Aquatic Mammals 2022, *48*(2), ###-###, DOI 10.1578/AM.48.2.2022.###

Short Note

Potential Infanticide Attempt of Common Bottlenose Dolphins (*Tursiops truncatus*) on a Young Calf in a Tropical Caribbean Atoll

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Bottlenose dolphins (*Tursiops* spp.) regularly display agonistic behaviors and aggression toward members of their own species (Connor et al., 1992; Samuels & Gifford, 1997; Scott et al., 2005) and other species (Ross & Wilson, 1996; May-Collado, 2010; Cotter et al., 2012). These interactions are typically not lethal but sometimes involve mortality (Ross & Wilson, 1996; Patterson et al., 1998; Dunn et al., 2002). Dolphins often direct this aggression toward conspecific calves—ramming, tossing, and attempting to submerge them, sometimes intensely enough to cause long-term harm or infanticide—the intentional killing of an infant by conspecifics (Kaplan et al., 2009; Robinson, 2014; Ronje et al., 2020). Reports of agonistic and infanticidal behavior in multiple populations of common bottlenose dolphins (*Tursiops truncatus*) suggest these behaviors may not be uncommon.

Infanticide has evolved in many mammalian species (Hrdy, 1979; Ebensperger, 1998). In marine mammals, while infanticide has been documented in a range of taxa, including polar bears (*Ursus maritimus*; Taylor et al., 1985) and pinnipeds (Campagna et al., 1988; Ryazanov et al., 2018), it is most often observed in delphinids (Zheng et al., 2016; López et al., 2018; Towers et al., 2018). Motivators for these agonistic attacks include increased access to sexually reproductive females, removal of competition for resources, and removal of ill and unrelated young. In some cases, these lethal events confer no clear fitness advantages (Hrdy, 1979). Infanticide can benefit reproductively ready males in some species if the loss of offspring drives females into estrus, thereby facilitating mating success with the female (Hrdy, 1974; Packer & Pusey, 1983).

The drivers of infanticidal attacks in bottlenose dolphins are largely unknown but likely include removal of genetic competition and increased sexual access to females (Robinson, 2014; Ronje et al., 2020). Documenting and describing calf-directed agonistic behaviors is important for understanding their function in dolphins and can facilitate the interpretation of associated behaviors such as the use of acoustic calls indicative of aggression or stress and epimeletic or caregiving behaviors when dolphins attempt to assist calves (e.g., Perrtree et al., 2016).

Herein, we report the intraspecific agonistic behavior of multiple adult bottlenose dolphins directed toward a young calf observed on 7 March 2008 in a shallow tropical lagoon at Turneffe Atoll, Belize. The intensity of the attack suggests the adult dolphins were attempting to commit infanticide, but this interpretation could not be confirmed. The group consisted of residents of the atoll, with at least three dolphins confirmed as attacking the calf. A repeated whistle type with downsweeping contours was detected in-air in videos recording surface activity. These whistles coincided with times when the calf's head or entire body were above the water's surface, suggesting they may have been produced by the distressed calf, but this could not be confirmed. This description adds to the growing list of observations of infanticidal behavior in bottlenose dolphins across multiple populations (e.g., Kaplan et al., 2009; Robinson, 2014; Perrtree et al., 2016; López et al., 2018).

Surface observations were made by one of the authors (IS) during a boat-based trip to sight dolphins in shallow waters (0.5 to 5 m) in the Central Lagoon of Turneffe Atoll (17° 22' 45" N, 87° 50' 56" W; Figure 1), which is found in offshore waters 30 km east of mainland Belize. The atoll is comprised of mangrove cayes enclosing

