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Short Note

Recent Visual and Acoustic Records of Melon-Headed Whales, Interspecific Associations in Tanzania, and a Review of Regional Records in the Southwest Indian Ocean

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Documenting the presence of not previously or rarely observed animals in data deficient areas is important as such records contribute towards baseline knowledge of marine biodiversity and help the scientific community to better understand animals' ranges and habitat use, which is essential for national management of seascapes and their wildlife. Five visual sightings of melon-headed whales (*Peponocephala electra*, Gray, 1846) and recordings of their acoustic repertoire were made during dedicated humpback whale (*Megaptera novaeangliae*) research conducted off the south of Tanzania mainland, Mtwara region, in July 2022 and in January and August 2024. This current record represents the first documented multiple sightings of the species along the southern coast of Tanzania and appears to be the third documented encounter of the species within the territorial waters of the country (Peddemors & Ross, 1988; Sea Shepherd Australia, 2018), and its first interspecific interactions with Risso's dolphins (*Grampus griseus*) known to date. Melon-headed whales are known around oceanic islands with a wide distribution range (Jefferson & Barros, 1997; Dulau-Drouot et al., 2008; Kiszka et al., 2010; Martien et al., 2017); however, dedicated research effort in continental coastal waters, including Tanzania, has been limited. Hence, it is essential to continue the effort to further understand the species' presence and habitat use.

Melon-headed whales are a globally distributed pantropical species with high population connectivity among ocean basins (Jefferson & Barros, 1997; Martien et al., 2017). The species prefers offshore pelagic waters but can also be found near oceanic islands where slopes are steep with a high site fidelity (Dulau-Drouot et al., 2008; Kiszka et al., 2010; Martien et al., 2017). Melon-headed whales are often seen in association with other cetaceans, including Fraser's dolphins (*Lagenodelphis hosei*), rough-toothed dolphins (*Steno bredanensis*), spinner dolphins (*Stenella longirostris*), pantropical spotted dolphins (*Stenella attenuata*), and bottlenose dolphins (*Tursiops* sp.), as well as with short-finned pilot whales (*Globicephala macrorhynchus*), and rarely with humpback whales (Jefferson & Barros, 1997; Migura & Meadows, 2002; Dulau-Drouot et al., 2008; Rossi-Santos et al., 2009; Frankel & Yin, 2010; Kiszka & Brownell, 2019; Davenport, 2021).

Previous acoustic studies of the species' vocal repertoire are limited and primarily focused on the waters of Hawaii, the Caribbean, and off Indonesia (Watkins et al., 1998; Baumann-Pickering et al., 2010; Frankel & Yin, 2010; Kaplan et al., 2014). Bioacoustic characteristics of the melon-headed whales consist of echolocation clicks, burst-pulsed sounds, and whistles (Baumann-Pickering et al., 2010; Frankel & Yin, 2010), as well as repeated call types (Kaplan et al., 2014). Whistles were generally characterized by lower frequencies, below 10 kHz, with a mean duration of 0.58 s (Frankel & Yin, 2010). The frequency range varied slightly among regions, with whistles recorded in the Caribbean showing higher frequencies compared to those in Hawaiian waters (Watkins et al., 1998). In Hawaiian waters, the peak frequency was reported to be around 7 kHz (Kaplan et al., 2014). Additionally, the species predominantly produced upsweep, downsweep, and sine wave contour shapes (Frankel & Yin, 2010).

Melon-headed whales are listed as of "Least Concern" by the International Union for Conservation of Nature's (IUCN) *Red List*, although the species is under some threat from entanglement on pelagic longlines and gillnets, as well as intentional persecution, marine debris, and noise pollution (Gordon et al., 2004; Kiszka et al.,

2008; Davenport, 2021). Documented mass stranding events of melon-headed whales, which are often attributed to multiple contributing factors, including certain coastal topographies and global earth processes, as well as potential anthropogenic influences such as loud and impulsive noise sources, are likely to play a negative role in the population status of the species, specifically in the location where the baseline data are scarce to none (Jefferson & Barros, 1997; Kiszka et al., 2009a, 2009b; Southall et al., 2013; Plön et al., 2020a, 2020b; Ofori-Danson et al., 2022). Melon-headed whales have been documented showing behavioural alterations, area avoidance, and mass strandings in response to military sonar events and bathymetric seafloor mapping exercises (Jefferson & Barros, 1997; Gordon et al., 2004; Kiszka et al., 2009a, 2009b; Southall et al., 2013; Martien et al., 2017; Plön et al., 2020a, 2020b; Ofori-Danson et al., 2022). Therefore, further research on melon-headed whale ecology, especially within the region earmarked for offshore oil exploration, which is currently facing operational onshore and offshore gas extraction, such as Mtwara, is imperative so that effective mitigation and appropriate conservation actions can be applied (Must & Rustad, 2019).

