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Diversity of Sharks in the Gulf of Suez, Red Sea, Egypt: A first Annotated Regional Checklist

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ABSTRACT

Diversity of sharks was studied in the Gulf of Suez for a period of two years from January 2021 to December 2022. This is the first annotated checklist of sharks in the Gulf of Suez, a distinctive and crucial fishing area in the Egyptian waters of the Red Sea. It can serve as a baseline for future studies assessing the impacts of various factors, such as targeted and bycatch fisheries, habitat destruction, anthropogenic effects, and global warming on shark populations in this important water body. There were 2377 individual sharks recorded that were captured from the waters of the Gulf of Suez. The study revealed the occurrence of 18 species belonging to 3 orders, 8 families and 12 genera. Of these 18 species, only 5 species namely: *Carcharhinus sorrah*, *Rhizoprionodon acutus*, *Loxodon macrorhinus*, *Carcharhinus brevipinna* and *Mustelus mosis* were found to be most abundant contributing about 23, 22, 18, 17, and 16% of the total number of sharks, respectively. The tiger shark, *Galeocerdo cuvier* constituted 2% of the recorded sharks whereas the rest of the species collectively represented by only 2%. The results revealed that small-sized sharks dominated among the recorded sharks. Of the 18 species recorded, 10 species are considered as migratory sharks and 2 species are potentially dangerous to humans, the tiger shark, *Galeocerdo cuveir* and the shortfin mako *Isurus oxyrhincus*. All species reported in the current study represent a conservation challenge worldwide. According to the International Union for Conservation of Nature (IUCN) Red List, fourteen species are classified as threatened and four species are categorized as near threatened. Thus, we are raising the concerns about the diversity of sharks in the Gulf of Suez. An urgent necessity exists to create and perform suitable management strategies for conservation of sharks as vital resources.

INTRODUCTION

The class Chondrichthyes (sharks, rays and chimeras) is the most evolutionary distinctive group of vertebrates and one of the three lineages of fishes **(Dulvy *et al.*, 2021)**. For decades, numerous shark populations around the world have declined as a result of their capture in global fisheries as target and bycatch species, approximately 37% of shark species are at danger of going extinct **(Dulvy *et al.*, 2008; Worm *et al.*, 2013; Clarke *et al.*, 2015; Temple *et al.*, 2024)**. These species in particular are sensitive to overfishing owing to their reproductive traits such as late maturity, low productivity and slow growth **(Cortés, 2002; Simpfendorfer *et al.*, 2008; Cortés *et al.*, 2010)**. Currently, numerous shark species are facing extinction **(Cardeñosa *et al.*, 2018; Fields *et al.*, 2018)**. Many species are devoid of basic scientific data

essential for developing and executing management strategies to sustainably use these important marine creatures **(Barker & Schluessel, 2005)**.

Sharks constitute around 500 of the more than 1200 known chondrichthyan species worldwide, including the largest fish species **(Last & Stevens, 2009)**.

Sharks are charismatic, vital and valuable members of the aquatic ecosystem. Ecologically, they act as apex predators in marine webs, offering a regulating function that promotes ecological balance. Commercially, sharks can be entirely utilized, with each portion used for certain purpose as shark flesh, skin, liver, jaws, teeth, fins and cartilages.

As the apex predators in the marine ecosystem, the ecosystem may be significantly impacted if sharks disappear **(Myers *et al*., 2007)**.

The significant global rise in shark fisheries for their numerous benefits, combined with the massive shark bycatch during teleost fisheries, led to a catastrophic drop in numerous populations in recent decades. More than 100 million sharks are yearly killed around the world, and many millions of them are killed just for their fins **(Watts & Wu, 2005)**.

The decline of shark populations is particularly alarming owing to the threat to shark diversity, and because the loss of predators may irreversibly disrupt ecosystem services and alter the community structure **(Ferretti *et al*., 2010)**.

Migratory marine species (MMS) such as sharks are currently among the most endangered because of the wide variety of stresses they face when traveling for long distances **(Lascelles *et al*., 2014)**. There were 95 shark species categorized as migratory **(Fowler, 2014)**.

Given the significant decline in the shark populations, for the conservation of these species, it is critical to establish management and protection plans, which need a solid knowledge of the biodiversity and conservation status of these vital resources **(Simpfendorfer *et al*., 2011)**.

