AQUATIC RESEARCH

E-ISSN 2618-6365

Aquat Res 6(1), 64-71 (2023) • https://doi.org/10.3153/AR23007 *Short Communication*

New record of the prickly shark *Echinorhinus cookei* (Pietschmann, 1928) and evidence of scavenging by the coyote *Canis latrans* (Say, 1823) in Bahia de Los Angeles, Baja California, Mexico

Jorge I. ROSALES-VÁSQUEZ[1], Vicente ANISLADO-TOLENTINO[1], Brandon ESCÁRCEGA-MIRANDA[2]

Cite this article as:
Rosales-Vásquez, J.I., Anislado-Tolentino, V., Escárcega-Miranda, B. (2023). New record of the prickly shark *Echinorhinus cookei* (Pietschmann, 1928) and evidence of scavenging by the coyote *Canis latrans* (Say, 1823) in Bahia de Los Angeles, Baja California, Mexico. Aquatic Research, 6(1), 64-71. https://doi.org/10.3153/AR23007

[1] Grupo de Investigadores Libres Sphyrna, Allende 755-3, Bustamante, 22840, Ensenada, Baja California, México

[2] Universidad Autónoma de Baja California Carretera Transpeninsular Ensenada-Tijuana no. 3917, Playitas, 22860, Ensenada, Baja California, México

ORCID IDs of the author(s):
J.I.R.V. 0000-0001-5245-3376
V.A.T. 0000-0002-2184-0047
B.E.M. 0000-0002-3629-2784

Submitted: 21.06.2022
Revision requested: 17.09.2022
Last revision received: 08.10.2022
Accepted: 09.10.2022
Published online: 29.12.2022

Correspondence:
Jorge I. ROSALES-VÁSQUEZ
E-mail: carcharodon.rosales@gmail.com

Available online at
http://aquatres.scientificwebjournals.com

ABSTRACT

Echinorhinus cookei is a rare, large, demersal, deep-sea species of shark inhabitant of the Pacific Ocean basin. A sub-adult female with a total length of 262.7 cm was found naturally stranded in 2021 at Bahia de Los Angeles, Baja California, Central Gulf of California. It presents two spineless dorsal fins closer to the pelvic fins, large star-shaped dermal denticles, and distally oriented multi-cusplet cutting-type teeth. Along the shark, a peninsular coyote *Canis latrans peninsulae* was observed scavenging on the shark carcass. This study documents the first record of *E. cookei* in the Bahia de Los Angeles area and the first record of scavenging by the coyote *C. latrans* on any echinorhiniform shark to date.

Keywords: Natural stranding, Dermal denticles, Oceanography, Scavenging

Introduction

The Pacific prickly shark *Echinorhinus cookei* Pietschmann, 1928, (Chondrichthyes: Echinorhiniformes) is a rare species of demersal shark associated with the continental and island slopes of the Pacific Ocean basin (Compagno, 1984), being found up to 1100 m deep (Cox & Francis, 1997). Considered as large sharks (up to 4.5 m in total length) (Ebert et al., 2021), its deep-sea habits make this species little known and little studied; however, it is considered an active and top predator of deep-zone ecosystems (Ebert, 2003). Diagnostic features include the absence of anal fin, the origin of the two spineless dorsal fins closer to the pelvic fins, and large star-shaped dermal denticles grouped in patches along the body, without being fused into plates (Compagno, 1984). For the coasts of California, United States, it is associated with submarine canyons (Dawson & Starr, 2009) however, aggregations of more than 30 individuals have been reported less than 40 m deep for Monterey Bay (Crane & Heine, 1992). There are few confirmed reports of the presence of *E. cookei* along the Mexican Pacific coast: Altata, Sinaloa and Punta Rosa, Nayarit (Chávez-Ramos & Castro-Aguirre, 1974); off the coast of Mazatlán, Sinaloa (Álvarez-León & Castro-Aguirre, 1983); near Isla Cerralvo, Baja California Sur, Southern Gulf of California (Galván-Magaña et al., 1996); Isla San Jose, Baja California Sur, Southern Gulf of California and Isla Socorro at the Revillagigedo archipelago (Mariano & Villavicencio, 1998); off the coast of Boca de Apiza, Michoacan (Aguirre et al., 2002); Vizcaino Bay, Baja California and off the coast of Cabo San Lucas, Baja California Sur (Ruiz-Campos et al*.,* 2010); Isla Guadalupe, off the coast of Magdalena Bay, Baja California Sur and at off the coast of Oaxaca (Del Moral-Flores et al., 2015). For the Gulf of California, none of the reports records the presence of this species further north of the La Paz Bay, Baja California Sur, Southern Gulf of California (Figure 1).