Systematically designed boat surveys targeting humpback whales were conducted in the south of Tanzania in the Mtwara region spanning from 2021 to 2024, with a total survey effort of 206 h (Figure 1). The survey area included both the coastal and offshore pelagic waters off Mnazi Bay Ruvuma Estuary Marine Park (MBREMP)—a Marine Protected Area (MPA) which was designated in 2000 for its biodiversity and natural resources, including the potential for oil and gas extraction (Machumu & Yakupitiyage, 2013), with a survey area coverage of 529 km^2. This seascape is characterised by a narrow continental shelf, with the seabed dropping to a depth of 1,000 m to the north of the study area, with two narrow canyons extending from the southwest to the northeast with depth ranges from 200 to 900 m.

Due to the primarily photo-identification nature of the survey protocol, random routes with stratified effort on locations that had higher sighting chance of target species were used. The crew consisted of six members, including a skipper, a data logger, three observers, and one photographer, who used a Nikon D7200 with 70-300 mm zoom lens. Data on species' presence, sighting location, angle from the bow and estimated distance, group cohesion, behaviour, and photo-identification and acoustic data,

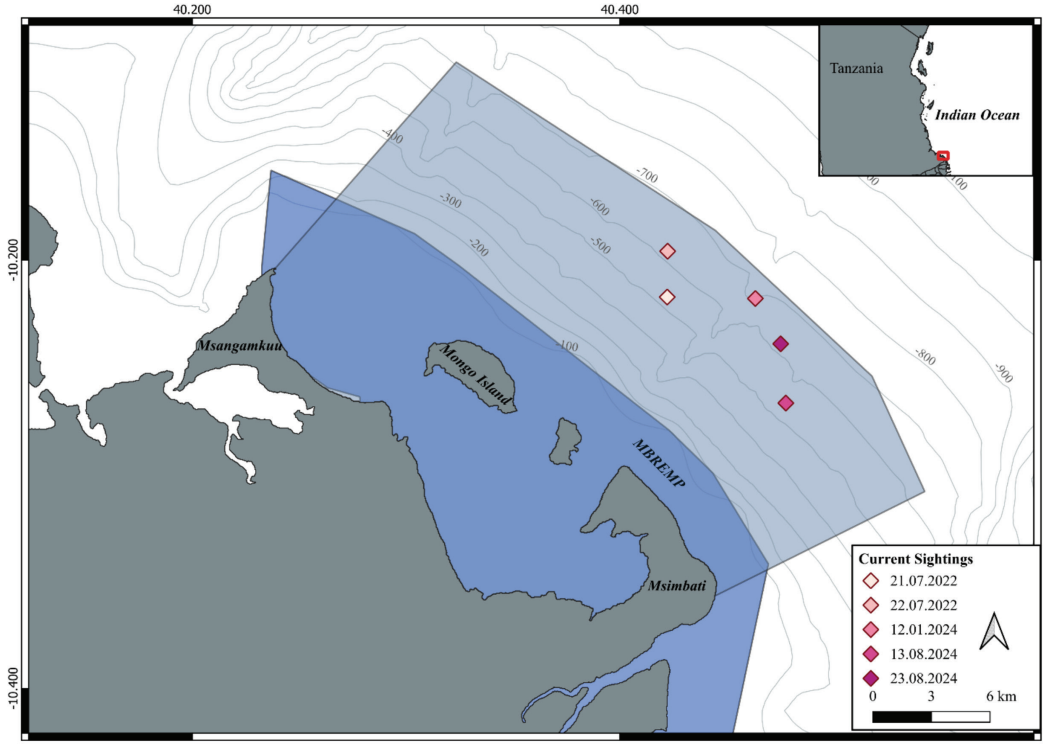

Figure 1. Survey area off Mnazi Bay Ruvuma Estuary Marine Park (MBREMP) and current study sightings of melon-headed whales (*Peponocephala electra*) in Tanzania

along with environmental parameters and anthropogenic presence in the area, were collected. The data were stored in *Logger2010* software. The acoustic data were processed using *Raven Pro*, Version 1.6, and *PAMGUARD*, Version 2.02.09, with a sampling rate of 96 kHz. The spectrogram was set to 24 kHz with 0.5 s intervals to have a visible focus on each tonal sound. The strength of the tonal sound was categorised as weak (the start and end of the whistle were not clear), mid (the start and end of the whistle were clear but its contour held some not visible sections), or good (the whistle contour was clear with a strong signal from the start to the end). Weak whistles were discarded from further analysis. For both nonharmonic whistles (referred to as whistles hereafter) and harmonic whistles, low and high frequency, peak frequency, delta frequency, and delta time were summarised and grouped by the whistle contour shape. Whistle contour shapes were identified under eight main types, with the letters A to E representing upsweep, downsweep, flat, concave, concave with tail, and convex shapes, respectively (Figure 2). Additionally, the contour shapes "sine" and "wave" were identified when more than two inflection points were present, with the former being vertical and the latter horizontally aligned (Figure 3). All statistical analyses were performed in *RStudio*, Version 4.3.2.

