

SHORT COMMUNICATION **OPEN ACCESS**

Killer Whale Predation on a Giant Manta Ray (*Mobula birostris*), a Sicklefin Devil Ray (*Mobula tarapacana*) and a Tiger Shark (*Galeocerdo cuvier*) in the Southwest Indian Ocean

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ABSTRACT

Knowledge of killer whale (*Orcinus orca*) feeding ecology in tropical waters is scarce. In the southwest Indian Ocean, opportunistic sightings provide a valuable source of information to better understand their behaviour, diet and distribution. Here, we compile existing records of killer whale predation on elasmobranchs in the southwest Indian Ocean, including sightings of three undescribed prey species regionally: a giant manta ray (*Mobula birostris*), a sicklefin devil ray (*Mobula tarapacana*) and a tiger shark (*Galeocerdo cuvier*). Documenting such observations is important to increase knowledge on killer whale ecology in the tropics and the cascading impact they might have on prey populations.

1 | Introduction

Killer whale (*Orcinus orca*) foraging ecology has been studied for decades in polar and temperate waters, resulting in a comprehensive understanding of prey specialisation and predation techniques for several high-latitude populations (Ford et al. 1998; Jourdain et al. 2020; Pitman and Ensor 2003). For example, in the northeast Pacific Ocean, resident-type killer whale populations feed exclusively on fish and transient-type killer whales solely on marine mammals (Ford et al. 1998). Similarly, in Antarctic waters, different killer whale populations feed preferentially on either whales, seals or penguins (Durban et al. 2017; Pitman and Ensor 2003). However, very little is known about tropical killer whales. This is mostly due to their offshore distribution and potentially widespread ranges, hampering the ability to conduct long-term research on these populations (Baird et al. 2006; Kiszka et al. 2021). Previous

studies have suggested that some tropical killer whale populations are generalist feeders, either predating on cetaceans and cephalopods in Hawaiian waters ($n=6$, Baird et al. 2006), on a combination of sea turtles, elasmobranchs, fish and marine mammals in the eastern Tropical Pacific ($n=9$, Vargas-Bravo et al. 2020), or on odontocetes and sharks in the Caribbean Sea ($n=8$, Kiszka et al. 2021).

In the tropical Mozambique Channel (southwest Indian Ocean), killer whales are present year-round, with increased sightings from July to October, during humpback whale (*Megaptera novaeangliae*) breeding season (M. Terrapon, pers. obs.). Their diet has been described only from sporadic and opportunistic observations ($n=6$, Terrapon, Kiszka, and Wagner 2021), and their distribution range, abundance and movements within the region are unknown. Killer whales are also sighted regularly in the temperate waters of southern South Africa (Western Cape

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and Eastern Cape provinces) (Best, Mejer, and Lockyer 2010; Towner et al. 2022). This includes a few known individuals that specialise in feeding on large predatory shark species, such as white sharks (*Carcharodon carcharias*) (Towner et al. 2024), as well as some individuals depredating on fish from longline fisheries (S. Elwen, pers. comm.). No overlap has been reported to date between individuals from the South African populations and the tropical Mozambique Channel (M. Terrapon, pers. obs.).

Here, we describe the first documented occurrence of killer whale predation on a giant manta ray (*Mobula birostris*) in the sub-tropical waters off Durban, Kwa-Zulu Natal, South Africa, and on a sicklefin devil ray (*Mobula tarapacana*) and a tiger shark (*Galeocerdo cuvier*) in Mayotte (northern Mozambique Channel, France). In addition, we compile past records of predation on other elasmobranchs in the Mozambique Channel in order to provide new insights into the foraging ecology of killer whales and to increase knowledge on predator-prey interactions regionally.

2 | Methods

We compiled sightings from various sources (charter and recreational fishers, whale-watching operators) (Table 1), which were verified by the authors through detailed discussions with the observers and, if available, photographs or video footage to ensure accuracy of information. Where possible, we identified prey species from photographs using a species identification guide (Last et al. 2016).

3 | Results

We compiled six ray (Batoidea) and three shark predation events in the last decade in the Mozambique Channel (Figure 1, Table 1). Two ray species (*M. birostris* and *M. tarapacana*) and one shark species (*G. cuvier*) were confirmed as killer whale prey for the first time in the southwest Indian Ocean.