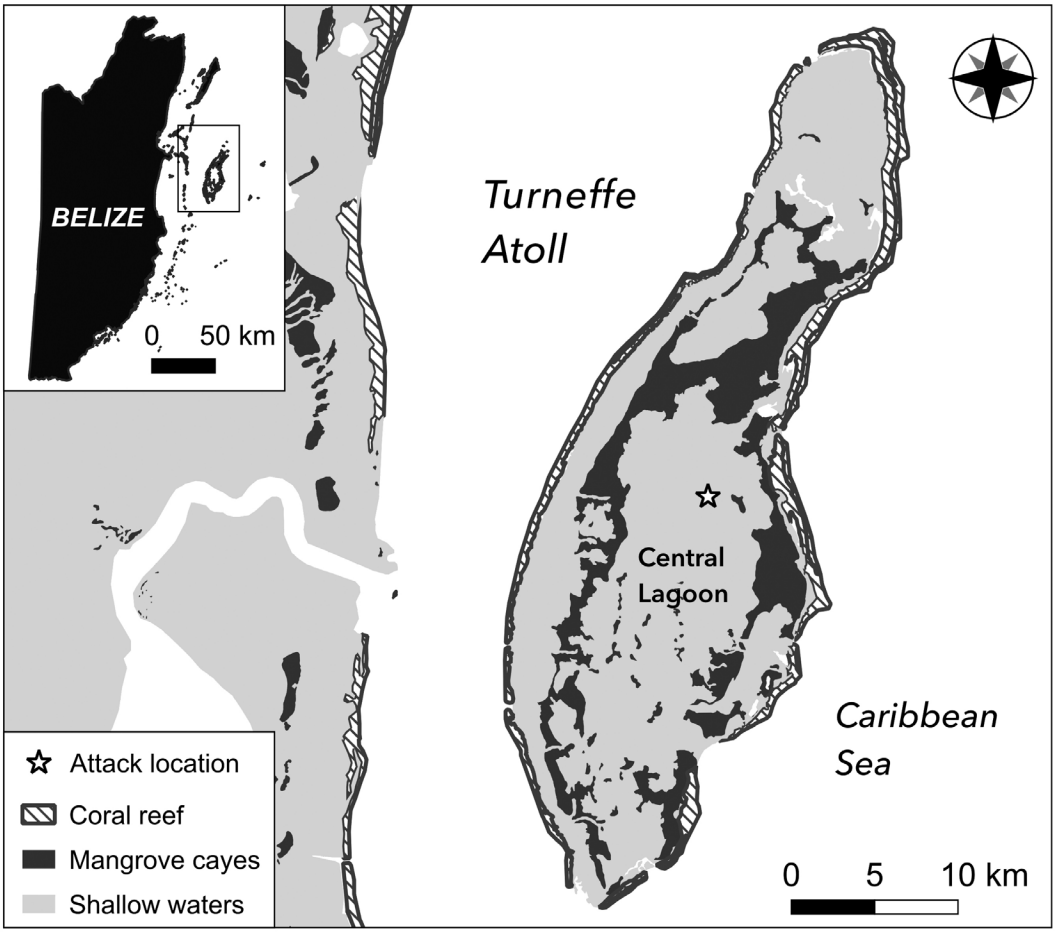

Figure 1. Study site at Turneffe Atoll in the offshore waters 30 km east of mainland Belize, and the location of the event (star) within the atoll's Central Lagoon. A population of common bottlenose dolphins (*Tursiops truncatus*) inhabit the atoll's shallow water lagoon and reef habitats year-round.

three shallow lagoons of mainly seagrass bottoms with a fringing coral reef system. Boat trips conducted aboard a 7-m-long skiff with an outboard engine followed predetermined and random boat routes through the Central and Southern Lagoons. Data were gathered as part of ongoing, long-term studies conducted on the local year-round population of coastal bottlenose dolphins since 1992. The small population (194 identified dolphins: Ramos et al., 2018b; Castelblanco-Martínez et al., 2021; abundance estimates: 83 to 260 individuals: Campbell et al., 2002; Dick & Hines, 2011) inhabits the atoll's shallow water lagoon and reef habitats, with many individuals displaying long-term site fidelity (Ramos et al., 2018b).

