

## INTERACTION BETWEEN KILLER WHALES (*ORCINUS ORCA*) AND HAMMERHEAD SHARKS (*SPHYRNA SP.*) IN GALÁPAGOS WATERS

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**ABSTRACT:** A possible predatory interaction between killer whales (*Orcinus orca*) and hammerhead sharks (*Sphyrna sp.*) was observed during April 1991 near Punta Cormorant, Galápagos Islands. Three killer whales were observed in close proximity to a freshly dead female hammerhead. One of the killer whales (approximately 6m in length) was observed motionless in a vertical position above the shark carcass and later was seen chasing an approximately 40cm hammerhead, supposedly a pup born prematurely from the dead shark. The sharks are thought to have been scalloped hammerheads (*S. lewini*).

**RESÚMEN:** Una posible interacción predatoria entre orcas (*Orcinus orca*) y peces martillo (*Sphyrna sp.*) fue observada en Abril de 1991 cerca de Punta Cormorán, Islas Galápagos. Tres orcas fueron vistas muy próximas a una hembra de pez martillo recién muerta. Una de las orcas (de unos 6m de longitud), fue observada inmóvil en posición vertical sobre la carcasa del tiburón y después fue vista persiguiendo a un pez martillo de unos 40cm, supuestamente una cría nacida prematuramente de la hembra muerta. Se piensa que los tiburones pudieran ser cornudas negras (*S. lewini*).

**KEYWORDS:** killer whale; *Orcinus orca*; hammerhead shark; *Sphyrna*; predation.

Observations of killer whales (*Orcinus orca*) feeding on, or attacking sharks are relatively infrequent (Table 1). Reports of killer whales off the Galápagos Islands are not common (e.g., Day, 1994; Merlen, 1999; Smith and Whitehead, 1999) as during a 27-year period of record keeping (1973-2000) only 38 records have been collated (Palacios, 2002 in Palacios *et al.*, 2004). Although cetacean strandings and remains have been well documented from the area (Palacios *et al.*, 2004), there are no records of killer whales stranding or being beach-cast onto the Galápagos Islands. There are only two published accounts of killer whale predation on sharks in this area, including a Galápagos shark (Fertl *et al.*, 1996) and an unidentified hammerhead shark (Merlen, 1999). Given

the infrequent sightings and even rarer number of observations of killer whale predation off the Galápagos Islands, we report here on a possible predatory interaction between killer whales and hammerhead sharks (*Sphyrna sp.*).

During April 1991, as part of a photo-journalistic expedition of the Galápagos Islands (Ecuador) (Sonnino Sorisio, 1991), one of the authors (LSS) was aboard a 22.5m motor yacht, the *Mistral*. The observations reported here were made near Punta Cormorant, Floreana Island (01°18'S, 90°27'W). Surface and underwater (snorkeling) observations were made during favourable conditions (Beaufort Sea State 1, sunlight and approximately 15m visibility).

**Table 1.** Published accounts of killer whales feeding on or attacking sharks (where species are known).

SPECIES	SOURCE
Sevengill shark ( <i>Notorynchus cepedianus</i> )	Reyes and García-Borboroglu (2004)
School shark ( <i>Galeorhinus galeus</i> )	Visser (2000a)
Whale shark ( <i>Rhincodon typus</i> )	Fertl <i>et al.</i> (1996)
Common thresher shark ( <i>Alopias vulpinus</i> )	Visser (2005)
Basking shark ( <i>Cetorhinus maximus</i> )	Brown and Norris (1956); Norris (1958); Yukhov <i>et al.</i> (1975); Fertl <i>et al.</i> (1996); Visser (2000b, 2005)
Great white shark ( <i>Carcharodon carcharias</i> )	Pyle <i>et al.</i> (1999)
Grey reef shark ( <i>Carcharhinus amblyrhynchos</i> )	Visser and Bonaccorso (2003)
Galápagos shark ( <i>Carcharhinus galapagensis</i> )	Fertl <i>et al.</i> (1996)
Shortfin mako ( <i>Isurus oxyrinchus</i> )	Visser <i>et al.</i> (2000)
Blue shark ( <i>Prionace glauca</i> )	Ternullo <i>et al.</i> (1993); Fertl <i>et al.</i> (1996); Visser (2000b, 2005)
Scalloped hammerhead shark ( <i>Sphyrna lewini</i> )	Visser and Bonaccorso (2003)
Smooth-hammerhead ( <i>Sphyrna zygaena</i> )	Visser (2005)

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Whilst the *Mistral* was anchored west of Punta Cormorant, a killer whale approximately 6m in length, compared to the size of the vessel, raised its head out of the water and appeared to investigate and then swim around the motor yacht. Approximately one minute later, it swam towards a point about 100m from the *Mistral*, where other two similarly-sized killer whales were observed surfacing. Based on size alone, it was not possible to determine if any of the whales were male or female (sub-adult males are a similar size to adult females), however they were clearly not adult males as they all lacked large pectoral fins, curled tail flukes and tall dorsal fins (see Bigg, 1982 for full descriptions of sexual dimorphism in killer whales).