There are limited studies currently focusing on the diversity, distribution and biology of sharks. It is essential to conduct complete and accurate regional checklists **(Jabado *et al*., 2015)**.

This checklist provides an assessment urgently required of the current shark diversity of the Gulf of Suez that can help conservation measures and ecological integrity in this important region of the Red Sea.

MATERIALS AND METHODS

Study area

The Gulf of Suez is a sizable, somewhat enclosed region (Fig. 1). It is about 346km long, 54.2km wide, and 40 meters deep. The Gulf's entire surface area is about 10,510km² **(Shaaban *et al*., 2018)**. The Gulf of Suez lies entirely within Egyptian territory, and is therefore considered a very important regional water body.

The Gulf of Suez is the principal fishing ground in the Egyptian sector of the Red Sea. Regarding fisheries, the Gulf of Suez is the most significant fishing area in the Egyptian Red Sea waters. The Gulf of Suez's continental shelf has an area of almost 8400km^2, which is nearly equal to the remainder of the Red Sea's Egyptian shelf **(Sanders & Morgan, 1989)**.

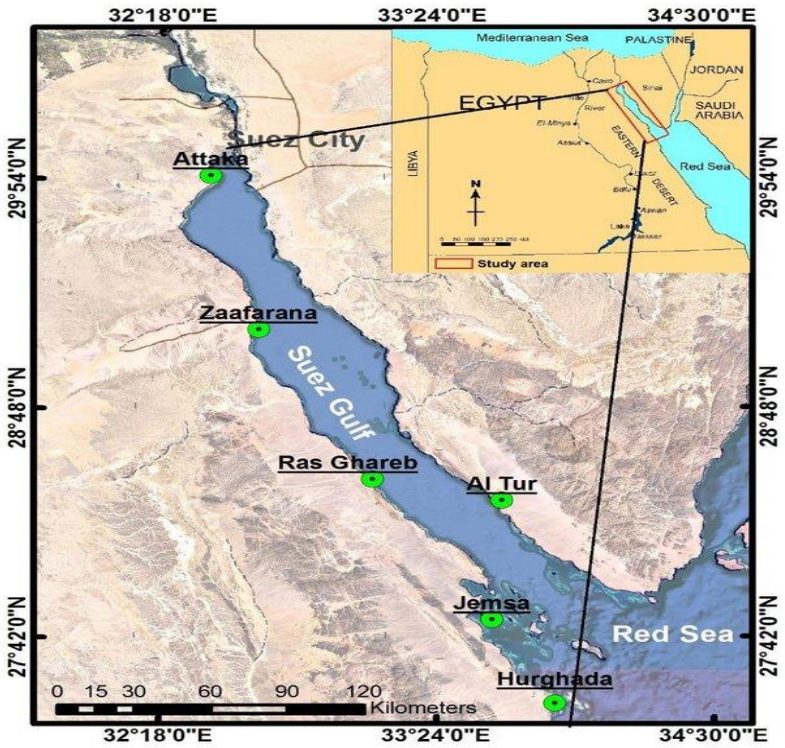

Fig. 1. Map of the Gulf of Suez

Sampling and data collection

Weekly surveys of markets and landing sites working in the Gulf of Suez were conducted between January 2021 and December 2022 to assess the diversity and relative abundance of sharks in the region.

There are two landing sites namely: El-attaka and El-salakhana harbors and one market called El-ansary. The study was based only on specimens that were landed whole, and thus could be classified to the species level. Sharks were identified using descriptions in **Compagno *et al*. (1984a, b)**, **Compagno (2001)**, **Bonfil and Abdallah (2004)**, **Last and Stevens (2009)**, **Jabado and Ebert (2015)** and **Ebert *et al*. (2021)**.

RESULTS

Overall, 2,377 sharks were recorded, captured from the waters of the Gulf of Suez. The total number of identified species was 18, belonging to 3 orders, 8 families, and 12 genera (Tables 1, 2). The most diverse family was Carcharhinidae, which contained 11 species across 5 genera.