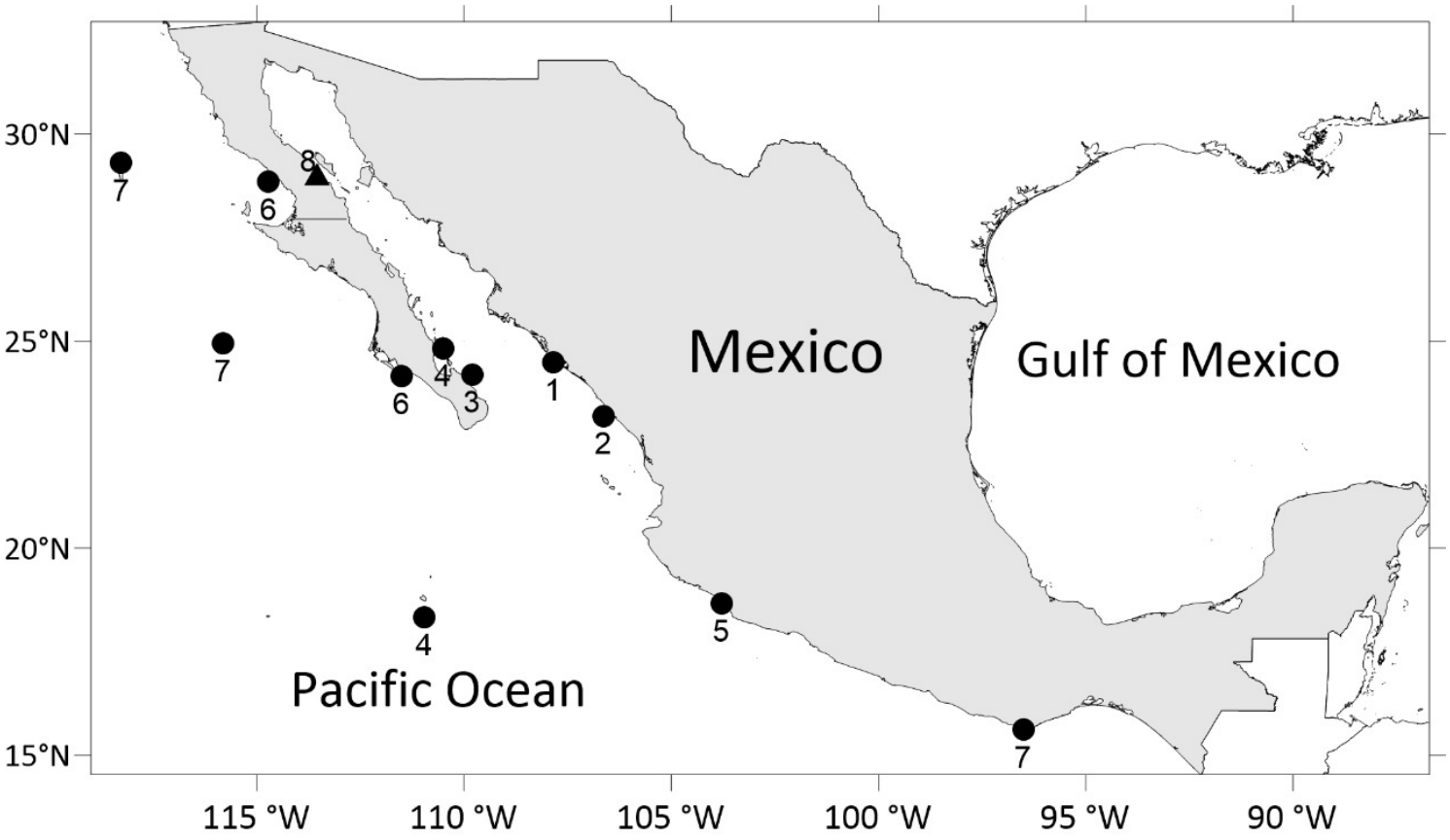

Figure 1. Prickly shark reports from the Mexican Pacific Ocean. 1, Chávez-Ramos & Castro-Aguirre, 1974; 2, Álvarez-León & Castro-Aguirre, 1983; 3, Galván-Magaña et al., 1996; 4, Mariano y Villavicencio, 1998; 5, Aguirre et al., 2002; 6, Ruiz-Campos et al*.,* 2010; 7, Del Moral-Flores et al., 2015; 8, this work (triangle marker)