The killer whales swam in close proximity (approximately one body length) to one another. Seabirds, including boobies (*Sula* sp.), frigatebirds (*Fregata* sp.) and brown pelicans (*Pelecanus occidentalis*) were observed circling above the whales. LSS and others from the *Mistral* boarded a smaller boat used as a tender and moved towards the killer whales, that were approximately 100m offshore, and had already split into two groups comprised of two and one animals, respectively.

When approximately 10-15m from the single killer whale, LSS and two others entered the water, leaving people on the boat. A dead female hammerhead shark could be clearly seen lying on the sandy bottom. It was estimated to be 2.5-3m long, compared to the size of the killer whale hovering approximately 3m directly above it. The whale was motionless, in a vertical position, with its rostrum oriented towards the shark. The shark was entire, and showed no visible signs of bites or external wounds.

After approximately one minute, the killer whale began moving towards the shark lying on the bottom. The divers moved closer to attempt to identify the shark species and noticed that the killer whale had begun to chase a small (approximately 40cm) hammerhead shark. Although the small shark appeared disoriented, was swimming lethargically and did not appear to avoid the killer whale, the whale made little effort to catch and eat it. After only a few minutes, the killer whale, whilst continuing to pursue the small hammerhead shark, swam out of visibility range. Whilst the divers were observing the killer whale underwater, the tender followed the two other killer whales, approximately 100m from the dead shark and the divers.

In the meantime, the divers saw two Galápagos sea lions (*Zalophus californianus wollebaeki*) swimming rapidly and in apparent random directions, but near the bottom. The single killer whale the divers had previously been watching reappeared without the smaller hammerhead shark and moved towards the divers. The killer whale ignored the sea lions that continued to swim rapidly in

the general area. As the killer whale moved towards the divers, they, unsure of its intentions, moved together into a tight group. When the whale was 10m from the divers it turned away and swam out of visibility range. During the entire encounter, which lasted a few minutes in total, only one killer whale was observed underwater. As far as could be ascertained the killer whales took no further notice of the female shark, lying dead on the bottom.

The three killer whales were then observed from the tender, surfacing together once, heading north and were not seen again. Whilst in the tender and returning to the *Mistral*, the fresh carcass of a young Galápagos sea lion was observed floating at the surface with no evident external wounds.

We believe the event reported here might represent an attack on a hammerhead shark, and as such it would be only the fourth published on any of the hammerhead species, following those reported by Skinner (1994)<sup>5</sup>, Merlen (1999), Visser and Bonaccorso (2003) and Visser (2005).

At least three species of hammerhead sharks occur in Galápagos waters; scalloped, smooth and great (*S. mokarran*) (Compagno *et al.*, 1984), but other species are possibly present (bonnethead *S. tiburo*, scalloped bonnethead *S. corona* and scoophead *S. media*) (Compagno *et al.*, 1984). With regard to the 2.5-3m dead shark reported here, the large size excludes bonnethead, scalloped bonnethead, and scoophead hammerhead sharks, as none of these species exceeds 150cm in length (Compagno *et al.*, 2005). However, its size falls into the average size for sexually mature female scalloped, smooth and great hammerhead sharks; and the size of the small (40cm) free-swimming specimen is consistent with a near-term embryo of these species (based respectively on size at maturity and at birth in Compagno *et al.*, 2005). Although identification to species, based on the underwater observations and photographs was not possible, the commonest hammerhead species in the Galápagos Islands area is the scalloped (schools of up to hundreds of individuals are regularly observed in these waters, J. Bird, pers. comm.) and this, along with the estimated sizes, suggests that the sharks were most likely scalloped hammerheads.

Tortonese (1956) reported that sharks often give birth during times of stress, such as when entangled in nets or when caught on lines. Scalloped hammerhead sharks are placental viviparous, *i.e.*, are born alive and fully functioning (Compagno *et al.*, 2005). Therefore, given the small size of the live hammerhead observed here, its proximity to the large female, and its apparent disorientation and lethargic swimming, it is probable that it was born prematurely or near full-term, during the death, or shortly after, of the female shark.

SKINNER, G. (1994) Kimbe Bay has it all. *Ocean Realm* (October): 21.

Given the observations of both the dead sea lion and female shark which had no external wounds, it is probable this event was not a feeding attack. Additionally, none of the killer whales were observed feeding on the sea lion or female shark, nor did the single killer whale appear intent on eating the newborn. However, these may have been training, practice or play mortalities. Furthermore, it cannot be ruled out that the shark died during parturition and the killer whales came across the carcass and aborted young, and were curious.