Groups were defined as all animals within 100 m of each other generally engaged in the same activity (Shane, 1990). Adults were classified according to their large size relative to confirmed adults from long-term photo-identification (photo-ID). The young age of the calf (< 2 mo old) was confirmed by its small size, the bends in its dorsal fin, and the presence of fetal lines (i.e., 5 to 7 symmetrically placed vertical lines on both sides of the calf's body; Mann & Smuts, 1999).

Photos of each dolphin's dorsal fin were taken with a Nikon D80 digital SLR camera (Nikon, Tokyo, Japan) equipped with a 70-300 mm telephoto lens to identify individuals. Images were reviewed and matched to dorsal fins of known individuals in the regional long-term photo-ID catalog using standard techniques (Würsig & Würsig, 1977). Scarring detected on dolphin bodies in high-quality photos were carefully reviewed to match features distinguishable in screenshots extracted from surface video recordings.

Notes on the behavior of all visible dolphins were recorded from the boat *ad libitum* (Altmann, 1974). Dolphin surface activity was filmed intermittently by a volunteer with a handheld digital camera (640 × 480 dpi; 30 fps; acoustic sample rate: 36 kHz) aimed in the direction of the dolphins. Nine video segments with a total recorded time of 198 s (duration range: 4 to 51 s) were analyzed (see Supplementary Video S1; the supplemental video is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). We documented behavior of all dolphins in the observation to describe the event. Instances of calf- and conspecific-directed behaviors were noted as well as the location of the calf relative to other dolphins, when possible, in attempts to identify the role of each animal in the event. Individual dolphins were identified as confirmed or possibly having engaged in agonistic behaviors or epimeletic behaviors (i.e., attempting to help the calf; Table 1). Calf-directed behaviors were defined as follows (e.g., Kaplan et al., 2009; Robinson, 2014; Perrtree et al., 2016): *flip ram*: dolphin rams the calf with its rostrum or head, flipping the calf on its side; flips sometimes place the calf into the air or over an adjacent dolphin; *forced submergence*: dolphin uses part of its body (typically the rostrum and head) to forcefully submerge the calf underwater; and *carry:* dolphin lifts calf with its rostrum onto its dorsum and carries it forward.

Photo-ID confirmed that the group of 12 dolphins sighted during this interaction (11 adults and a calf) included six part-time residents (found in several years over a decade) and five long-term residents (sighted frequently each year over multiple years). Table 1 provides details on the event, the individual dolphins involved, and their identified roles in the attack where possible to discern. Of the five long-term residents, four were first sighted in 2001, one in 1992, and all were resighted repeatedly in most years from their first sighting until 2016. The remaining six animals were at least part-time residents, sighted at least once from 2006 until the event in 2008. Sex was known for only four individuals (2 males and 2 females). Of the 11 adult dolphins, six were identified as engaging in agonistic behaviors: three were confirmed as displaying agonistic behavior toward the calf, including one long-term resident male and two part-time residents of unknown sex. Two dolphins displayed behaviors toward the calf that could be interpreted as epimeletic behavior, one of which may also have been aggressing against the calf. Our limited ability to identify animals or to clearly see their behavior made it infeasible to confirm this interpretation, however. The following is a summary of this event.

At 1437 h, two separate groups of bottlenose dolphins were sighted approaching each other with approximately 100 m between the groups. A group of at least six animals (5 adults and a calf)

Table 1. Information on the individual bottlenose dolphins (*Tursiops truncatus*) present in this event. Individuals were photo-identified and matched to the regional catalog extending from 1992. M = male, F = female, Un = unknown, A = adult, C = calf, LT = confirmed as a long-term resident, and PT = confirmed as at least a part-time resident. Large "X" indicates confirmation of behavior, and small "x" indicates possible use of behavior. "--" indicates the behavior was not identified.