On the other hand, the coyote *Canis latrans* (Say, 1823) is a species of land mammal of the canid family with wide distribution in North America (Kays, 2018). For the Baja California peninsula, there are two subspecies, the San Pedro Mártir coyote *Canis latrans clepticus* for the northern zone and the peninsular coyote *Canis latrans peninsulae* for the center and south of the peninsula (Nowak, 1979). Considered as a mesopredator (Berger & Conner, 2008), as far as its diet is concerned, it is an omnivore with seasonal variations in their diet covering a wide spectrum of prey. It actively preys on arthropods, crustaceans, small mammals, reptiles, birds, and offspring of large herbivorous mammals, in addition to vegetables (Grajales et al., 2003). The scavenging capacity of C. *latrans* is well-known, even stealing prey hunted by cougars or wolves (Wilmers et al., 2003). For Baja California, it is known that coyote populations related to coastal ecosystems take advantage of the food opportunities that the coastal zone offers, reaching up to 47.8% of their diet (Rose & Polis, 1998). Through scat studies, the consumption of marine organisms such as turtles, marine mammals both pinnipeds and cetaceans, birds, bony and cartilaginous fish has been recorded (Rose & Polis, 1998). Among the reported elasmobranchs are whip and guitar rays (Dasyatidae, Rhinobatidae), and thresher sharks (Alopiidae) (Rose & Polis, 1998).

This work presents the first confirmed record of *E. cookei* for Bahia de Los Angeles, Baja California, as well, a new evidence of the peninsular coyote *C. latrans* scavenging on elasmobranchs.

Material and Methods

At the beginning of April 2021, a local resident reported the presence of a stranded shark carcass of unknown species, in the area known as "La gringa beach", Bahía de Los Angeles (BLA), Baja California, Mexico near to 29.03234 N, 113.53808 W. (Figure 1).

Along with the shark found, the presence of an unsexed coyote *C. latrans* was observed scavenging on the aforementioned carcass (Figure 2).