Overall, 55 d were surveyed between 2021 and 2024, of which 7 and 25 d were in 2022 and 2024, respectively. In 2022, melon-headed whales were encountered on two occasions, on 21 and 22 July. The first sighting was recorded for 3 min at a location characterised by depth contours of 530 m (Figure 1). The encounter had 25 to 35 individuals in the group and was documented within 10 m distance of two adult humpback whales (Figure 4). The second encounter took place with 42 min of focal group follow at a location with a depth over 620 m. The group size was between 80 to 120 individuals. The species showed interspecies temporal association with five adult humpback whales and 15 Risso's dolphins. On both occasions, the melon-headed whales were following and frequently approaching the humpback whale group, with some performing bow riding on the humpback's rostrum (Figure 5). The humpback whales and the melon-headed whales demonstrated synchronous diving behaviour (Figure 6).

Six days (16 h 6 min) were spent on a dedicated survey in January 2024, with melon-headed whales recorded on 12 January with the similar to 2022 sightings' location's depth characteristics—520 m. The research team spent 25 min censusing the group, which consisted of 35 to 50 individuals, including at least ten subadults. This encounter was a multispecies group with 15 to 25 Fraser's dolphins present and mixed with the melon-headed whales. In August 2024, melon-headed whales were sighted twice, on 13 and 23 August, at the