No.	Dolphin ID	Name	Sex	Age class	Date first sighted	Residency status	Agonistic behavior	Epimeletic behavior
1	TA069	Propeller	M	A	26 March 1992	LT	X	--
2	TA118	Gregory	F	A	20 March 2001	LT	--	--
3	TA120	Gonzo	Un	A	23 March 2001	LT	--	--
4	TA130	Sym	Un	A	7 April 2001	PT	X	--
5	TA140	Mel	Un	A	27 April 2001	PT	--	x
6	TA150	Whiro	M	A	23 June 2006	LT	--	--
7	TA155	Cleo	F	A	3 June 2006	LT	x	x
8	TA162	Star	Un	A	4 May 2006	PT	X	--
9	TA163	Chunk	Un	A	5 May 2006	PT	x	--
10	TA165	Pointer	Un	A	18 July 2006	PT	--	--
11	TA181	Crackle	Un	A	9 January 2008	PT	x	--
12	TAC013	No name	Un	C	7 March 2008	--	--	--

appeared to be pursued by a group consisting of at least six adult dolphins (Table 1). The research vessel approached within 30 m of the group to observe the event. Multiple dolphins were active at the surface when the two groups merged, swimming quickly toward the center of the group. The calf was first observed several minutes into the sighting, swimming rapidly at the water's surface, sometimes between adults and sometimes to one side of them. One to three adults clustered < 1 m from each other and the calf (Figure 2a), creating large splashes as the rest of the group swam nearby (< 5 m away).

From 1442 to 1506 h, four to five dolphins repeatedly displayed agonistic behaviors toward the calf. Two to three dolphins each carried the calf on their backs at least four times while swimming fast (estimate of 3 to 10 m/s). The calf was launched airborne at least four times when one to two dolphins flip rammed it over another dolphin or straight into the air (Figure 2b-e). At least four dolphins repeatedly flanked the calf and flip rammed it over the dorsum of another dolphin next to it (Figure 2e). A minimum of three dolphins forcefully submerged the calf underwater by swimming on top of it and pushing it beneath the surface. It was not possible to tell if the same dolphins were repeatedly engaging with the calf or if different animals displayed these behaviors. Similarly, we were unable to identify who the mother was or if she was in the group.

The calf attempted numerous evasive maneuvers to avoid oncoming adults but was unable to swim fast enough to evade physical attacks. As the calf attempted to surface for a breath on multiple occasions, several dolphins in close pursuit forcefully submerged it. The observation ended when the dolphin groups swam out of sight, preventing us from identifying the mother of the calf or determining if it was severely injured.

The fast movements of all animals during the attack made it infeasible to identify the role of most dolphins throughout the event. "Cleo" (TA155, a resident female) was identified as one of the animals most active in the surface video and still images because of her highly distinguishable white trailing-edged dorsal fin, which enabled more detailed tracking of her behavior in visual data.

In the photos and video, Cleo appeared to forcefully interact with the calf more than any other dolphin. However, this was likely influenced by the relative ease of identifying her compared to other dolphins in the group. Similarly, as we were unable to confirm who the mother was, it is possible she was the mother, explaining in part her high level of engagement and proximity with the calf. Cleo stayed close to the calf throughout the event as three to four other highly active dolphins clustered around them. She repeatedly swam underneath the calf, lifting it and carrying it on her head and back (Figure 2e & f). As the calf attempted to lift its head above the water, Cleo swam on top of it and used her head and rostrum to forcefully submerge it. In one clip, Cleo swam between two other dolphins as the calf swam ahead. She then darted forward and flip rammed the calf on its right side, launching it sideways and partially out of the water. On at least two occasions, Cleo darted forward just below the water's surface and emerged near two other dolphins appearing to block her path.

Loud whistles were audible to observers and were recorded on surface video when the dolphins were within 5 to 20 m from the boat as the calf's head was above water, both when it was evading adults and when it was being lifted into the air by the pursuing adult dolphins. Vocalizations recorded on the audio track were converted to WAV format for visual inspection and measurement of acoustic parameters in spectrograms (sample rate: 32 kHz; 1,024 DFT; Hann window; 95% overlap; 10 s resolution) using *Raven*, Version 1.5 (Cornell Lab of Ornithology, Ithaca, NY, USA). Vocalizations were classified as tonal whistles (Caldwell & Caldwell, 1965) or high repetition burst pulses (Blomqvist & Amundin, 2004). Whistle contours were classified by the shape of their slope in the spectrogram as rising, downsweeping, convex, concave, or flat (Tyack, 1986). Thirty-one vocalizations were detected in 198 s of recording: 23 whistles and seven burst pulse calls (Figure 3). Most of the whistles were similar in structure: a primarily downward sloping contour (n = 16; Figure 3a & b). Of the remaining whistles, four were convex (i.e., a downward sloping contour beginning with a rising contour; Figure 3c & d), two were rising, and one was flat.

