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NOTA

A BIBLIOGRAPHIC AND FIELD RECORD CHRONOLOGY OF SHARKS AT CABO PULMO NATIONAL PARK, GULF OF CALIFORNIA

Cronología de tiburones del Parque Nacional Cabo Pulmo, Golfo de California; registros bibliográficos y de campo

RESUMEN. El arrecife de Cabo Pulmo en el suroeste del Golfo de California, México (23° 26´ N, 109° 25´ W), es considerado una de las áreas protegidas más exitosas del Pacífico americano, ya que durante este siglo han habido aumentos en abundancia y biomasa de peces carnívoros residentes (pargos, cabrillas, jureles, tiburones, etc.). Ello se debe al régimen de no pesca y el buen estado de conservación que le permiten mantener niveles altos de productividad primaria y secundaria. El aumento en el flujo de materia y energía ha provocado la llegada de especies de niveles tróficos altos como los tiburones, los cuales son más frecuentes y representan una atracción turística local. El objetivo del presente trabajo es presentar una cronología de la aparición de las distintas especies de tiburones en Cabo Pulmo, con base en bibliografia, trabajo de campo y consultas con residentes locales, guías de buceo y especialistas que han visitado la zona en los últimos 15 años. Los resultados muestran que en el arrecife de Cabo Pulmo se han registrado 11 especies de tiburones de 9 géneros y 6 familias; ocho de estas fueron anotadas en diversas fuentes bibliográficas; aquí se cita por primera vez la ocurrencia de tres más (*Sphyrna lewini, Gynglymostoma cirratum* y *Carcharhinus longimanus*). La llegada de estas especies a la zona arrecifal pudiera ser indicativo de un buen estado del ecosistema local, por ello es de esperarse que los próximos años se registre un número mayor de especies de tiburones, o de su biomasa.

Reyes-Bonilla, Héctor[1], Arturo Ayala-Bocos[2*], Francisco Javier Fernández-Rivera Melo[3], Ronald Zepeta-Vilchis[4], Andrea Asúnsolo-Rivera[5] & James Thomas Ketchum[5]. [1]Universidad Autónoma de Baja California Sur. Departamento Académico de Biología Marina. Carretera al sur km 5.5., Col. El Mezquitito. CP 23080. La Paz, B.C.S., México. Ph: (612) 123-8800, ext. 4160. Fax: (612) 123-8819. [2]Ecosistemas y Conservación; Proazul Terrestre A.C. Camineros 196, Fraccionamiento del Sol, CP 23076, La Paz, B.C.S., México. [3]Comunidad y Biodiversidad A. C. Isla del Peruano 215, Lomas de Miramar, CP 85448, Guaymas, Sonora, México. [4]Comisión Nacional de Áreas Naturales Protegidas. Parque Nacional Cabo Pulmo. [5]Pelagios Kakunjá A.C. Sinaloa 1540, Col. Las Garzas. La Paz, B.C.S., México. *Correspondence author: artboc@yahoo.com.

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The Cabo Pulmo reef in the southern Gulf of California, Mexico (23° 26´ N, 109° 25´ W) is part of a national park that has been recognized as having among the highest fish biomass in the eastern Pacific, as a result of a prohibition of fishing activities since 1995 (Aburto-Oropeza *et al*., 2011). This condition was caused by an increase in abundance and size of large predators (snappers, groupers, jacks, sharks, etc.) that take advantage of the approximately 5,300 tons per year of biomass that the reef exports to adjacent areas (Reyes-Bonilla et al., 2014). The presence and activity of large fishes have caused a significant decrease in the abundance of invertebrates (Reyes-Bonilla & Alvarez-Filip, 2009), but it has also open the opportunity for the arrival of species from higher trophic levels.