While there were 18 species in total, most were detected in small numbers, with only five species dominating landings: *Carcharhinus sorrah*, *Rhizoprionodon acutus*, *Loxodon macrorhinus*, *Carcharhinus brevipinna*, and *Mustelus mosis*. Their relative abundances among the total species were 23, 22, 18, 17, and 16%, respectively. The tiger shark, *Galeocerdo cuvier*, constituted 2% of the total recorded sharks, while the remaining species collectively represented only 2% (Fig. 2).

The family Carcharhinidae was the most abundant, contributing about 81% of the sharks, followed by Triakidae at 16% and Galeocerdidae at 2%. The other five recorded families represented only 1% of the total sharks (Fig. 3). Images of the shark species recorded in the current study are included in the plates.

Table 1. Taxonomic list of shark species recorded from the Gulf of Suez

Order	Family	Genus	English common	Species scientific name
Carchariniform	**Carcharinidae**	***Carcharhinus***	**Sandbar shark**	***Carcharhinus***
			Spinner shark	***Carcharhinus***
			Spot tail shark	***Carcharhinus sorrah***
			Black tip reef shark	***Carcharhinus***
			Silky shark	***Carcharhinus***
			Black tip shark	***Carcharhinus limbatus***
			Dusky shark	***Carcharhinus obscurus***
		Rhizoprionodo	**Milk shark**	***Rhizoprionodon acutus***
		Loxodon	**Slit-eye shark**	***Loxodon macrorhinus***
		Triaenodon	**White tip reef shark**	***Triaenodon obesus***
		Negaprion	**Sickle fin lemon**	***Negaprion acutidens***
	Galeocerdidae	***Galeocerdo***	**Tiger shark**	***Galeocerdo cuvier***
	Triakidae	***Mustelus***	**Arabian smooth**	***Mustelus mosis***
	Hemigalidae	***Hemigaleus***	**Sickle fin weasel**	***Hemigaleus***
	Sphyrnidae	***Sphyrna***	**Scalloped**	***Sphyrna lewini***
Orectolobiform	**Stegostomatid**	***Stegostoma***	**Zebra shark**	***Stegostoma tigrinum***
	Rhincodontid	***Rhincodon***	**Whale shark**	***Rhincodon typus***
Lamniformes	**Lamnidae**	***Isurus***	**Shortfin mako**	***Isurus oxyrinchus***

Table 2. Contribution of each species recorded in the Gulf of Suez in terms of number (N), percentage and minimum and maximum total lengths (L_T)

Species scientific name	Species authorship	N	%	Minimum L_T (cm)	Maximum L_T (cm)
Carcharhinus plumbeus	(Nardo, 1827)	7	0.29	120.0	165.0
Carcharhinus brevipinna	(Valenciennes, 1839)	411	17.29	66.3	173.7
Carcharhinus sorrah	(Valenciennes, 1839)	537	22.59	53.0	134.5
Carcharhinus melanopterus	(Quoy & Gaimard, 1824)	1	0.04	90.0	90.0
Carcharhinus falciformis	(Bibron, 1839)	8	0.34	90.0	120.0
Carcharhinus limbatus	(Valenciennes, 1839)	1	0.04	78.0	78.0
Carcharhinus obscurus	(Lesueur, 1818)	1	0.04	340 .0	340.0
Rhizoprionodon acutus	(Rüppell, 1837)	520	21.88	44.6	97.2
Loxodon macrorhinus	(Müller & Henle, 1839)	430	18.09	50.0	92.5
Triaenodon obesus	(Rüppell, 1837)	2	0.08	87.0	89.0
Negaprion acutidens	(Rüppell, 1837)	1	0.04	73.0	73 .0
Galeocerdo cuvier	(Péron & Lesueur, 1822)	45	1.89	83.0	130.0
Mustelus mosis	(Hemprich & Ehrenberg, 1899)	387	16.28	41.5	111.0
Hemigaleus microstoma	(Bleeker, 1852)	6	0.25	93.7	101.0
Sphyrna lewini	(Griffith & Smith, 1834)	3	0.13	59.5	213.0
Stegostoma tigrinum	(Forster, 1781)	3	0.13	110.0	165.0
Rhincodon typus	(Smith, 1828)	5	0.21	500.0	700.0
Isurus oxyrinchus	(Rafinesque, 1810)	9	0.38	210.0	273.0
Total		2377	100		

