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Short Note

Records of Postmortem Attentive Behavior on an Irrawaddy Dolphin (*Orcaella brevirostris*) Calf and Implications for Conservation in Kuching Bay, Sarawak, East Malaysia

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Postmortem Attentive Behaviors (PABs), also known as epimeletic behaviors, have been observed in terrestrial mammalian species, such as primates, giraffes, and elephants (Nakamichi et al., 1996; Douglas-Hamilton et al., 2006; Li et al., 2012; Strauss & Muller, 2013), as well as in aquatic mammals (Reggente et al., 2016; Bearzi & Reggente, 2017; Bearzi et al., 2017). In cetaceans, epimeletic behavior is described as one or more adults attending to an injured, distressed, dying, or deceased animal by keeping it afloat if sinking, pushing it down if buoyant, performing "resuscitation" attempts, and/or carrying it on the dorsum, head, rostrum, or in the mouth (Reggente et al., 2016; Bearzi & Reggente, 2017). Most records of cetacean PAB involved Indo-Pacific humpback dolphins (*Sousa chinensis*), common bottlenose dolphins (*Tursiops truncatus*), and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) (e.g., Porter, 2002; Kuczaj et al., 2015; Bearzi et al., 2017, 2018; Cheng et al., 2018; Reggente et al., 2018; Pedrazzi et al., 2022). Until now, only one case of this behavior has been documented in Irrawaddy dolphins (*Orcaella brevirostris*) from Balikpapan Bay, Indonesia (Kreb et al., 2020). Herein, we describe a rare event of PAB towards an Irrawaddy dolphin calf in Kuching Bay, Sarawak, East Malaysia, and its implications for conservation.

Identified as an Important Marine Mammal Area (IUCN-MMPATF, 2019), the Kuching Bay is home to four species of coastal cetaceans, namely Irrawaddy dolphins, Indo-Pacific finless porpoises (*Neophocaena phocaenoides*), Indo-Pacific humpback dolphins, and Indo-Pacific bottlenose dolphins (Minton et al., 2011). The best mark-recapture abundance estimate for Irrawaddy dolphins in the Kuching Bay, based on data collected between 2007 and 2010, was 233 (CV = 22.5%; 95% CI 151 to 360; Minton et al., 2013). The 95% confidence interval of this estimate overlapped with that of the line transect estimate generated for the same species in the same area between 2010 and 2012: 149 (CV = 27.9%; 95% CI 87 to 255). Mark-recapture studies indicated that the population has a high degree of site fidelity and year-round residency (Minton et al., 2013). The representative range and core area of Irrawaddy dolphins estimated using fixed kernel range estimates were 246.42 km^2 and 37.22 km^2, respectively, with the core area located in the Salak Estuary (Figure 1; Zulkifli Poh, 2013; Peter et al., 2016a). The Kuching Bay Irrawaddy dolphin population appears to be one of the largest in Borneo as other Bornean populations number fewer than 100 individuals (Minton et al., 2016; Peter et al., 2016a).

Kuching Bay includes two main bays connected by a series of rivers and inland mangrove channels (Figure 1). There are several national parks within the vicinity, namely the Kuching Wetlands National Park on the west (also a RAMSAR site), the Talang-Satang National Park ~10 km offshore, the terrestrial Bako National Park to the east, and Mount Santubong National Park (Figure 1).

Throughout their range, Irrawaddy dolphins are associated with estuarine environments and bays