Sharks are not common residents of reefs in the Gulf of California, but they are usually observed around rocky areas in pinnacles and seamounts (Jorgensen et al., 2009). Decades ago in the Gulf of California, these seamounts and pinnacles were important shark aggregation sites (Kimley et al., 1988). Over the last decades the populations of large predators such as sharks have decreased in numbers due mostly to the increase in fishing effort (Sala et al., 2004). However, these elasmobranchs are becoming common at Cabo Pulmo as a consequence of the good conservation status of the area (Aburto-Oropeza et al., 2011; Reyes-Bonilla et al., 2014), and their increase in number and the regularity of its appearance in specific locations, has driven the establishment of a diving attraction which is becoming more popular every year.

There are few references related to the presence of sharks at Cabo Pulmo reef. Brusca & Thomson (1975) cited the blacktip shark *Carcharhinus limbatus* (Muller and Henle, 1839) and the lemon shark *Negaprion brevirostris* (Poey, 1868) in the area; while Holguín-Quiñones (1976) pointed out the occurrence of the thresher shark *Alopias vulpinus* (Bonnaterre, 1788) in the local catch. Villarreal-Cavazos *et al*. (1999) referred the occurrence of the whale shark, *Rhincodon typus* Smith, 1821, while Aburto-Oropeza *et al*. (2011) state the presence of other species such as the tiger shark, *Galeocerdo cuvier* (Peron & Leuseur, 1822), bull shark, *Carcharhinus leucas* (Valenciennes, 1839) and white tip shark, *Triaenodon obesus* Ruppel, 1837), all of which, according to these authors, have noticeably increased in numbers at Cabo Pulmo during the first decade of the XXI Century. In the web page of Robertson and Allen (2015) there is a record of Mustelus lunulatus Jordan and Gilbert 1882 in the reef, a species that has not been referred to in any previous document.

The objective of this paper is to present a chronology of bibliographic and field records of the appearance of the different shark species that have been observed or cited at Cabo Pulmo reef, particularly in the years 2000 to 2014 when the positive effect of the protective actions has been evident; the paper may be useful as a baseline to evidence future changes in the composition of the local elasmobranch assemblages. To build this chronology we also compiled information from field work performed by the authors in those years (over 600 fish census in transects, each covering from 100 to 120 square meters in area, as

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well as more than 1,000 hours of observations by divers trained in identifying fish and sharks), and contacted specialists, dive guides and local residents with a background of natural history, who have made direct observations of sharks at Cabo Pulmo in the last fifteen years.

The results of the compilation are presented in Table 1. As noticed, 11 shark species from 9 genera and 6 families have been observed at Cabo Pulmo reef, most of them in the last 15 years. Other species reported in the literature, the first ones seen after the year 2000 were *T. obesus* and *R. typus*. The latter is a species that has become common in the area that nowadays can be seen every year during spring. In contrast *Alopias vulpinus*, although recorded in the 1970s, has not been recorded again in the site. The most recent addition to the checklist is the ocean whitetip shark, *Carcharhinus longimanus* (Poey, 1861), first observed at Cabo Pulmo in 2014.

According to Robertson and Allen (2015), there are 40 shark species in coastal areas of the Gulf of California, and 32 may be found in the region surrounding Cabo Pulmo; notwithstanding, their database confirms the presence of 4 species at the reef (*C. limbatus, M. lunulatus, N. brevirostris* and *R. typus*). Of the remainder 28 species, in this communication we support the occurrence of another four (*C. leucas, C. longimanus, G. cuvier* and *S. lewini*). There are two other shark species that were observed in the reef by divers: the Galapagos shark, *C. galapagensis*, and the small tooth sand tiger *Odontaspis ferox*. These records must be confirmed with additional information to be considered as valid for the area.