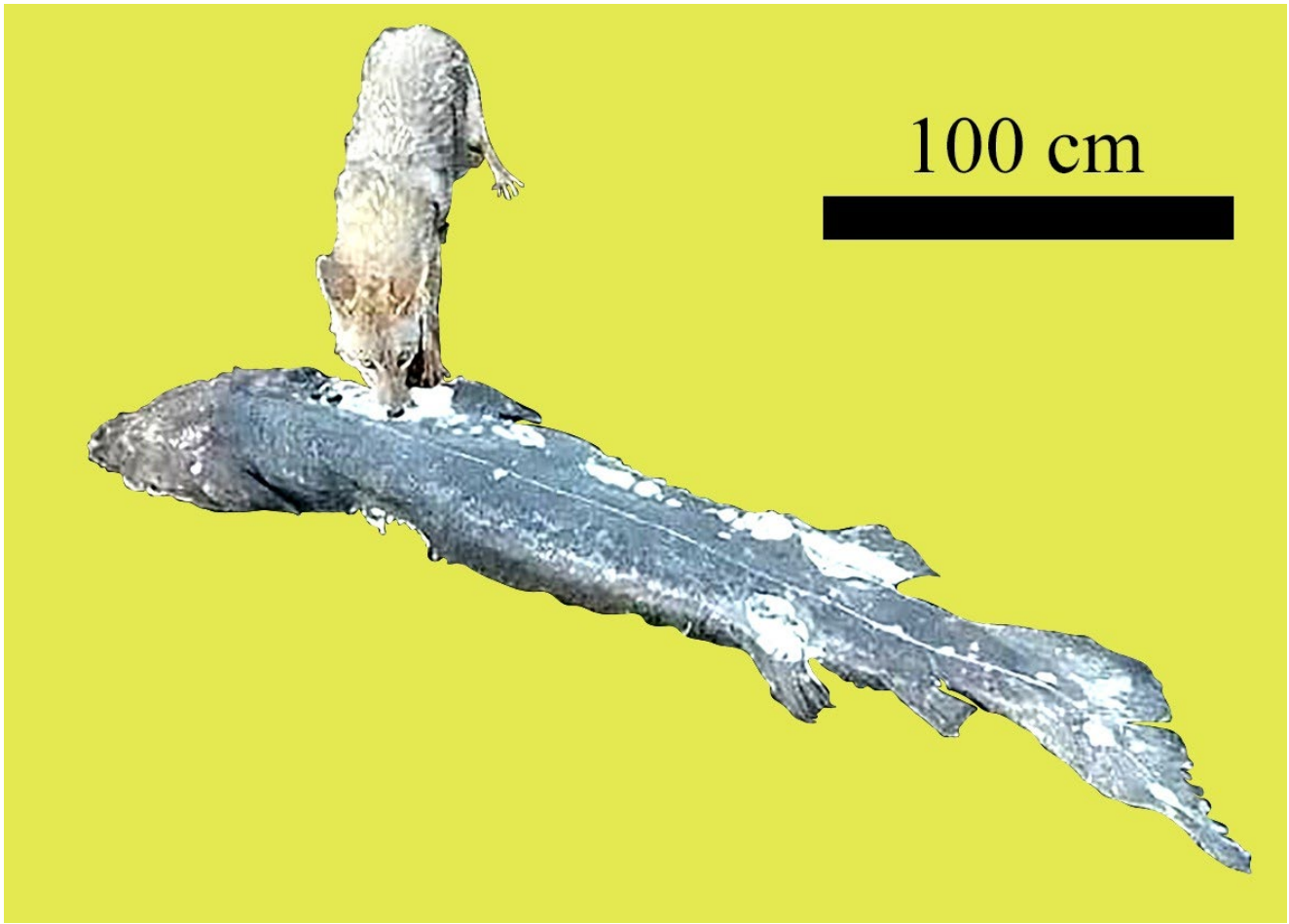

Figure 2. Scavenging by *C. latrans* on the carcass of *E. cookei*. Bite at the right side of the shark's body at the gill slits area. Photograph by Leopoldo M. Amezcua.

In order to know the species of the shark, the local villager kindly shared a photo and video graphics evidence obtained both at ground level and by air (using a drone) with the authors of this document. The photographs taken at the site were used to identify the shark following the identification guide of Compagno (1984) and Ebert et al. (2021). In addition, based on the initial estimate of the total length of the coyote made by the local resident, the precaudal length of the coyote was calculated according to what was established by Young & Jackson (1978), in order to be used as a scale in the photographs. Some of the most important measurements proposed by Compagno (1984) were calculated, as far as possible, for the shark using the ImageMeter® mobile phone application.

Results and Discussion

The initial estimate of the length of the coyote by the local resident was more than one meter in total length (>1 m). According to that observation, it was estimated that the precaudal length of the canid was approximately between 0.7 to 0.8 m. The shark analyzed was a female with an estimated total length (LT) of 262.7 cm and a precaudal length (PCL) of 186.3 cm (Figure 3a). The rest of the measurements obtained are shown in Table 1.

As for the state of decomposition of the shark, there was no evidence that the abdominal cavity was swollen or burst. Likewise, there is no evidence of discoloration or detachment of skin related to advanced decomposition of the body. The local villager said the body expelled a pronounced smell of ammonia. The shark presented superficial marks related to the coyote bite on its right side at the caudal and lateral regions (Figure 3a).

Exposed cartilage was also observed for the pelvic and dorsal fins base regions of the side mentioned above (Figure 3a). The most severe damage was observed in the gill area (Figure 3a) of both sides, in which pieces of detached tissue and exposed muscle was seen. Stands out aerial evidence of the moment in which the coyote was shredding a piece of tissue from the shark's gill area (Figure 2).

Table 1. Diagnostic characteristics and measurements (cm) obtained from the studied specimen based on digital material and comparison with Aguirre et al. (2002) and Álvarez-León & Castro-Aguirre (1983) records for *E. cookei*

Anal fin	Absent					
Number of dorsal fins	2					
Number of gill slits	NA					
	This study	**% TL**	**Aguirre et al. (2002)**	**% TL**	**Álvarez-León & Castro-Aguirre (1983)**	**% TL**
Sex	Female		Male		Female	
Natural total lenght (NTL)	262.7		37.7		350	
Fork lengh (FL)	234.8	89.4	NA		NA	
Precaudal lenght	186.3	70.9	26.1	69.2	246.9	70.5
Pre-first dorsal fin lenght (PD1)	143.9	54.8	21	55.7	179.8	51.4
Pre-second dorsal fin lenght (PD2)	173	65.9	23.8	63.1	220.6	63.0
Prepelvic lenght (PP2)	150.7	57.4	19.2	50.9	167.8	47.9

