishes > plants	Río San Diego, en la quebrada de Galindo, Durango	Cruz-García *et al.* 2017
Crustaceans > fishes > mollusks	Zona costera de Tuxpan, Veracruz	Grajales-García *et al.* 2019
Fishes > amphibians and insects	Río Bavispe-Yaqui, Sonora	Gallo-Reynoso 1996
Fishes > insects > mammals	Río Bavispe-Yaqui, Sonora	Rangel-Aguilar and Gallo-Reynoso 2013
Fishes > crustaceans > insects	Sierre Madre del Sur	Gallo-Reynoso 1989
	Río Los pecadores, Veracruz	Macías-Sánchez and Aranda 1999
	Río San Cipriano, Tabasco	Ramón 2000
	Río Ayuquila, Jalisco	Díaz-Gallardo *et al.* 2007
Fishes > insects > amphibians	Temascaltepec, Edo. de México	Monroy-Vilchis and Mundo 2009
Fishes > amphibians, arachnids, crustaceans	Río Mezquital-San Pedro, Durango	Charre-Medellín *et al.* 2011
Fishes > crustaceans > reptiles	Camino La Veleta, APFFLT**, Campeche	Santiago-Plata *et al.* 2013
Fishes > reptiles > insects	Río Grande, Reserva de la Biosfera Tehuacán-Cuicatlán (Puebla-Oaxaca)	Duque-Dávila *et al.* 2013
Fishes > insects > reptiles	Reserva de la Biosfera Tehuacán-Cuicatlán (Puebla-Oaxaca)	Lavariega *et al.* 2020
	Río Santiago, Nayarit-Jalisco	Guerrero *et al.* 2018
Fishes > crustaceans > mollusks and mammals	Laguna La Sangría, Palizada**, Campeche	This work

Acknowledgement

To the Laboratorio de Vida Silvestre y Colección Científica of the Centro de Estudio en Desarrollo Sustentable (CEDESU - UACAM), especially to O. G. Retana Guiascón for the invaluable information provided, as well as two anonymous reviewers that improved the writing. This work was carried out in the facilities of the Facultad de Ciencias Naturales, Universidad Autónoma del Carmen, as part of the project registered with the Dirección General de Investigación y Posgrado of UNACAR with the code number FCN / 2016 / 07 and with the authorization of the following permits before SEMARNAT: OFFICIAL NO. SGPA / DGVS / 09059 / 15, SGPA / DGVS / 15249 / 15, SGPA / DGVS / 05057 / 17 and OFFICIAL NO. SGPA / DGVS / 09274 / 17. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Jorge Ayala-Berdón
Submitted: January 19, 2022; Reviewed: March 23, 2022.
Accepted: June 21, 2022; Published on line: June 29, 2022.