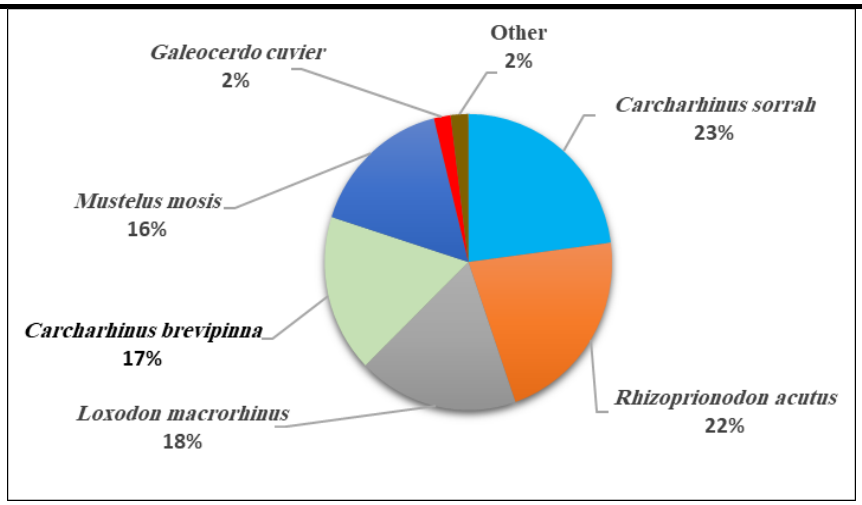

Fig. 2. Relative abundance (%) of species recorded in the Gulf of Suez

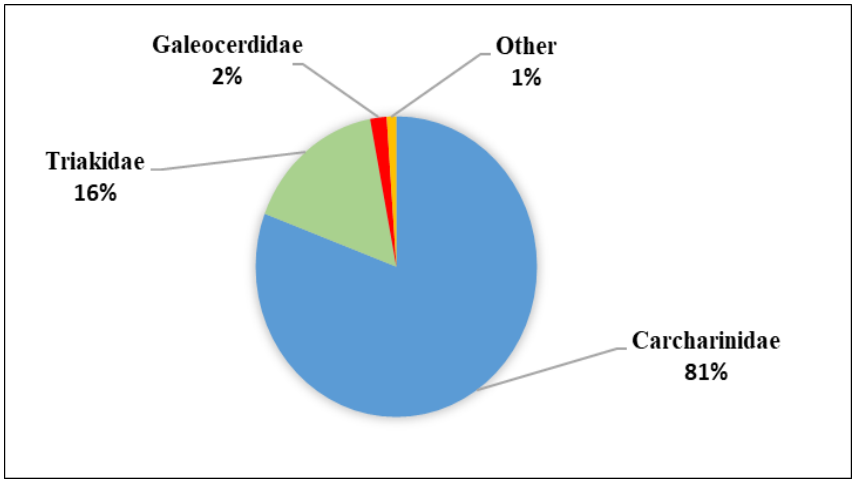

Fig. 3. Percentages of shark families recorded in the Gulf of Suez

DISCUSSION

Taxonomic clarity and the identification of species are fundamental requirements and constitute the essential initial step for biodiversity monitoring and conservation **(White & Last, 2012)**.

In this study, a total of 18 shark species were reported. In the Red Sea and Gulf of Aden, 44 species have been recorded **(Bonfil & Abdallah, 2004)**, while studies from the Red Sea have confirmed 28 shark species **(Golani & Bogorodsky, 2010)**. Additionally, 34 species have been identified in Maldivian waters **(Anderson & Ahmed, 1993)**, and 36 shark species have been identified in Omani waters in the Arabian Sea region **(Henderson *et al.*, 2007; Henderson & Reeve, 2011)**. Surveys in Malaysia recorded 48 species **(Ali *et al.*, 1999)**, in India 66 species of sharks were detected **(Raje *et al.*, 2002)**, and in Sri Lanka 61 species were recorded **(Herath, 2012)**.

Family Carcharhinidae dominated with 81 % of the species recorded during this study. This family has been shown to be extremely valuable in both industrial and artisanal fisheries worldwide, and in many tropical regions, shark catches are dominated by species of this family **(Castillo- Geniz *et al*., 1998; Compagno *et al*., 2005; Henderson *et al*., 2007; White, 2007; Last & Stevens, 2009; Jabado *et al*, 2015)**.