To identify the association between the in-air sounds we recorded and the surface behavior of dolphins, original videos were combined with spectrograms of their sound data to create a time-synced video illustrating recorded sounds alongside surface observations (Figure 3a-d). This file was reviewed to determine dolphin surface activity (i.e., who was at and above the surface of the water) at the time of recorded whistles to identify if calls could be attributed to any dolphins. A subset of whistles (n = 17) opportunistically recorded in the surface video co-occurred with times when the calf's head, and typically most of its body, were above the water's surface (Figure 3a-d). However, because only in-air audio recordings were available, the adults were always near or above the surface at the time of whistle production, and most dolphins were not captured in the field-of-view of the surface camera, we could not confirm the source of the calls.

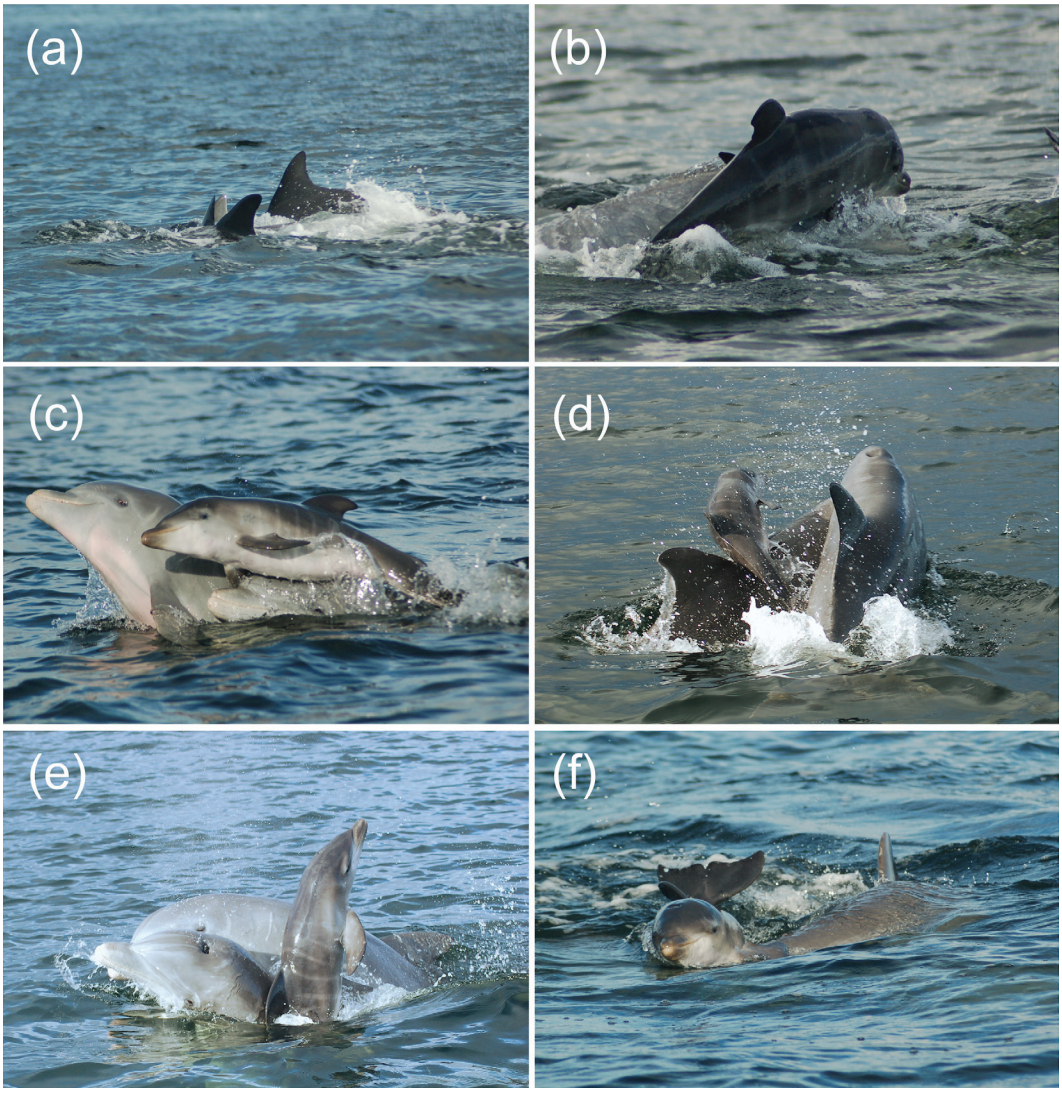

Figure 2. Images of intraspecific agonistic behavior by common bottlenose dolphins directed toward a young calf: (a) throughout the event, the group clustered tightly while thrashing and creating surface splashes making it difficult to discern individual behavior of dolphins or determine their roles in the event; (b) the calf is lifted above the water's surface; its numerous fetal lines and its small relative size suggest it was likely 1 to 4 months old; (c) two adult dolphins emerged head out from the water next to each other, launching the calf airborne; (d) dolphins repeatedly tossed and rammed the calf into different orientations above the water's surface; (e) Cleo (TA155, a resident female) lifted and flip rammed the calf in the air with another dolphin against her right side; and (f) Cleo repeatedly swam underneath the calf, forcefully lifting and carrying it forward.

The recorded vocalizations could have been produced by the adults, the calf, or both, and the function of these calls is unclear. The frequent repetition of similarly structured whistles, recorded as the calf was being chased and attacked, may have been the result of the calf or its mother vocalizing in distress in possible attempts to reunite. Each dolphin produces a signature whistle, a stereotyped whistle contour that serves as a vocal label conveying identity information on individuals (Caldwell & Caldwell, 1965; Quick & Janik, 2012). Signature whistles are often exchanged by dolphins during interactions to alert their presence to others (Janik et al., 2006) and are sometimes