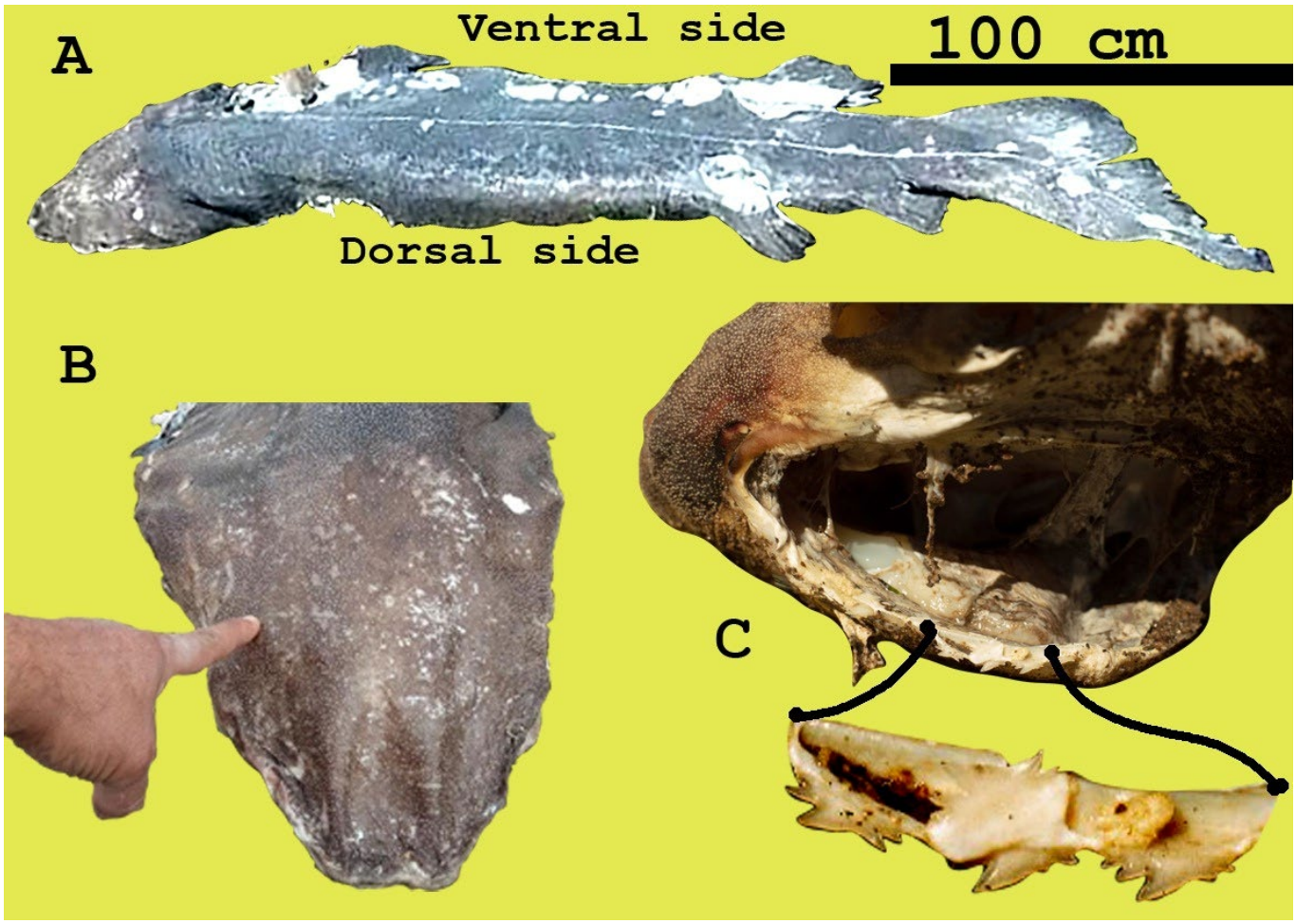

Figure 3. Aerial view of the prickly shark *E. cookei* with scavenging marks made by coyote *C. latrans*. (A). Detail of the large dermal denticles of the head area (B). Close up to the lower multi cusplet teeth of *E. cookei* (C). Photographs A and B by Leopoldo M. Amezcua, C by Meliza Le Alvarado