The spottail shark *Carcharhinus sorrah* is one of the five abundant species in the current study. This species is abundant and common in the region, usually recorded in the landings of the islands of southern Maldives **(Anderson & Ahmed, 1993)**, the Red Sea landings **(Bonfil, 2001)**, Omani catches **(Henderson *et al*., 2007)**, and landings of Iran **(FAO, 2009)**. However, in Australia, it is among the most commercially significant species known to exist **(Davenport & Stevens 1988; Last & Stevens, 2009)**.

The milk shark, *Rhizoprionodon acutus*, is one of the five dominant species in the present study. This is a common species, extensively dispersed across its habitat and several reports indicate that it primarily dominates catches in the regions where it is found **(Krishnamoorthi & Jagadis, 1986; Stevens & McLoughlin, 1991; Jayaprakash *et al*., 2002; Capape *et al*., 2006; FAO, 2009)**.

The slit-eye shark, *Loxodon macrorhinus*, is one of the five abundant species in the current study (comprising 18% of species). Besides, it was one of the most common species in landings in Oman **(Henderson *et al*., 2007)**. In the UAE as well, this species was abundant in the landings **(Jabado *et al*., 2015)**. In a research survey conducted in the Maldives as well, it constituted 70% of sharks caught **(Anderson & Ahmed, 1993)**.

Our findings concerning the abundance of the Arabian smoothhound, *Mustelus mosis* are consistent with **Moore and Peirce (2013)**, who reported it as the second most prevalent shark species in the catches in Bahrain.

The scarcity of certain species documented in this study, particularly large-sized sharks, as *Carcharhinus obscurus*, *Galeocerdo cuvier*, *Rhincodon typus*, and *Isurus oxyrinchus*, may suggest that these species are either less abundant or exhibit migratory behavior.

Many carpet shark species, such as the zebra shark (*Stegostoma tigrinum*), which has low market value, are often discarded at sea. As a result, they are likely underrepresented in landings **(Jabado *et al*., 2015)**, which may explain the limited recorded numbers of these species in the present study.

Only one specimen of the blacktip shark, *Carcharhinus limbatus* was recorded in the present investigation. Our results are in agreement with the limited historical reports of *C. limbatus* in different areas. It was uncommon in landings of Qatar, Kuwait, and Bahrain **(Moore & Peirce, 2013)**. Moroever, it has only been reported in small numbers in the Maldivian waters **(Anderson & Ahmed, 1993)**.

In the present study, a small number of species (five) of small sized sharks were more abundant, which mirrors trends observed in other regions. Landings in Oman were dominated by eight species **(Henderson *et al*., 2007)**, in Iran, three species were abundant **(FAO, 2009)**, in Chinese markets five species constituted more than 90% of the recorded sharks **(Lam & Sadovy de Mitcheson, 2011)**, in Sri Lankan landings 12 species were most abundant **(Herath, 2012)**. It is likely that large species may have been overfished to a certain degree, and the fishery currently mostly depends on smaller sharks that dominate landings **(Jabado *et al*., 2015)**.

Rhizoprionodon acutus, *Loxodon macrorhinus* and *Mustelus mosis* were the most dominant shark species in the current study. These shark species have comparatively small bodies; their total length (TL) is less than 150cm. They often form large schools or groups and are found to be prevalent in coastal areas **(Compagno *et al.*, 2005; Last & Stevens, 2009)**. It is necessary to remember that various species differ greatly in the degrees of resilience and susceptibility to overfishing **(Stevens *et al.*, 2000; Bonfil, 2001)**. Sharks of small bodies generally grow quickly, mature early, having short lifetimes, and they exhibit aseasonal reproductive cycles with relatively high fecundity **(Wourms, 1977; Stevens & McLoughlin, 1991; Shaaban *et al.*, 2018)**. These biological traits make them more biologically productive and less vulnerable to overfishing than larger species and may therefore explain their abundance in most markets worldwide.