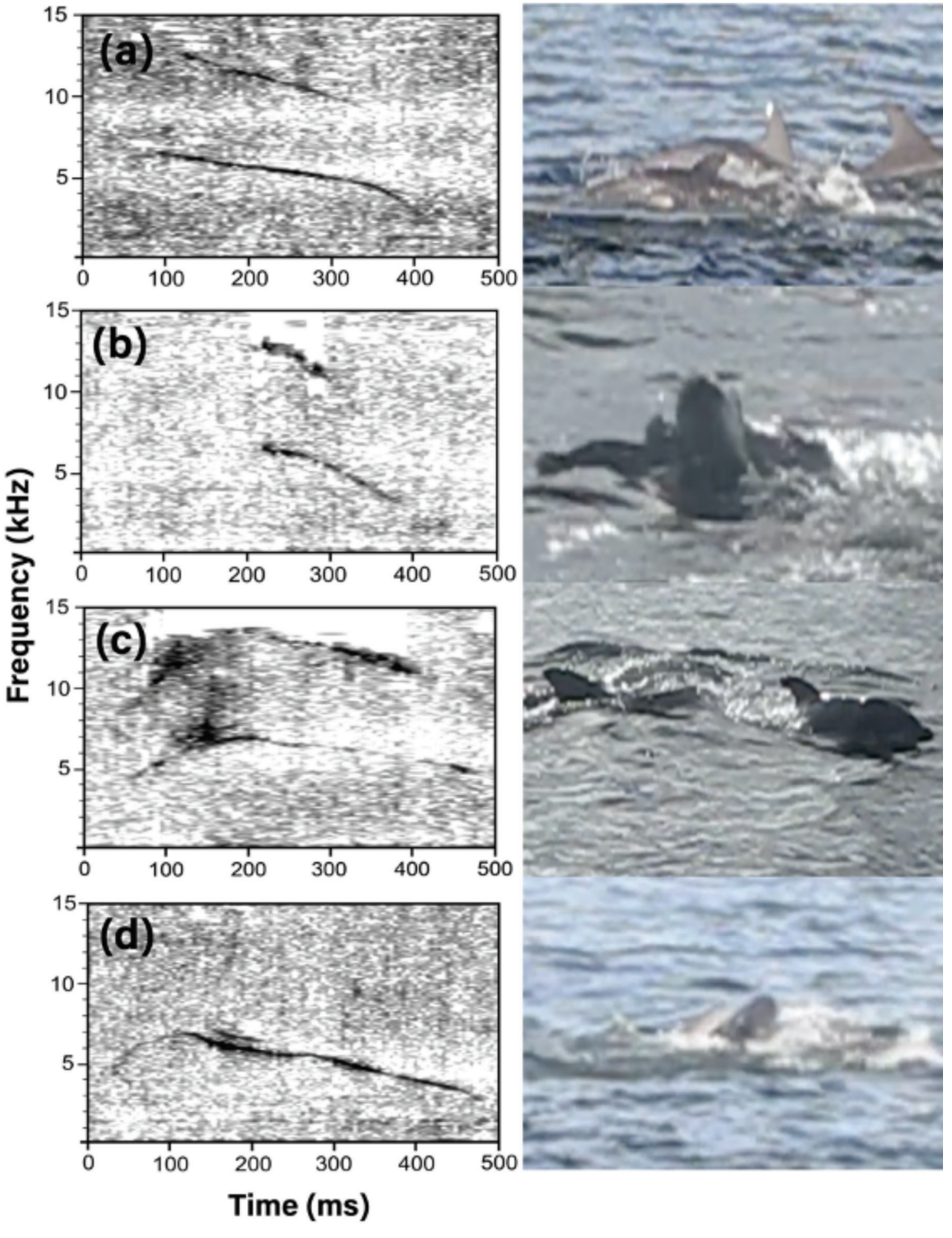

Figure 3. Spectrograms of bottlenose dolphin whistles recorded with the audio track of an in-air camera as multiple dolphins directed agonistic behavior toward a young calf. Spectrograms (a) and (b) are examples of whistles of the downward sloping contour; and (c) and (d) are examples of a downward sloping contour beginning with a short rise. Review of surface video observations confirmed all vocalizations were detected when the calf's head or entire body was above the water's surface. In the four examples here, the image to the right was extracted from surface video at the time the whistle was recorded. Spectrogram parameters: 1,024 DFT; Hann window; 95% overlap; 10 s resolution.

copied by others to address individuals (King et al., 2013). These signals are particularly important for maintaining contact between a mother and her calf and for reuniting following any separation (Sayigh et al., 1990; Smolker et al., 1993; Mello & Amundin, 2005; Kuczaj et al., 2015). High production rate of a single stereotyped whistle in dolphins, typically their signature whistle, has been associated with social behaviors (Jones & Sayigh, 2002; Quick & Janik, 2008), interactions with humans (Scarpaci et al., 2000), and stressful contexts (e.g., when isolated and/or in distress; Lilly, 1963; Esch et al., 2009). Alternatively, if the calls came from adult dolphins in the group, these sounds may have been produced in excitement or in association with agonistic behaviors. Sounds with downsweeping contours are commonly produced by many vertebrates during aggressive behaviors (Morton, 1977) and are similar in appearance to the downward sloping contours of distress whistles reported in bottlenose dolphins (Lilly, 1963) and described in a young, injured, and mortally ill bottlenose dolphin (Reiss & Castellotte, 2003). The burst pulse calls recorded during this observation are typically recorded during social and agonistic interactions in dolphins (Overstrom, 1983; Blomqvist & Amundin, 2004). Burst pulses were reported by Perrtree et al. (2016) during an infanticide attempt by bottlenose dolphins on a newborn calf, and by McCowan & Reiss (1995) in maternal discipline behaviors in captive dolphins. Unlike the brief in-air recordings we analyzed here, Perrtree et al. (2016) used a hydrophone to record a variety of dolphin vocalizations, including whistles, low-frequency tonal sounds, burst-pulse sounds, buzzes, and body contact sounds. The dominant whistle Perrtree et al. reported (46% of all whistles) consisted of rising and falling elements thought to be the signature whistle of the mother produced in distress, but this was not confirmed.