a) Identification of *Echinorhinus cookei*

In reference to the diagnostic characteristics that can be noticed in the analyzed specimen and following the stipulations of Compagno (1984), the absence of anal fin places it as a Squalomorph shark. Although the gill slit count could not be performed, due to damage caused by coyote scavenging, the presence of two spineless dorsal fins eliminates the possibility that the shark it is a Hexanchiform. The fusiform body, not being dorso-ventrally flattened "ray type" and the short rostrum without the presence of a saw indicates that the analyzed shark belongs to the order of the Squaliformes (Compagno, 1984). However, according to Ebert et al. (2021), the origin of the dorsal fins closer to the pelvic fins, as well as the presence of star-shaped dermal denticles (Figure 3b), appreciated at glance, place the organism in the order Echinorhiniformes. This order have a single family: Echinorhinidae and two species *Echinorhinus cookei* for the Pacific Ocean and *Echinorhinus brucus* for the Atlantic (Ebert et al., 2021). The presence of dermal denticles grouped in patches, unfused, not forming plates and the locality where it was found identified the shark as *E. cookei*. The absence of claspers on the pelvic fins indicates that the specimen was a female. According to Compagno, (1984), the sexual maturity for females of *E. cookei* is reached at 299 cm of total length, the estimated total length of the studied shark (262.7 cm), indicates that it was an immature organism. It is also noteworthy that no evidence of wounds caused by fishing hooks, harpoons or fishing nets were found in the body, so it can be concluded that the observation is the product of a natural stranding, not caused by a

fishing discard. To date, there is no report of any other stranded individual of *E. cookei* for the Pacific Ocean basin, so this is the first record of this type of event for the species. Nakamura et al. (2015) found that *E. cookei* present positive buoyancy and vertical diel migrations, the death of the shark at low deep because of the diel migration behavior, the positive buoyancy of the body and the strong currents at the Bahia de Los Angeles zone could cause the stranding of the shark carcass at the beach. Unfortunately, due to the remoteness of the location and the lack of on-site facilities, no tissue samples or necropsy was made in order to determine the cause of death of the organism.

b) Environmental feasibility of the presence of *E. cookei* in BLA

BLA is located in the central part of the Gulf of California (GC) in the area known as the "midriff islands". This area is characterized by the presence of the two largest islands of the GC (Angel de la Guarda and Tiburon). For the coast of Baja California, the natural channel between the coast and Angel de la Guarda Island is known as the "Ballenas channel" (BC), which has a depth of up to 1600 m and very stable temperatures, around 11° C throughout the year (Álvarez-Borrego, 2007). The oceanography for the BC is considered unique and different from the rest of the GC, with very strong tidal currents that promote an intense mixture resulting in a condition of constant upwelling (Álvarez-Borrego, 2007). This produces the highest surface concentrations of CO_2 and nutrients throughout the GC, which leads to high primary productivity (Álvarez-Borrego, 2007) and the presence of macroplanktophagous organisms such as great whales (*Balaenoptera musculus, B. physalus, B. edeni, Eschrichtius robustus*) or whale-sharks (*Rhincodon typus*), as well as various odontocetes (*Delphinus delphis, Globicephala macrorhynchus, Physeter macrocephalus, Orcinus Orca*) (Heckel et al., 2007). Likewise, BC is characterized by high concentrations of oxygen at great depth (Heckel et al*.,* 2007). These oceanographic conditions are similar to those of Monterey Bay, California (Broenkow https://montereybay.noaa.gov/sitechar/phys2.html), where the presence of *E. cookei* is known. This makes the presence of *E. cookei* feasible for the Ballenas Channel area in the GC. BLA presents small-scale fisheries aimed for geoduck clam, octopus, sharks, bony fish, mullet, squid, crabs, swimming crabs, and seaweed, as well as an industrial sardine fishery (Danemann et al*.,* 2007). With regard specifically to shark fisheries, there is no commercial interest on *E. cookei* and because of that, most of the previous records for Mexican waters are the result of bycatch (Chávez-Ramos & Castro-Aguirre, 1974; Álvarez-León & Castro-Aguirre, 1983; Mariano & Villavicencio, 1998; Ruiz-Campos et al*.,* 2010; Del Moral-Flores et al. 2015) or scientific collect (Galván-Magaña et al. 1996; Aguirre et al. 2002). It is likely that the absence of previous reports of *E. cookei* in BLA is due to fishers not accessing the usual depths (400-1100 m) (Cox & Francis, 1997) inhabited by this species and also, not having any commercial interest on this shark.

c) Coyote scavenging on *E. cookei* carcass

As described by Nowak, (1979) and by the geographical area where the observation was made, the scavenging coyote on the shark's carcass corresponds to the peninsular subspecies *Canis latrans peninsulae*. Coyotes have a maximum length between 1.1 to 1.3 m, being the subspecies of the Baja California peninsula smaller (1.1 m LT max.) than their northern counterparts. Morphometric analysis performed on coyotes indicate that their tails are between 30 and 40 cm long (Nowak, 1979). According to this, the precaudal length of the coyote was 80 cm and was used as a scale in the photograph to make the measurements of the shark. Coyotes are the first know canids that present antibodies to counteract the neurotoxin produced by *Clostridium botulinum*, a deterioration bacterium that occurs in carcasses and is responsible for the disease known as botulism (Ohisi et al., 1979), hence the ability of these mammals to feed on carcasses. It is noteworthy that although it has been previously described that coyotes can feed on elasmobranchs (Rose & Polis, 1998; Morales, 2008) to date there is no record of the scavenging of *C. latrans* or any other canid on *E. cookei* or any other echinorhiniform shark.