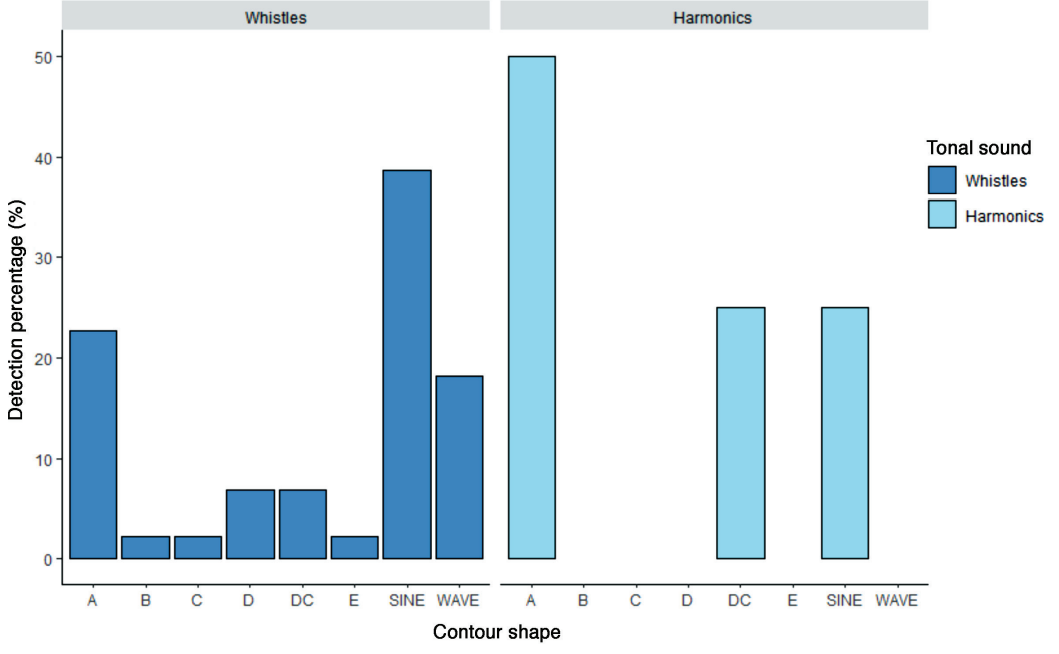

Figure 2. Variation on the contour shape by type of tonal sounds

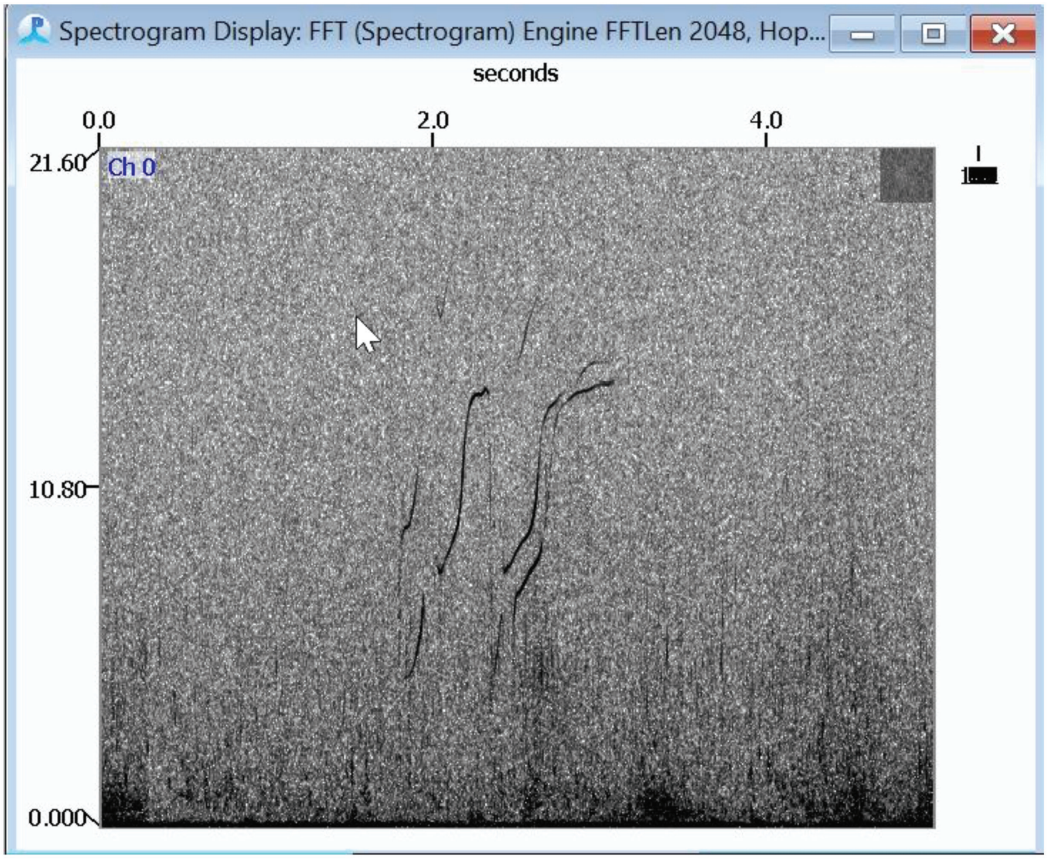

Figure 3. Sine showing two inflexions frequently displayed in whistles of melon-headed whale recordings

Figure 4. Melon-headed whales observed in Tanzania off Mnazi Bay Ruvuma Estuary Marine Park on 21 July 2022, identified by visual observations during this encounter and confirmed by consecutive photographic analysis (*Photo credit:* E. Kalashnikova, COSTECH Permit N 2021-421-NA-2021-138)

Figure 5. Melon-headed whales bow riding on a humpback whale (*Megaptera novaeangliae*) rostrum on 22 July 2022, observed off Mnazi Bay Ruvuma Estuary Marine Park (*Photo credit:* E. Kalashnikova, COSTECH Permit N 2021-421-NA-2021-138)

Figure 6. Synchronous diving behaviour of melon-headed whales and humpback whales observed in Tanzania on 22 July 2022 off Mnazi Bay Ruvuma Estuary Marine Park (*Photo credit:* E. Kalashnikova, COSTECH Permit N 2021-421-NA-2021-138)

locations with the 540 m depths, and group sizes of 30 to 50 and 80 to 100 individuals, respectively.

Although data on acoustics were collected on three different days, post-acoustic analysis was conducted for 13 August 2024 as the sighting had no other odontocete species in the group, which provided the accuracy of single species analysis. The audio held 5:23 min of recordings, containing 68 tonal sounds of which weak, mid, and clear tonal sounds were categorised on 19, 22, and 27 occasions, respectively. From the recorded sounds, only four had harmonic whistles, while the remaining 64 identified vocalizations were nonharmonic. Further, the emitted whistle contour shapes showed variations, with sine, A (upsweep), and wave the most frequently detected tonal sounds for whistles, and similarly shaped A for harmonic whistles.

Whistle contour shape A held the lowest range of frequencies while D had the highest frequency ranges (Figure 7). The frequency duration was highest when the whistles had a sine shape.

The tonal sounds of melon-headed whales ranged between 2.2 to 19.7 kHz. These had a mean low frequency of 5.8 ± 2.01 kHz and high frequency of 11.1 ± 3.6 kHz. The mean peak frequency was 7.9 ± 2.5 kHz (Table 1). The duration of the whistle ranged from 0.08 to 1.39 s with a mean of 0.6 ± 0.3 s.

In an additional note, echolocation clicks with a median peak frequency of 33.6 kHz (48 kHz was the maximum frequency available for study and it is likely some clicks exceeded this frequency) were also present. The peak frequency of clicks in a single click train was highly variable, but highest amplitude clicks showed peak frequency of over 39 to 46 kHz. Lower peak frequency clicks are likely related to orientation to the hydrophone as these can immediately precede or follow clicks of higher peak frequency.

Melon-headed whales are known to be resident in the Southwest Indian Ocean (SWIO) with sighting and stranding reports in Mayotte (Comoros Archipelago), Comoros, Seychelles, La Reunion, and Mauritius (Best & Shaughnessy, 1981; Leatherwood et al., 1991; Corbett, 1994; Kiszka et al., 2007, 2010; Dulau-Drouot et al., 2008; Laran et al., 2017; Plön et al., 2020a, 2020b). The species has also been reported off Madagascar, Mozambique, and Kenya with a single animal stranded off South Africa, yet in the Atlantic Ocean (Best & Shaughnessy, 1981;