Although the drivers for this attack are unclear, the intense intraspecific agonistic behavior involving vigorous and repeated attacks on the calf strongly suggests multiple dolphins were attempting to injure and kill it, or to steal it. Mother bottlenose dolphins and Atlantic spotted dolphins (*Stenella frontalis*) sometimes aggress against their own or related calves during infant departures and during disciplinary activity (McCowan & Reiss, 1995; Hill et al., 2007; Weinpress & Herzing, 2015). Alternatively, young female dolphins will quickly swim near unrelated calves and lead them away (Mann & Smuts, 1998), taking advantage of their following response to separate them from their mother, which is similar to kidnapping reported in primates (Silk, 1999). The behaviors we document here are like previous reports of bottlenose dolphin infanticidal and agonistic behavior (e.g., Dunn et al., 2002; Kaplan et al., 2009; Robinson, 2014; Perrtree et al., 2016) and the killing of porpoises (e.g., Patterson et al., 1998; Cotter et al., 2012). Without additional information, identification of the mother, or confirmation of who aggressed and who did not, we are not able to speculate as to the possible causes for this attack.

We were unable to reidentify the calf in any future observations over the next 2 years, nor could we confirm if the mother was within the dolphin groups observed during the event or if it was a lone (possibly orphaned) calf, separated from its mother. At least three of the observed adult dolphins in the Turneffe Atoll population were confirmed as aggressors. At least four of the dolphins in these groups were males, but we could not confirm their roles in the attack. Cleo forcefully interacted with the calf on multiple occasions, ramming it, carrying it on her head and back (Figure 2f), and tossing it into the air (Figure 2e; see Supplemental Video S1). Some of her behaviors were like reports of other possible infanticide attempts during which the mother repeatedly surfaced with the calf on her head in apparent attempts to evade attacking males (Perrtree et al., 2016). Cleo is of particular interest because she showed behaviors that could be interpreted as both aggressive and epimeletic directed toward the same calf. If it was her own calf, attempts to protect the calf by forcefully moving it out of harm's way and/or becoming aggressive with the calf as a form of discipline are both plausible explanations for her behavior. Alternatively, she may have been attempting to steal the calf of another female. Since the observations and video recorded were of surface behavior only, it was not possible to accurately verify the relative positions and behaviors of the aggressing animals relative to the calf. Thus, determining the actual function of Cleo's behavior remains unclear.

This short note provides additional evidence for possible infanticidal behavior in bottlenose dolphins in another population, suggesting that infanticide may be more widespread in this species. Our limited ability to determine the animals' individual roles prevented us from identifying which animals were aggressing against the calf, the extent of harm intended, and if any dolphins might have been attempting to protect it. The use of downsweep whistles during this event should be investigated further in other contexts to better understand their possible role in dolphin distress and aggression. Future studies employing small drones and underwater acoustic recordings can facilitate a better understanding of the behavioral contexts surrounding rare dolphin infanticidal events and enable a

more detailed picture of rarely documented subsurface activity (Ramos et al., 2018a, 2020).

Acknowledgments

We thank the Oceanic Society for their support in conducting this research in Belize. Thanks to the volunteers who helped to gather data on the boat. This research was conducted under permits to conduct marine mammal research granted to the Oceanic Society by the Forestry Department of Belize. We dedicate this manuscript to our recently passed coauthor and wonderful colleague, Isidore D. Szczepaniak, and thank him for his tireless dedication to marine mammals.

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