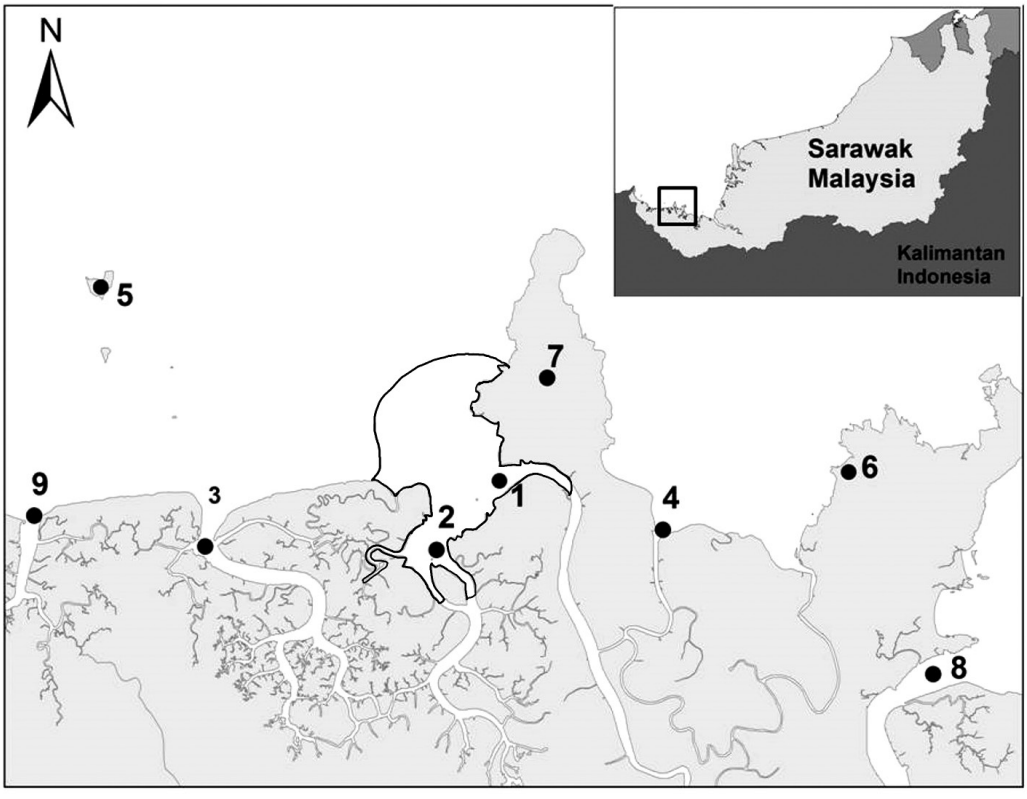

Figure 1. The study area in Kuching Bay, Sarawak, East Malaysia, with specific locations identified: (1) Santubong River, (2) Salak River, (3) Sibu Laut River, (4) Buntal River, (5) Talang-Satang National Park, (6) Bako National Park, (7) Mount Santubong, (8) Muara Tebas, and (9) Kuala Rambungan. The darker black line indicates the contours of the 50% Utilization Distribution (UD) range of Irrawaddy dolphins (*Orcaella brevirostris*) based on sightings and photo-identification data collected between 2008 and 2012 (*Sources:* Peter, 2012; Zulkifli Poh, 2013; Peter et al., 2016a).

with freshwater input (Smith, 2018; Kreb et al., 2020). In Kuching Bay, the species was statistically more likely to be present in waters within a 6 km radius of river mouths and more likely to be inshore during high tides and offshore during low tides (Peter et al., 2016a). Confirmed observations of neonate Irrawaddy dolphins indicate that the nearshore areas of Kuching Bay are used as calving and nursing grounds for this species (Minton et al., 2011, 2013). Observations also suggest that Irrawaddy dolphins have dietary preferences and specialized hunting techniques that restrict them to the shallow waters of nearshore habitats (Peter et al., 2016a).

A high degree of overlap between observed fisheries and cetacean distribution in the Kuching Bay renders them particularly vulnerable to bycatch in artisanal fishing gears, especially gillnets (Peter et al., 2016b; Brownell et al., 2019; Hines et al., 2020). Kuching Bay has also hosted a marine and coastal wildlife watching industry since the early 2000s, which has introduced potential threats from underwater noise and the risk of vessel strike generated by tourism vessels (Mustika et al., 2017). Other anthropogenic threats faced by the species include habitat loss and degradation due to coastal development, decreased fitness from chemical pollution, and a suspected reduction in prey due to intensive fishing activities (Jaaman et al., 2009; Kreb et al., 2020). A study conducted from 2008 to 2011 revealed that 6.5% of 124 photo-identified individuals had small to large skin nodules (Van Bressem et al., 2014). Though most individuals had a relatively low number of lesions, one had numerous nodules distributed over all visible portions of its body (Van Bressem et al., 2014). In 2017, the species was assessed as "Endangered" on the International Union for Conservation of Nature's *Red List of Threatened Species* (Minton et al., 2017).

On 13 September 2011, upon receiving a report of a dead Irrawaddy dolphin in the Salak estuary of Kuching Bay (coordinates 1.702357

N, 110.291816 E), an observation team, including the first, second, and third authors, arrived at the site at 1740 h. At that time, four dolphin-watching tour boats were surrounding the floating calf, which was low in the water with only one flipper visible above the waterline. The tour boats departed at 1749 h, and four adult Irrawaddy dolphins (hereafter referred to as "bystanders"; *sensu* Bearzi et al., 2018) began circling the dead calf. One adult approached the carcass, repeatedly attempting to push it down in the water. This adult is referred to from here on as the "Postmortem Attender" (PA) (Bearzi et al., 2018; Figure 2A).

Our vessel maintained a distance of 100 m from the animals to avoid disturbing their behavior while we collected photos and videos for photo-identification (photo-ID). The PA was reliably recognizable by the presence of small to large skin nodules on its left flank that were visible at different angles and in poor lighting towards sunset (see supplemental video on the *Aquatic Mammals* website). The PA continuously pushed the floating carcass down using its lower jaw and slipping over it at least eight times in 1.5 min. The bystanders swam slowly at a distance of ~50 m from the PA and carcass, and were not in contact with the carcass, nor did they show any aggressive or sexual behavior towards the adult–dead calf pair (as has been observed in other PAB events; Bearzi et al., 2018).