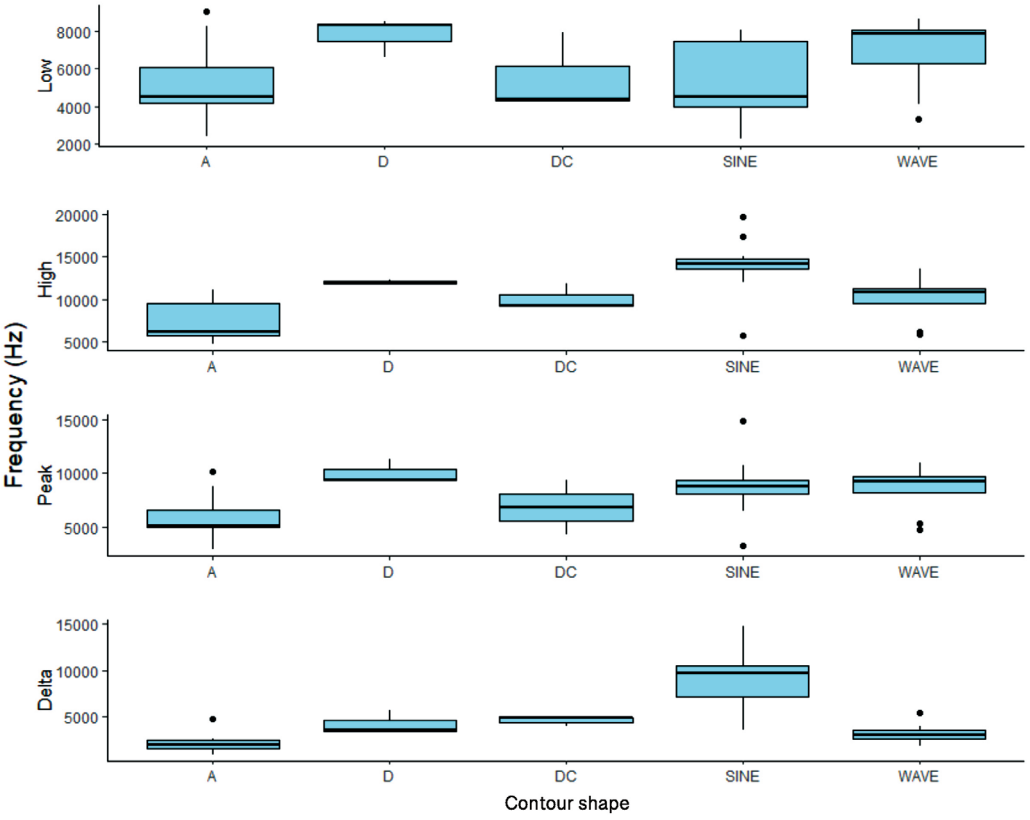

Figure 7. Box plot distribution of whistle contour shapes per the frequency parameters

Table 1. The whistle parameters of melon-headed whales (*Peponocephala electra*) on 13 August 2024

Parameters	Min.	Max.	Median	Mean	SD	SE
Low frequency	2,242	9,019	5,019	5,754	2,014	304
High frequency	4,688	19,771	11,573	11,104	3,582	540
Peak frequency	2,906	14,812	8,672	7,947	2,456	370
Delta frequency	968	14,726	4,178	5,349	3,555	536
Delta time	0.08	1.39	0.63	0.60	0.28	0.04

Collins et al., 2009; Kiszka et al., 2009b; Southall et al., 2013; Laran et al., 2017; Cerchio et al., 2022; Table 2). Melon-headed whales have been reported on at least four occasions in Tanzania. The first sighting of the melon-headed whales was made in the Pemba Channel in 1985 (Peddemors & Ross, 1988). More than 20 y later, the species was resighted in Pemba Channel in 2006 with no photographic documentation (A. Sutton, pers. comm., 2006). Another report of the species was in 2018 within the EEZ of Tanzania, yet the sighting's exact location was not documented (Sea Shepherd Australia, 2018). One individual was stranded alive and successfully refloated off the northern coast of Unguja, Zanzibar, on 24 December 2024 (M. Dzikowski, pers. comm., 24 December 2024). The current study represents the first report of multiple sightings of melon-headed whales from the coastal waters south of Tanzania, revealing an interspecies connection within three taxa.

Despite the ample records of this delphinid species' presence in the SWIO region, demonstrated evidence of melon-headed whales' occurrence in Tanzania has been restricted to the northern waters and is mostly of an opportunistic nature. Most recent information and sightings of the species in the SWIO region comes from oceanic islands, such as Mauritius, Mayotte, Comoros, and La Reunion, as well as from Madagascar (including Northern Mozambique Channel, Central Mozambique Channel, South Mozambique Channel, and East Madagascar) and Seychelles (Peddemors et al., 1997; Kiszka et al., 2007, 2008, 2009a, 2009b, 2010, 2015; Dulau-Drouot et al., 2008; Southall et al., 2013; Laran et al., 2017; Plön et al., 2020a, 2020b; Cerchio et al., 2022). From an encountered cetaceans' numbers perspective, melon-headed whales were documented to be the most abundant species around La Reunion (Dulau-Drouot et al., 2008). High densities of small Globicephalinae, which melon-headed were grouped into, were recorded in the central and northern areas of Mozambique Channel off Madagascar (Laran et al., 2017). However, there are rare records of the species in the waters of Mozambique and Kenya, with the latest scientifically reported sightings in these countries made 25 and 26 y ago, respectively (Peddemors, 1999; Mwango'mbe et al., 2021). Despite being rarely seen in coastal waters, in the present record, the whales were sighted over a continental shelf's edge and a continental rise at a depth contour ranging from 500 to 700 m, which generally conforms to the species' preferred bathymetry range.