Conclusion

The oceanographic characteristics of BLA and BC, similar to other areas (Monterey Bay, CA) with the registered distribution of *E. cookei*, make the presence of this species, not registered for BLA to date, viable. The natural stranding of *E. cookei*, analyzed in this study, confirms the presence of this species for BLA and BC zone and increases the ichthyologic knowledge of the area. Likewise, the scavenging by the coyote *C. latrans* is another evidence of the feeding opportunities that the sea provides to these terrestrial carnivores, being this another record of scavenging feeding by *C. latrans* on elasmobranchs and the first record by any canid over echinorhiniform sharks to date.

Compliance with Ethical Standards

Conflict of interests: The authors declare that for this article they have no actual, potential, or perceived conflict of interest.

Ethics committee approval: This study was conducted in accordance with ethics committee procedures of animal experiments

Funding disclosure: -

Acknowledgments: We thank Mr. Leopoldo M. Amezcua for his trust in giving us his testimony and the photographic and video graphic evidence with which this study was carried out. We also thank Meliza Le Alvarado for more photographic material focused on the dermal denticles of the head and the teeth of the shark.

Disclosure: -

References

Álvarez-León, R., Castro-Aguirre, J.L. (1983). Notas sobre la captura incidental de dos especies de tiburón en las costas de Mazatlán (Sinaloa) México. *Studies on Neotropical Fauna and Environment,* 18, 201-207. https://doi.org/10.1080/01650528309360635

Álvarez-Borrego, S. (2007). Oceanografía de la región de las grandes islas. En: Bahía de los Ángeles: recursos naturales y comunidad. Línea base 2007, Instituto Nacional de Ecología, 45-65. ISBN: 9789688178911, 9688178918

Aguirre, H., Madrid, V.J., Virgen, J.A. (2002). Presence of *Echinorhinus cookei* off central Pacific Mexico. *Journal of Fish Biology*, 61(6), 1403-1409. https://doi.org/10.1111/j.1095-8649.2002.tb02485.x

Berger, K.M., Conner, M.M. (2008). Recolonizing wolves and mesopredator suppression of coyotes: impacts on pronghorn population dynamics. Ecological Applications, 18(3), 599-612. https://doi.org/10.1890/07-0308.1

Broenkow W.W. (2021). Monterey Bay national marine sanctuary: Physical oceanography. (https://montereybay.noaa.gov/sitechar/phys2.html) (accessed 04.10.2021).

Chávez-Ramos, H., Castro-Aguirre, J.L. (1974). Notas y observaciones sobre la presencia de *Echinorhinus cookei* Pietschmann, 1928, en el Golfo de California, México. *Anales de la Escuela Nacional de Ciencias Biológicas*, 21, 155-164.

Compagno, L.J.V. (1984). FAO Species Catalogue, 4. Sharks of the World. An Annotated and Illustrated Catalogue of Shark Species Known to Date Part 1 – Hexanchiformes to Lamniformes. FAO Fish. Synopsis No. 125. FAO. Roma, Italia. 675 pp. ISBN: 978-1930665767

Cox, G., Francis, M. (1997). Sharks and rays of New Zealand Waters. Canterbury University Press. New Zealand. ISBN: 0-908812-60-4

Crane, N.L, Heine, J.N. (1992). Observations of the prickly shark (*Echinorhinus cookei*) in Monterey Bay, California. *California Fish Game*, 78(4), 166-168.