Musick *et al.* (1993) observed that in regions such as northwest Atlantic and southeastern Africa, overfishing of large-sized sharks has led to the prevalence of smaller sharks. However, **Henderson *et al.* (2007)** found that smaller sharks like *Loxodon macrorhinus* and *Carcharhinus macloti* displaced larger sharks like *Sphyrna lewini* and *Carcharhinus limbatus* in the Omani shark fishery. Regarding the sustainability of fisheries, such shifts in the species diversity and length distribution of caught sharks possess disastrous effects.

The occurrence of all life stages (neonates, juveniles and adults) of the five abundant species reported in the present study likely implies that these species are native to the Gulf of Suez. However, all recorded specimens of tiger sharks were neonates or juveniles, suggesting that the Gulf is likely a critical habitat, serving as a parturition and nursery ground for this species, which has an extensive home range of up to 634,944km² **(Chapman, 2017; Ebert *et al.*, 2021)**.

In the current study, five individuals of the whale shark (*Rhincodon typus*), with total lengths (TL) ranging from 5 to 7 meters, were recorded. The Arabian Gulf has historically been inhabited by *R. typus* **(Bishop & Abdul-Ghaffar, 1993)**. However, large groups of *Rhincodon typus* were observed in the offshore waters in Qatar, with individuals ranging in length from 4 to 8 meters **(Robinson *et al.*, 2013)**. One male individual, measuring 4.452 meters TL, was recorded by **Jabado *et al.* (2016)** from the artisanal fishery in the United Arab Emirates.

According to **Chapman (2017)**, two shark species are considered potentially dangerous to humans: the tiger shark, *Galeocerdo cuvier* and the shortfin mako, *Isurus oxyrinchus*..

All species reported in the current study represent a conservation challenge worldwide. According to the International Union for Conservation of Nature (IUCN) Red List, 14 species are categorized as threatened (Vulnerable, Endangered and Critically Endangered) and 4 species are categorized as near threatened (Table 3).

Ten of the 18 species recorded in the current study are migratory (Table 3), accounting for 21% of all sharks, whereas the remaining eight species comprise 79% of all sharks observed.

Based on the IUCN Red List, migratory sharks face a higher relative extinction risk compared to non-migratory species. All migratory species categorized in the IUCN Red List as threatened are considered to have an unfavorable conservation status due to the impacts of overfishing, which have drastically reduced their populations below historic levels **(Fowler, 2014)**.

Furthermore, many endangered shark species are highly migratory, moving widely throughout ocean waters, and as a result, they frequently evade national authority. Therefore, actions in other countries' waters or on the high seas may undercut conservation efforts in one country **(Stevens *et al*., 2000)**.

Table 3. Species recorded in the Gulf of Suez with their migratory status (HM = Highly Migratory; M = Migratory) and IUCN Red List status (CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened)

English common name	Scientific name	Migratory status	IUCN Red List status and reference
Sandbar shark	*Carcharhinus plumbeus*	M	EN (Rigby *et al*., 2021a)
Spinner shark	*Carcharhinus brevipinna*	HM	VU (Rigby *et al*., 2020a)
Spot tail shark	*Carcharhinus sorrah*		NT (Simpfendorfer *et al*., 2021a)
Black tip reef shark	*Carcharhinus melanopterus*		VU (Simpfendorfer *et al*., 2020a)
Silky shark	*Carcharhinus falciformis*	M	VU (Rigby *et al*., 2021b)
Black tip shark	*Carcharhinus limbatus*	M	VU (Rigby *et al*., 2021c)
Dusky shark	*Carcharhinus obscurus*	M	EN (Rigby *et al*., 2019a)
Milk shark	*Rhizoprionodon acutus*		VU (Rigby *et al*.,2020b)
Slit- eye shark	*Loxodon macrorhinus*		NT (Rigby *et al*., 2021d)
White tip reef shark	*Triaenodon obesus*		VU (Simpfendorfer *et al*., 2020b)
Sickle fin lemon shark	*Negaprion acutidens*	HM	EN (Simpfendorfer *et al*., 2021b)
Tiger shark	*Galeocerdo cuvier*	M	NT (Ferreira & Simpfendorfer, 2019)
Arabian smooth hound	*Mustelus mosis*		NT (Pollom *et al*., 2019)
Sickle fin weasel shark	*Hemigaleus microstoma*		VU (Sherman *et al*., 2021)
Scalloped hammerhead	*Sphyrna lewini*	M	CR (Rigby *et al*., 2019b)
Zebra shark	*Stegostoma tigrinum*		EN (Rigby *et al*., 2024)
Whale shark	*Rhincodon typus*	HM	EN (Pierce & Norman, 2016)
Shortfin mako	*Isurus oxyrinchus*	HM	EN (Rigby *et al*., 2019c)