Field-notes describing killer whale behaviour during these predation events were available for two of the sightings. On 31 March 2022, two killer whales (one male and one female/juvenile) were seen 4 km offshore of Durban (Table 1). A giant manta ray (*M. birostris*) was observed nearby, swimming at the surface, with pectoral fin tips breaking the surface of the water (Figure 2). Killer whales showed interest in the ray, following it closely, sometimes biting one of the pectoral fins from behind. Several attempts were made to turn the ray upside down: the male swam over and put its weight on the pectoral fin of the manta ray, attempting to sink it, while the second individual approached from below to lift the other side of the ray, pushing one pectoral fin above the surface. The ray remained close to the boat, seemingly seeking shelter below the vessel. After several unsuccessful attempts at turning their prey upside down, the killer whales started breaching on top of the ray, which remained at the surface and was eventually partially turned upside down. After a final breach from the large male, directly onto the ray, the ray visibly started bleeding. Following this last strike, the prey was pulled down to depth and killer whales only surfaced briefly to breathe. Pieces of flesh (possibly the

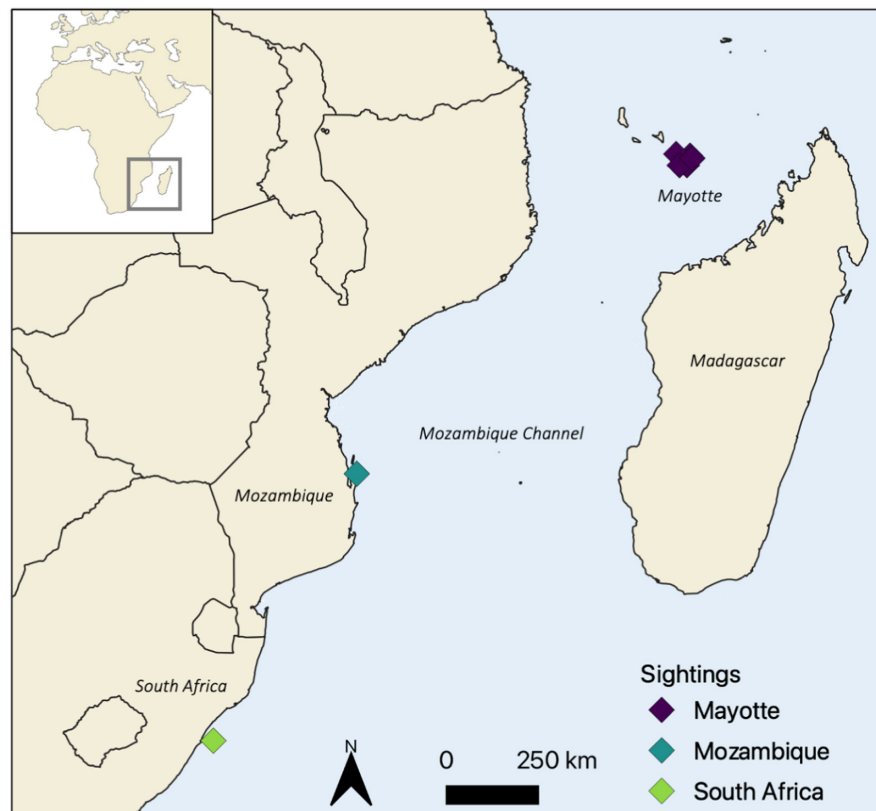


FIGURE 1 | Locations of killer whale predation events on elasmobranchs in the Mozambique Channel (Table 1) between 2013 and 2023 in Mayotte ($n = 7$), Mozambique ($n = 1$) and South Africa ($n = 1$).

TABLE 1 | Reported killer whale predation events on rays in the Mozambique Channel, southwest Indian Ocean.

Date	Location	Prey species	Killer whale estimated group size	Source
9 May 2013	Bazaruto Archipelago, Mozambique	Manta ray (<i>Mobula</i> sp.)	NA	D. A. M. Rato, pers. comm. (charter fisher)
21 August 2015	Mayotte, France	Devil ray (<i>Mobula</i> sp.)	8	Terrapon, Kiszka, and Wagner 2021
21 August 2015	Mayotte, France	Portuguese dogfish (<i>Centroscyllium coeleste</i>)	4	Terrapon, Kiszka, and Wagner 2021
24 August 2015	Mayotte, France	Devil ray (<i>Mobula</i> sp.)	4	Terrapon, Kiszka, and Wagner 2021
6 November 2016	Mayotte, France	Unidentified shark (> 2 m)	6	Terrapon, Kiszka, and Wagner 2021
13 August 2021	Mayotte, France	Devil ray (<i>Mobula</i> sp.)	10	This study (whale-watching operator)
31 March 2022	Durban, South Africa	Giant manta ray (<i>M. birostris</i>)	2	This study (recreational fisher)
9 October 2023	Mayotte, France	Sicklefin devil ray (<i>M. tarapacana</i>)	7	This study (whale-watching operator)
10 October 2023	Mayotte, France	Tiger shark (<i>Galeocerdo cuvier</i>)	7	This study (whale-watching operator)

gills) floated at the surface when the vessel left the area. The entire event took place over the course of 50 min.