Regardless, by reporting events such as the one here, we hope to encourage further investigations to establish how rare such cases are in the Galápagos area, and help to understand sources of natural mortality for Galápagos elasmobranchs.

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### References

- BIGG, M.A. (1982) An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. *Reports of the International Whaling Commission* 32:655-666.
- BROWN, D.H. AND NORRIS, K.S. (1956) Observations of captive and wild cetaceans. *Journal of Mammalogy* 37(3): 311-326.
- COMPAGNO, L. J. V. (1984) FAO species catalogue. Vol. 4. Sharks of the world. Part 2. Carcharhiniformes. Fisheries Synopsis, 125. FAO, Rome, Italy.
- COMPAGNO, L., DANDO, M. AND FOWLER, S. (2005) *Sharks of the World*. Princeton University Press, Princeton, NJ, USA, 480pp.
- DAY, D. (1994) List of cetaceans seen in Galápagos. *Noticias de Galápagos* 53(5): 5-6.
- FERTL, D., ACEVEDO-GUTIÉRREZ, A. AND DARBY, F.L. (1996) A report of killer whales (*Orcinus orca*) feeding on a carcharhinid shark in Costa Rica. *Marine Mammal Science* 12(4): 606-611.
- MERLEN, G. (1999) The orca in the Galápagos: 135 sightings. *Noticias de Galápagos* 60(December): 1-9.
- NORRIS, K.S. (1958) Facts and tales about killer whales. *Pacific Discovery* (January): 24-27.
- PALACIOS, D.M., SALAZAR, S.K. AND DAY, D. (2004) Cetacean remains and strandings in the Galápagos Islands, 1923-2003. *Latin American Journal of Aquatic Mammals* 3(2): 127-150.
- PYLE, P., SCHRAMM, M.J., KEIPER, C. AND ANDERSON, S.D. (1999) Predation on a white shark (*Carcharodon carcharias*) by a killer whale (*Orcinus orca*) and a possible case of competitive displacement. *Marine Mammal Science* 15(2): 563-568.
- REYES, L.M. AND GARCÍA-BORBOROGLU, P. (2004) Killer whale (*Orcinus orca*) predation on sharks in Patagonia, Argentina: A first report. *Aquatic Mammals* 30(3): 376-379.
- SMITH, D.S. AND WHITEHEAD, H. (1999) Distribution of dolphins in Galápagos waters. *Marine Mammal Science* 15(2): 550-555.
- SONNINO SORISIO, L. (1991) Alle Galapagos sulla scia della Beagle. *Nautica* 355: 302-313.
- TORTONESE, E. (1956) *Fauna d'Italia Vol.II. Leptocardia, Ciclostomata, Selachii*. Calderini, Bologna, Italy. 334pp.
- VISSER, I.N. (1999) Benthic foraging on stingrays by killer whales (*Orcinus orca*) in New Zealand waters. *Marine Mammal Science* 15(1): 220-227.
- VISSER, I.N. (2000a) Killer whale (*Orcinus orca*) interactions with longlines fisheries in New Zealand waters. *Aquatic Mammals* 26(3): 241-252.
- VISSER, I.N. (2000b) *Orca (Orcinus orca) in New Zealand waters*. Ph.D. dissertation, University of Auckland, Auckland, New Zealand. 194pp.
- VISSER, I.N. (2005) First observations of feeding on thresher (*Alopias vulpinus*) and hammerhead (*Sphyrna zygaena*) sharks by killer whales (*Orcinus orca*), which specialise on elasmobranchs as prey. *Aquatic Mammals* 31(1): 83-88.
- VISSER, I.N. AND BONACCORSO, F.J. (2003) New observations and a review of killer whale (*Orcinus orca*) sightings in Papua New Guinea waters. *Aquatic Mammals* 29(1): 150-172.
- VISSER, I.N., FERTL, D., BERGHAN, J. AND VAN MEURS, R. (2000) Killer whale (*Orcinus orca*) predation on a shortfin mako shark (*Isurus oxyrinchus*), in New Zealand waters. *Aquatic Mammals* 26(3): 229-231.
- YUKHOV, V.L., VINOGRADOVA, E.K. AND MEDVEDEV, L.P. (1975) Ob'ekty pitaniya kosatok (*Orcinus orca* L.) v Antarktike i sopredel'nykh vodakh [The diet of killer whales (*Orcinus orca* L.) in the Antarctic and adjacent waters]. Pages 183-185 in AGARKOV, E.G. (Ed.) *Morskije mlekopitayushchie [Marine Mammals]*. Naukova Dumka, Kiev.

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