CONCLUSION

Although the findings of this investigation cannot give a clear picture about the condition of stocks of sharks in the Gulf of Suez, they can be used as a basis for future investigations to evaluate the impact of various factors such as targeted and bycatch fisheries, habitat destruction, anthropogenic impacts and global warming on shark populations in this crucial water body. And thereby, helping in the future effective control and management of the recorded shark species.

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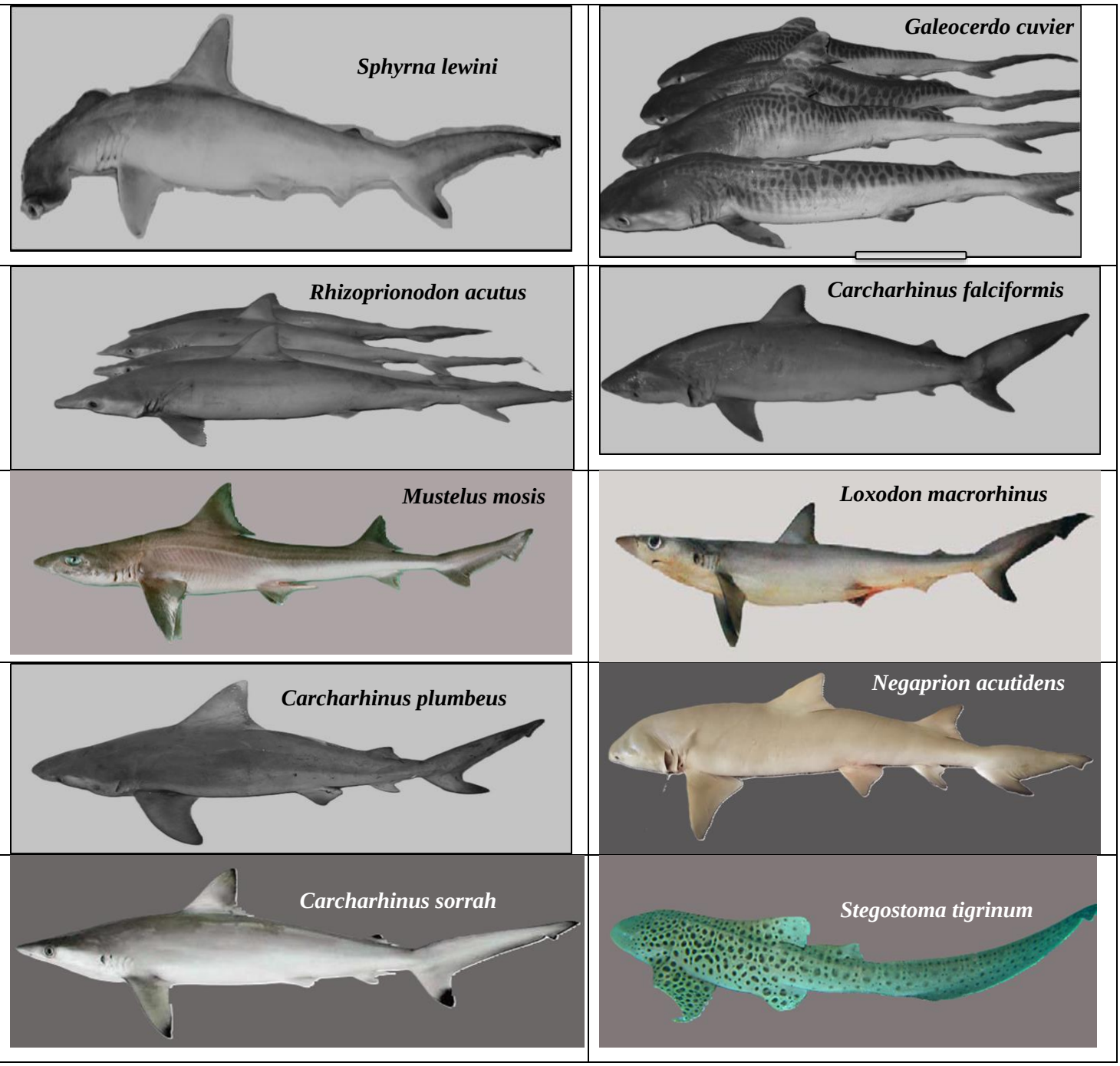
PLATES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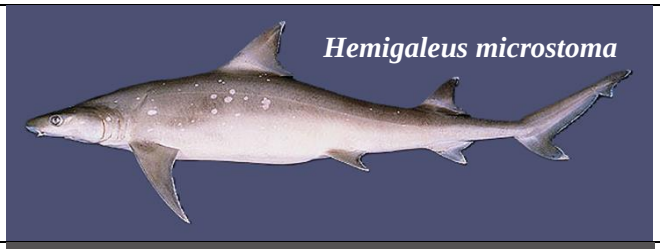
Carcharhinus sorrah
Stegostoma tigrinum