Based on the current 4-y effort, including two seasons (four field surveys in the austral summer and one in the austral winter), the five sightings of the species across these years and seasons, and a most recent stranding off Zanzibar in December 2024, suggest that these animals may not be as infrequently encountered in our study region and in Tanzania in general as previously thought. The earlier assumption of rarity likely stemmed from the lack of previous records, which may have resulted from limited survey efforts in the region, where melon-headed whales could be more common than previously believed. However, whether the species is forming coastal units in the southern waters of Tanzania, similar to island-associated populations known from the Philippines and Hawaii, and also demonstrated by other delphinids (Jefferson & Barros, 1997; Andrews et al., 2010; Martien et al., 2017), or not, is not known and requires further evidence. A very narrow continental shelf of southern Tanzania (Masalu, 2008) may play an essential role in shaping a habitat favoured by pelagic species. The presence of daily shoreward–offshore movement patterns is also a plausible reason for them to be observed near the southern Tanzanian coast during the daytime (Martien et al., 2017). Nevertheless, the absence of dedicated studies on targeted species prevents us from understanding the species distribution range and habitat use in detail in Tanzania.

This short note documents a close interspecies interaction of melon-headed whales with humpback whales, Risso's dolphins, and Fraser's dolphins. Melon-headed whales are known to be associated with other cetacean species, yet the close spatial proximity with Risso's dolphins was the first case for the species to our knowledge (Jefferson & Barros, 1997; Migura & Meadows, 2002; Dulau-Drouot et al., 2008; Rossi-Santos et al., 2009; Kiszka & Brownell, 2019; Davenport, 2021).

As mentioned, melon-headed whales are listed as of "Least Concern" on the IUCN's *Red List*, although they—as do other cetaceans—face multiple threats. Melon-headed whales are one of the six odontocete species that account for 96% of large mass strandings globally (Hamilton, 2018). Strandings, often in big numbers, are known from several global and regional documented events, including the most recent occasions of 80 to 100 individuals in Ghana and multiple strandings in China in 2021, 70 animals in Mauritius in 2020, approximately 100 animals reported stranded in Madagascar in 2008, and 265 and 70 melon-headed whales, respectively, stranded in Cape Verde Islands (Jefferson & Barros, 1997; Peddemors et al., 1997; Van Waerebeek et al., 2008; Collins et al., 2009; Kiszka et al., 2009b, 2015; Southall et al., 2013; Kiszka & Brownell, 2019; Plön et al., 2020a, 2020b; Wang et al., 2021; Ofori-Danson et al., 2022). The individual, most recently stranded off Zanzibar reportedly had a milky eye, with no other visible injuries, and was assisted back to the deep waters (M. Dzikowski, pers. comm., 24 December 2024). Melon-headed whale strandings have been associated with various factors and

Table 2. The melon-headed whale reports within the Southwest Indian Ocean. Best estimation of group sizes for individual sightings and mean (marked with §) group size for multiple sightings embraced in one record, demonstrating occurrence.

Year	Country	Type	Group size	References
1974	Seychelles	Stranding	6	Best & Shaughnessy, 1981
1975	Seychelles	Stranding	10	Leatherwood et al., 1991, cited in Jefferson & Barros, 1997
1976	South Africa	Stranding	1	Best & Shaughnessy, 1981
1985	Tanzania	Sighting	300	Peddemors & Ross, 1988
1994	Mauritius	Sighting	UND	Corbett, 1994, cited in Kiszka et al., 2008
1999	Mozambique	Sighting	UND	Peddemors, 1999
2002	Union of the Comoros*	Sightings	183§	Kiszka et al., 2010
2004-2005	Mayotte (Comoros Archipelago)	Sighting	310	Kiszka et al., 2007
2005	Mauritius	Stranding	70	Ministry of Agro-Industry & Fisheries, 2005
2005	La Reunion*	Sighting	477§	Dulau-Drouot et al., 2008
2006	Tanzania	Sighting	2	Pers. comm. without photographic documentation
2006	La Reunion*	Sightings	477§	Dulau-Drouot et al., 2008
2007	La Reunion*	Sightings	477§	Dulau-Drouot et al., 2008
2008	Madagascar	Stranding	100	Collins et al., 2009; Southall et al., 2013
UND	Madagascar*	Sightings	UND	Cerchio et al., 2009a, 2009b, cited in Kiszka et al., 2009a
UND	Madagascar*	Sightings	40§	Cerchio et al., 2022
UND	Madagascar*	Sightings	100§	V. E. Bedier, unpub. data cited in Cerchio et al., 2022
2009-2010	Madagascar NW*	Sightings	38.5-87.1§	Laran et al., 2017
2009-2010	Madagascar CW*	Sightings	47.7§	Laran et al., 2017
2009-2010	Madagascar SW*	Sightings	63.1§	Laran et al., 2017
2009-2010	Madagascar NE*	Sightings	83§	Laran et al., 2017
2009-2010	La Reunion*	Sightings	83§	Laran et al., 2017
2009-2010	Mauritius*	Sightings	83§	Laran et al., 2017
2009-2010	Seychelles*	Sightings	83§	Laran et al., 2017
2014	Kenya	Sighting	10	Mwango'mbe et al., 2021
2011-2019	Kenya	Stranding	2	Mwango'mbe et al., 2021
2018	Tanzania	Sighting	UND	Sea Shepherd Australia, 2018 (video posted in a tweet on X; grey literature with photographic documentation)
2020	Mauritius	Stranding	52	Plön et al., 2020a
2022	Tanzania	Sightings	30, 100	Current study
2024	Tanzania	Sightings	40, 30, 80	Current study
2024	Tanzania	Live stranding	1	Michal Dzikowski, pers. comm., with photographic documentation