On 9 October 2023, a group of seven killer whales was observed in the southeast of Mayotte (Table 1). A sicklefin devil ray (*M. tarapacana*), only seen on its back at depth, was identified near the killer whales in an underwater video. The killer whales surrounded the ray, and one individual initially gently poked it from underneath with its rostrum, causing a slight reaction (change of direction and pectoral fin movements; Figure 2). No visible injury (such as bite wound or bleeding) was observed and the ray showed faint but continued movement and ventilation. However, one killer whale then struck the ray head-on from beneath to which the ray showed no reaction, suggesting it was killed. No feeding was seen. The same killer whale individuals were observed feeding on a tiger shark (*G. cuvier*) liver the following day (Figure 2). Prey capture was not observed and the shark was already dead at the start of the encounter. Killer whales either surrounded the prey (ventral side up with organs exposed) at depth (approximately 15 m), or carried it back to the surface by biting into a pectoral fin or gently pushing the shark with their rostrum.

An anecdotal sighting of killer whale predation on a manta ray (*Mobula* sp.) was reported in 2013 in waters around the Bazaruto Archipelago, Mozambique (Table 1). The killer whale was described as gently biting the pectoral fins of the manta ray while at the surface. However, this record was not photographically verified. Killer whales were also reported to feed on a large ray (*Mobula* sp.) on 13 August 2021 in Mayotte (Table 1). Body markings on some photographed individuals in this group confirmed that the same individuals had taken part

in a previous predation event on rays in 2015 in the same area (Terrapon, Kiszka, and Wagner 2021).

4 | Discussion

Killer whales worldwide display a range of individual or population-based diet preference, feeding on seals (Jourdain et al. 2020), baleen whales (Pitman and Ensor 2003), sharks (Towner et al. 2022) or fish (Ford et al. 1998). To date, only a single population in New Zealand has been described as specialising in feeding on rays (Visser 2005). Killer whale predation on rays and sharks in other tropical and sub-tropical regions has been reported, but current knowledge suggests these observations are mostly opportunistic (Alava and Merlen 2009; Higuera-Rivas et al. 2023; Totterdell 2016; Ortega-Ortiz et al. 2023). In the northern Mozambique Channel, killer whales feed on humpback whales, dolphins, sharks and rays (Terrapon, Kiszka, and Wagner 2021). However, whether there are individual preferences remains to be established. The resighting of known individuals feeding on elasmobranchs in this study suggests a degree of site fidelity and the potential for individual prey preference, though additional data is needed to validate this hypothesis.

To our knowledge, this is the first evidence of killer whale predation on sicklefin devil ray, giant manta ray and tiger shark in the Indian Ocean. The only other published description of predation on a giant manta ray took place in the Galápagos Islands, where killer whales dragged their prey to deeper water to kill and eat it (Alava and Merlen 2009). This behaviour, observed for both ray predation events reported here, only occurred after the fatal breach by the killer whale onto the giant manta ray. Interestingly, in both