On the other hand, the presence of *A. vulpinus* was mentioned in the literature (Holguín-Quiñones, 1976) but has not been confirmed in the field in the last 15 years, while the record of *Ginglymostoma cirratum* (Bonnaterre, 1788) in Table 1 is considered as a new record for the location, as well as *S. lewini* and *C. longimanus*. Also *T. obesus* is often seen at Cabo Pulmo (Aburto-Oropeza et al., 2011) and mainly at Los Cantiles (personal observations by the authors of this note; 23° 26´ 20´´ N and 109° 25´ 04´´ W) and at Cabo San Lucas (22° 52´ 34´´N and 109° 53´ 41´´W, at the tip of the Baja California peninsula). It is interesting to notice that key references such

Table 1. Shark species recorded at Cabo Pulmo reef, arranged by the year when the species was first reported or seen. Key for frequency of observation (from 2004 to 2014): Common: Annual observation. Frequent: Seen from 6 to 11 years; Sporadic: seen from 2 to 5 years; Rare: Observed in a single year, or only mentioned in the literature. Literature records by: a) Brusca & Thomson, 1975; b) Holguín-Quiñones, 1976; c) Villarreal Cavazos *et al*. (2000); d) Aburto-Oropeza *et al*. (2011); e) Robertson & Allen (2015).

Species	Bibliographic record	Year of first observation in the field (between 2004-2014)	Frequency of observation	General habitat at the park
Carcharhinus limbatus (Muller and Henle, 1839). Blacktip shark. Family Carcharhinidae.	a; 1975	2014	Frequent	Off the reef; pelagic
Negaprion brevirostris (Poey, 1868). Lemon shark. Family Carcharhinidae.	a; 1975	2011	Rare	Coastal margin
Alopias vulpinus (Bonnaterre, 1788). Thresher shark. Family Alopiidae	b; 1976	Not seen	Rare	Off the reef; pelagic
Rhincodon typus Smith, 1828. Whale shark. Family Rhincodontidae	c; 2000	2004	Common	Reef edge
Triaenodon obesus (Ruppel, 1837); Whitetip shark. Family Carcharhinidae.	d; 2011	2005	Sporadic	Reef edge; caves
Carcharhinus leucas (Valenciennes, 1839); Bull shark. Family Carcharhinidae.	d; 2011	2010	Frequent	Reef
Galeocerdo cuvier (Peron and Lesueur, 1822); Tiger shark. Family Carcharhinidae.	d; 2011	2011	Frequent	Reef
Mustelus lunulatus Jordan and Gilbert, 1882. Sicklefin smooth-hound shark. Family Triakidae.	e; 2015	Not seen	Rare	No information in the original record
Sphyrna lewini (Griffith and Smith, 1834). Hammerhead shark. Family Sphyrnidae.		2007	Sporadic	Off the reef; pelagic
Gynglymostoma cirratum (Bonnaterre, 1788); Nurse shark. Family Ginglymostomatidae		2013	Rare	Reef
Carcharhinus longimanus (Poey, 1861); Oceanic whitetip shark. Family Carcharhinidae.		2014	Rare	Off the reef; pelagic

as Robertson & Allen (2015) and Froese & Pauly (2015) do not consider this specie as present at Cabo Pulmo, nor in the Gulf of California, and even these web pages state that local records are wrong, but sightings are confirmed by the authors, scientist and local guides. Including all records, there are still 22 shark species left that are nominally present at the site but according to information obtained in this study all have not been observed recently (last 15 years at least), but may be possibly the assumption that in the coming years the good condition from the ecosystem and success of the natural protected area continues, these species of sharks will be seen in the coming years. Also, it is to be expected that the shark biomass will increase, in order to take advantage of the high secondary production of the site (Reyes-Bonilla *et al*., 2012). Finally, is important to mention that in the last years the bull shark diving in Cabo Pulmo has become popular mainly at the site known as El Vencedor.

In conclusion, there are 11 shark species reported or observed at Cabo Pulmo reef, about a third of the expected 32 species are resident around the area. It is feasible that in future years this checklist will include more taxa, mainly if the condition of the reef ecosystem is maintained or improved by correct management actions. It is thus another good evidence of the success of the natural protected area strategy.

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