* = Summary for multiple sightings; § = mean group size for multiple sightings.

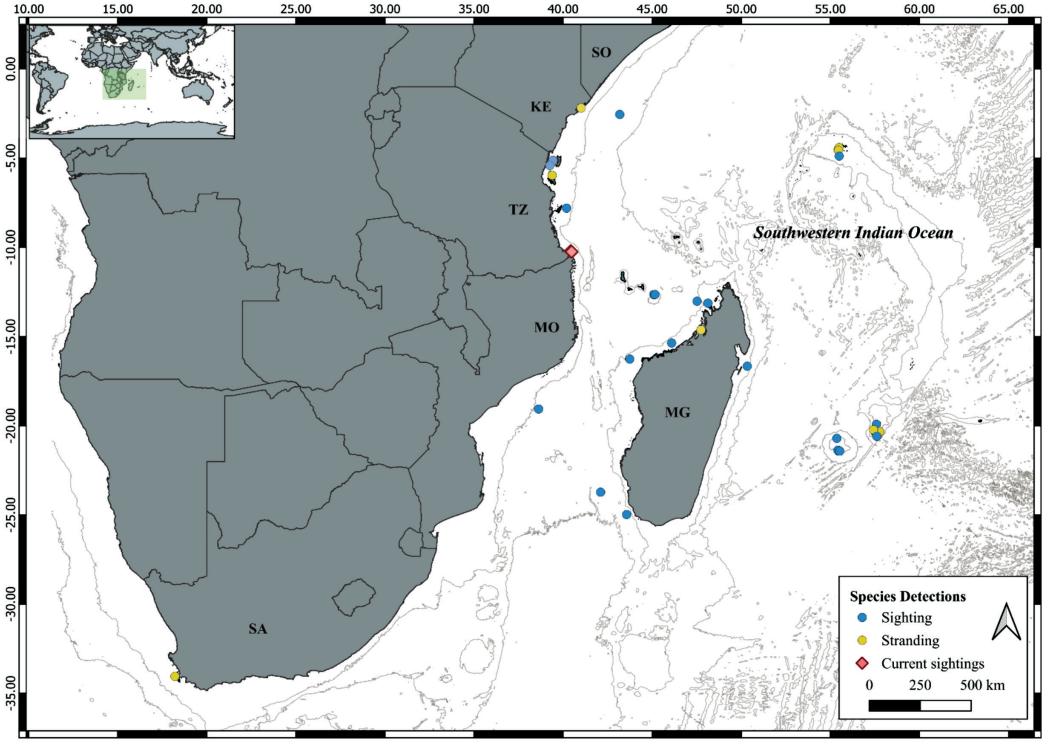

Figure 8. The records of melon-headed whale sightings and strandings (both dead and alive) as well as known occurrences in the Southwest Indian Ocean