Danemann, G.D., Torreblanca-Ramírez E., Smith-Guerra, F. (2007). Pesca ribereña. En: Bahía de los Ángeles: recursos naturales y comunidad. Línea base 2007, Instituto Nacional de Ecología. 605-629. ISBN: 9789688178911 9688178918

Dawson, C.L., Starr, R.M. (2009). Movements of subadult prickly sharks *Echinorhinus cookei* in the Monterey Canyon. *Marine Ecology Progress Series*, 386, 253-262. https://doi.org/10.3354/meps08067

Moral–Flores, L.F.D., Morrone, J.J., Durand, J.A., Espinosa–Pérez, H., León, G.P.P.D. (2015). Listado anotado de los tiburones, rayas y quimeras (Chondrichthyes, Elasmobranchii, Holocephali) de México. *Arxius de Miscel·lània Zoològica*, 13, 47-163. https://doi.org/10.32800/amz.2015.13.0047

Ebert, D. (2003). Sharks, rays, and chimaeras of California (No. 71). University of California Press. USA. ISBN: 9780520234840

Ebert, D.A., Dando, M., Fowler, S. (2021). Sharks of the world: a complete guide. Princeton University Press. ISBN: 978-0691205991 https://doi.org/10.1515/9780691210872

Galván-Magaña, F., Abitia-Cárdenas, L.A., Rodríguez-Romero, J., Pérez-España, H., Chávez-Ramos, H. (1996). Lista sistemática de los peces de la isla Cerralvo, Baja California Sur, México. *Ciencias Marinas,* 22, 295-311. https://doi.org/10.7773/cm.v22i3.863

Grajales-Tam, K.M., Rodríguez-Estrella, R., Cancino Hernández, J. (2003). Dieta estacional del coyote *Canis latrans* durante el periodo 1996-1997 en el desierto de Vizcaíno, Baja California Sur, México. *Acta zoológica mexicana*, 89,17-28. https://doi.org/10.21829/azm.2003.89891771

Heckel, G., De Guevara, P.L., Rojas–Bracho, L. (2007). Ballenas y delfines. En: Bahía de los Ángeles: recursos naturales y comunidad. Línea base 2007, Instituto Nacional de Ecología. 563-601. ISBN: 9789688178911, 9688178918

Kays, R. (2018). *Canis latrans* (errata version published in 2020). The IUCN Red List of Threatened Species 2018: e.T3745A163508579. https://doi.org/10.2305/IUCN.UK.2018-2.RLTS.T3745A163508579.en

Mariano-Meléndez, E., Villavicencio–Garayzar, C.J. (1998). Cuatro tiburones y una raya en la costa noroccidental de México. Rev. Biol. Trop, 46(2), 465-467.

Morales, O.S. (2008). Composición específica de elasmobranquios capturados por la pesca artesanal en Bahía Vizcaíno, BC, México: Análisis de un registro histórico. Tesis de Maestría. Centro de Investigación Científica y Educación Superior de Ensenada.

Nakamura, I., Meyer, C.G., Sato, K. (2015). Unexpected positive buoyancy in deep sea sharks, *Hexanchus griseus*, and a *Echinorhinus cookei*. *PloS One*, 10(6), e0127667. https://doi.org/10.1371/journal.pone.0127667

Nowak, R.M. (1979). History and Statistical Analysis of Recent Populations. En Wiley, E. O. (ed.). North American Quaternary *Canis*. 6. Lawrence, Kansas: University of Kansas Printing Service. USA. https://doi.org/10.5962/bhl.title.4072

Ohisi, I., Sakaguchi, G., Riemann H., Behymer, D., Hurvell, B. (1979). Antibodies to *Clostridium botulinum* toxins in free-living birds and mammals. *Journal of Wildlife Diseases*, 15(1), 3-9. https://doi.org/10.7589/0090-3558-15.1.3

Rose, M.D., Polis, G.A. (1998). The distribution and abundance of coyotes: The effects of allochthonous food subsidies from the sea. *Ecology*, 79(3), 998-1007. https://doi.org/10.1890/0012-9658(1998)079[0998:TDAAOC]2.0.CO;2

Ruiz-Campos, G., Castro-Aguirre, J.L., Balart, E.F., Campos-Dávila, L., Vélez-Marín, R. (2010). New specimens and records of chondrichthyan fishes (Vertebrata: Chondrichthyes) off the Mexican Pacific coast. *Revista Mexicana de Biodiversidad*, 81(2), 363-371. https://doi.org/10.22201/ib.20078706e.2010.002.259

Wilmers, C.C., Stahler, D.R., Crabtree, R.L., Smith, D.W., Getz, W.M. (2003). Resource dispersion and consumer dominance: scavenging at wolf-and hunter-killed carcasses in Greater Yellowstone, USA. *Ecology Letters*, 6(11), 996-1003. https://doi.org/10.1046/j.1461-0248.2003.00522.x

Young, S.P., Jackson, H.H.T. (1978). The Clever Coyote. University of Nebraska Press. 411 pp. ISBN: 978-0803258938