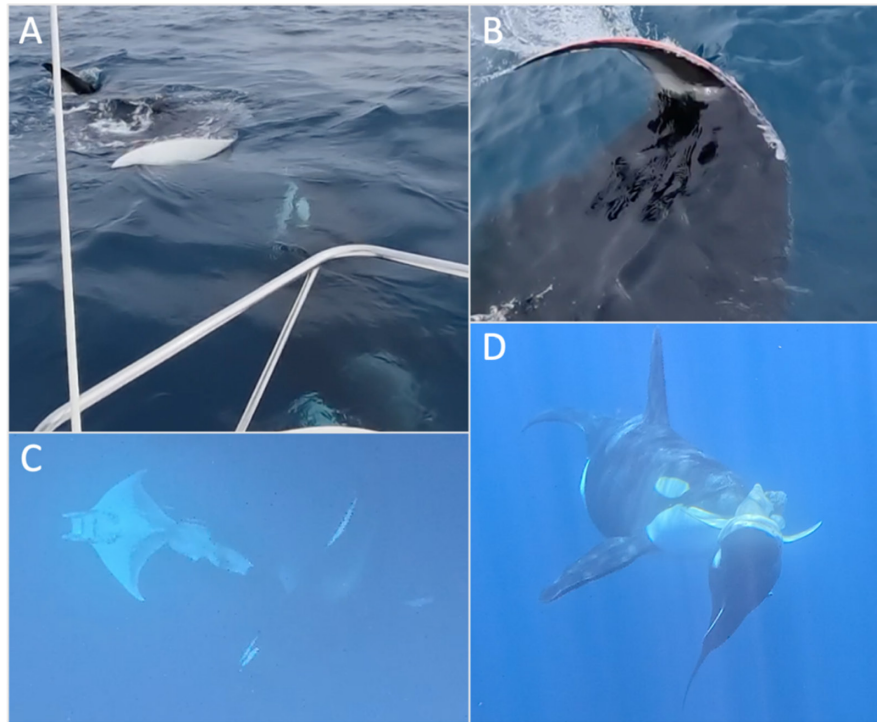


FIGURE 2 | (A) and (B) *Mobula birostris* with pectoral fin tips at the surface near the vessel on 31 March 2022. Wounds, likely from killer whale bites, are visible along the pectoral fin edge. (C) Video screenshot of *Mobula tarapacana* with ventral side up and killer whales nearby, taken from the surface looking down into the water. (D) Male killer whale carries *G. cuvier* with liver partially consumed.

cases, the predators did not try to kill their prey instantly. Instead, they were observed gently approaching, poking and biting them, attempting to turn the rays upside down. This could be a type of play behaviour, as killer whales have previously been described to play with their prey (Ballard and Ainley 2005; Gaydos et al. 2005). Alternatively, it could be older individuals teaching prey capture to younger, less experienced animals (Ford et al. 1998; Lopez and Lopez 1985). Killer whale flipping their prey upside down was also observed during shark predation events (Towner et al. 2023), suggesting it might be a behaviour used against elasmobranchs to induce tonic immobility. The only other published killer whale predation on a tiger shark took place in Western Australia (Totterdell 2016). Predation on other large sharks was reported in the temperate waters of South Africa where killer whales also appear to feed on their liver (Towner et al. 2022). Livers are very rich in lipids which represent a significant source of energy for killer whales (Ford et al. 2011); indeed, the ~52 kg liver of a 428 kg white shark could fulfil daily energy demands for an adult male killer whale (Towner et al. 2023). A mobulid liver is estimated at approximately 5% of its body mass. It is estimated to weigh ~9 kg in an adult sicklefin devil ray and ~60 kg in an adult giant manta ray of 5.5 m disc width (J. Rambahinarison, pers. comm.), suggesting that rays also represent energy-rich prey for killer whales.

Killer whales have the potential to drastically impact prey population dynamics should they feed exclusively on one species (Estes and Palmisano 1974; Towner et al. 2022). The Mozambique Channel hosts both reef (*Mobula alfredi*) and giant (*M. birostris*) manta rays (Marshall et al. 2023), as well as a wide range of smaller ray species. Tiger sharks are observed throughout the region, and though most research on this species has been conducted in South Africa (Daly et al. 2018) and southern Mozambique (Daly

et al. 2023), they are also sighted in the northern range of the Channel (Barkley et al. 2019). Based on current observations, predation on these species remains too rare to have a substantial impact on prey population levels, but could nonetheless lead to the temporary abandonment of ecologically important areas to avoid predation (Towner et al. 2023) and does represent an additional pressure for species impacted by anthropogenic threats. Larger devil rays, including sicklefin devil rays, are often mistakenly identified as manta rays and very little information exists on this species in the Mozambique Channel. As a result, predation events on this species could be underestimated.

Killer whales have rarely been reported in the KwaZulu-Natal region (Northeast South Africa) in the past (Best, Meyer, and Lockyer 2010), though sightings seem to have increased in the last decade (J. Olbers, pers. comm.). It is unknown whether the two individuals which preyed on the giant manta ray belong to a South African population known to feed at least partially on elasmobranchs (Best et al. 2014), or travelled from the northern Mozambique Channel (e.g., Mayotte) where foraging on this prey type is also observed (Terrapon, Kiszka, and Wagner 2021). The only other predation event reported from KwaZulu-Natal targeted small oceanic dolphins in March 2024 (S. Atkins, pers. comm.), and the killer whales involved could not be individually identified.

Given the current lack of information on the topic, it is important to document these rare observations in order to better understand killer whale diet in the Mozambique Channel, and their predation impact on previously unknown prey species. In areas where research is scarce, communication between different sectors such as the fishing and tourism industries, local communities, government entities and scientists is necessary to advance knowledge on

this wide-ranging species. While a single predation report is not enough to reveal a potential behavioural pattern, when brought together, these encounters can better inform behaviour and dietary specialisations that would otherwise be unknown.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Sightings data are provided, videos of the encounters are available upon reasonable request to the corresponding author.

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