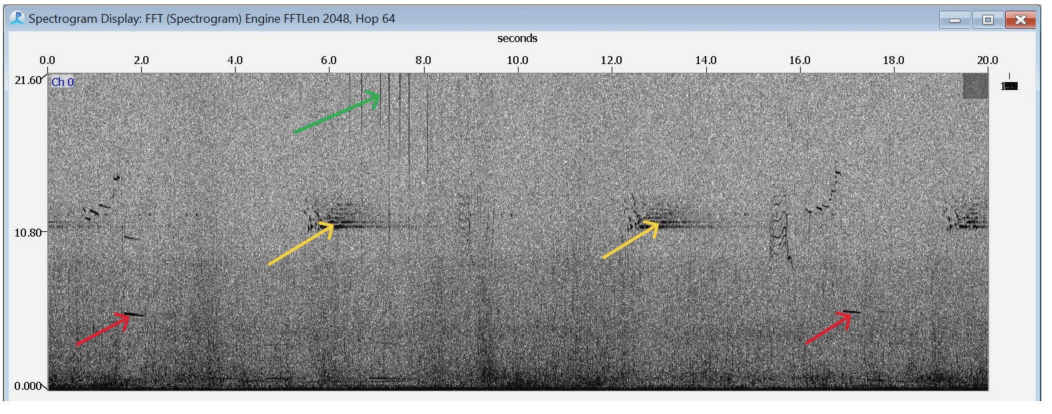

Figure 9. Spectrogram showing some clicks from melon-headed whales between 6 to 8 s (green arrow). A multi-beam echo-sounder was also present at 11 to 12.5 kHz with a 7 s interval (yellow arrows) along with a sub-bottom profiler (5.4 to 5.2 kHz) with a 15 s interval (red arrows).

often lack a clearly confirmed single cause. Better understanding of the species ecology, including bioacoustic studies, is therefore essential to effectively define potential regional and national threats and guide preventative and mitigation measures.

The current study presents the first approach to describing acoustic behaviour of melon-headed whales from the Western Indian Ocean. The reported tonal frequencies and their contour shapes align with findings from limited previous records (Watkins et al., 1998; Frankel & Yin, 2010; Kaplan et al., 2014). The recordings from the current study showed relatively short whistle durations averaging 0.6 s, similar to those reported in Hawaii (Frankel & Yin, 2010; Kaplan et al., 2014) and in the Caribbean Sea (Watkins et al., 1998). The low and high frequencies had a mean of 3 and 13 kHz, respectively, in Hawaii. In comparison, the current study documented a higher mean low frequency (5 kHz) and a slightly lower mean high frequency (12 kHz). The peak frequency (7 kHz) from the current study was overlapping with the range reported in Hawaiian waters (Kaplan et al., 2014). Lastly, the whistle contour shapes showed notable similarities across regions, with sine and upsweep whistles dominating the tonal sounds (Frankel & Yin, 2010; Kaplan et al., 2014). It is important to consider that variations in the behaviour of focal groups at the time, sampling size, and methodology, as well as post-acoustic analysis across different studies, may influence findings and do not necessarily reflect true regional differences. Nevertheless, despite these existing variations across three different oceanic regions, the species exhibited remarkably consistent whistle frequency modulations.

Clicks recorded showed a peak frequency ranging from 25.2 to 44 kHz (10th and 90th percentile median peak frequency values) with some click peak frequencies possibly outside the sampling rate capabilities (96 kHz) and above 48 kHz. Frankel & Yin (2010) used a sampling rate of 48 kHz and, therefore, were unable to describe the clicks above 24 kHz, while Kaplan et al. (2014) do not describe clicks recorded. Baumann-Pickering et al. (2010) describe the clicks of melon-headed whales as having a higher median peak frequency of 33.6 kHz (29.7 to 40.6 kHz, 10th and 90th percentile), when clicks with a peak below 20 kHz are excluded, with a daytime median peak being 28.1 kHz (23.4 to 39.4 kHz, 10 and 90th percentile) for clicks with peaks above 20 kHz. There is a marked difference from daytime clicks recorded by Baumann-Pickering et al. (2010) and those recorded in Southern Tanzania, but nighttime clicks above 20 kHz median peak of 33.6 kHz match precisely those found by Baumann-Pickering et al. (2010) and indicate that distance or orientation to the recording hydrophone was the possible reason daytime clicks had lower median frequencies in the 2010 study.

The study area represented in this report has been targeted by the offshore natural gas extraction companies, with the first onshore phase executed in Mnazi Bay in 2010. The offshore exploration is currently in the planning stage (Must & Rustad, 2019). Further, during the acoustic recording on 23 August 2024, the authors noted the presence of what is believed to be a multi-beam echo-sounder (frequency 11 to 12.5 kHz) and a sub-bottom profiler with a total sound output range from 3 to 14 kHz and with the highest amplitude signal a frequency modulated downsweep from 5.4 to 5.2 kHz with an approximate duration of 0.4 s (Figure 9). These were detected with a visual confirmation of the ship off the MBREMP, showing an overlapping presence with the species in the area. The multi-beam echo-sounder was active with an average of 7 s intervals, and the sub-bottom profiler was active with an average of 15 s between pulses throughout the 12-min recording (Figure 9). These anthropogenic sounds have the potential to impact all pelagic species, including melon-headed whales, that are permanently or temporarily attracted by the area's bathymetric features—narrow continental shelf, smooth gradient of the slope, steep continental rise, and intricate canyon systems (Masalu, 2008). Melon-headed whales may be vulnerable to such disturbances as has been suggested in particular by Southall et al. (2013) following a mass stranding in 2008 in nearby Madagascar. To ensure species management in the area, it is important that species baseline data, including occurrence and bioacoustics, are collected to clarify presence and habitat use, and to identify conservation threats and needs.

Acknowledgments

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