Triaenodon obesus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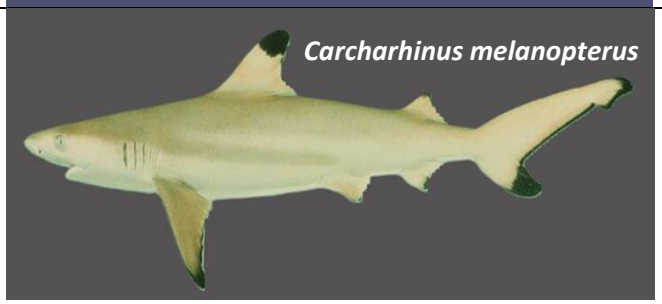
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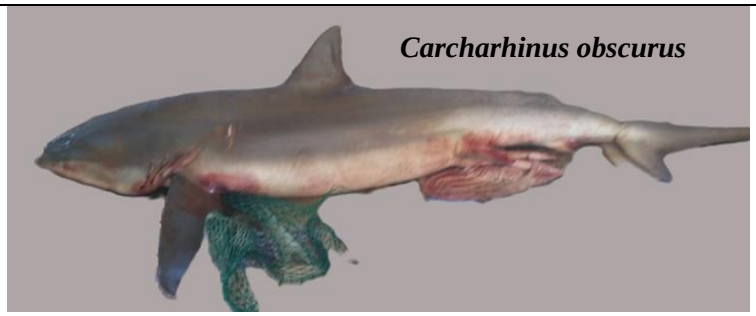
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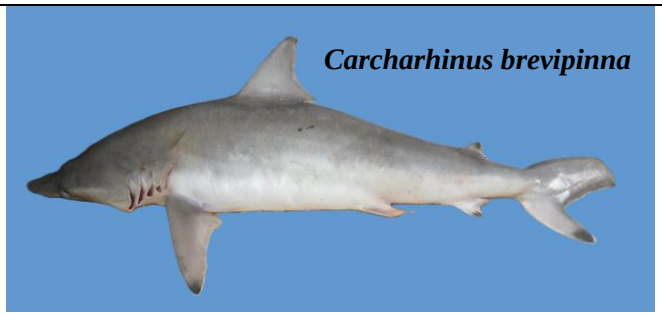
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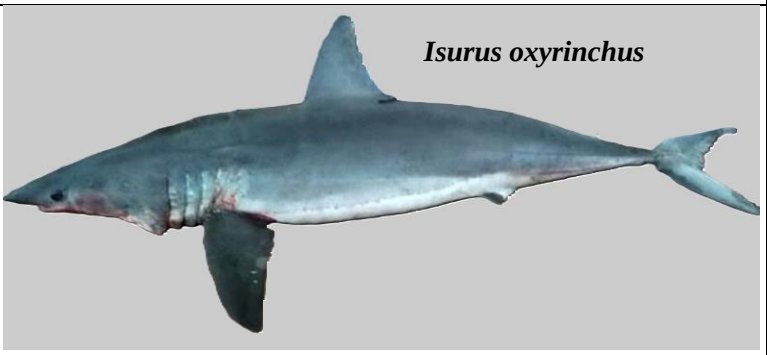
Isurus oxyrinchus


Rhincodon typus