After ~19 min, the PA and bystanders departed and were no longer visible in the area. Following consultation with the Sarawak Forestry Corporation (SFC) and Sarawak Marine Mammal Strandings Network, the carcass was collected for necropsy. The neonate female weighed 10 kg and measured 97 cm from the tip of the rostrum to the fluke notch. The umbilical cord stump and fetal folds were clearly visible (Figure 3A), and the teeth had not erupted. There were multiple 2-cm diameter circular scars on its left flank, possibly made by scavenging fish after death (Figure 3B). No other external injuries or abnormalities were observed. Following this initial examination, the carcass was transported to Universiti Malaysia Sarawak and stored in a chest freezer at the Institute of Biodiversity and Environmental Conservation lab. The team returned to the observation site the next morning (14 September 2011), but no dolphins were seen.

The PA was identified as KCH10-LDF-001 (Minton et al., 2011, 2013), a dolphin that had been observed on at least four occasions from 2010 through 2013 (4 March 2010, 19 July 2011, 18 July 2012, and 26 April 2013), though it was never observed with a calf. Two of the three bystanders were also photographed and compared to the existing photo-ID catalogue. One individual (KCH08-LDF-004) had a highly distinctive, partially amputated dorsal fin and was first photographed in 2008 (16 August) and again in 2009 (20 June) and 2010 (28 September). Following the PAB event, KCH08-LDF-004 was seen in 2012 (27 June, 18 July, and 10 October) and 2013 (26 April) (Figure 2B), always without a calf. Although KCH10-LDF-001 and KCH08-LDF-004 were never photographed together prior to the PAB event, they were observed together in July 2012 and April 2013 as part of groups composed of mixed age classes engaged in probable feeding behavior (Figure 4).

A second bystander (KCH11-RDF-048) was only observed during this event and was not recognized in any previous or subsequent surveys. Because of low-light conditions caused by light rain and approaching sunset, no photographs of suitable quality for comparison to the photo-ID database were obtained of the third bystander. The PAs and bystanders were never seen again after 2013 despite continuous fieldwork in Kuching Bay until 2022.

On 5 March 2012, a necropsy conducted at the Universiti Malaysia Sarawak found bruises in the right lateral region of the subcutaneous tissue (Figure 3C). No other external lesions were seen. There was evidence of antemortem hemorrhage in the carotid artery and bleeding in the thoracic area. These findings suggested that the calf was forcefully struck on its right side by a blunt object. Infanticide is a possible cause as it is characterized by subcutaneous hemorrhage within the throat, thoracic, and abdominal regions even in the absence of external lesions (Dunn et al., 2002; McLellan et al., 2013). A vessel strike represents another possibility as, in the case of impact with smooth objects, hemorrhages in the subcutaneous tissues and the abdominal and thoracic cavities may occur in the absence of external injuries (McLellan et al., 2013). The calf's other major organs (kidneys, stomach, intestines, and liver) appeared normal. The gastrointestinal tract was empty, and there were no parasites in the intestines. Postmortem gas bubbles were observed in the lung walls. Pathological examinations were not carried out because of lack of resources available at that time.

This short note presents a rare record of PAB involving an Irrawaddy dolphin calf and a conspecific in Kuching Bay, Sarawak, and is the second documented event in Borneo. Although the exact time of death of this calf is unknown, it likely occurred shortly before the PAB event was recorded as the carcass was still fresh with minimal drying or wrinkling of skin (i.e., code 2 of Geraci & Lounsbury, 1993) when recovered. While it is unknown if the PA was the calf's mother, this observation adds a new species to the list displaying PAB. Bearzi et al. (2017) speculated that staying near an injured or dead individual, maintaining physical

Figure 2. (A) Postmortem attender (PA), KCH10-LDF-001, recognisable by a large nodule on the left flank. KCH10-LDF-001was observed by the Sarawak Dolphin Project (SDP) on several occasions prior to, post, and including the observation with the calf carcass in 2011. The flipper of the calf carcass is in the black circle; and (B) KCH08-LDF-004, observed as a bystander during the event. This individual was observed by the SDP on four occasions prior to the incident and on four occasions after the incident, including two sightings with the PA. (*Photo source:* Sarawak Dolphin Project)

Figure 3. (A) Faint fetal folds were visible and teeth had not erupted; (b) circular scars measuring 2-cm diameter on the carcass's left flank; and (C) bruises were observed under the skin in the right lateral region. (*Photo source:* Sarawak Dolphin Project)

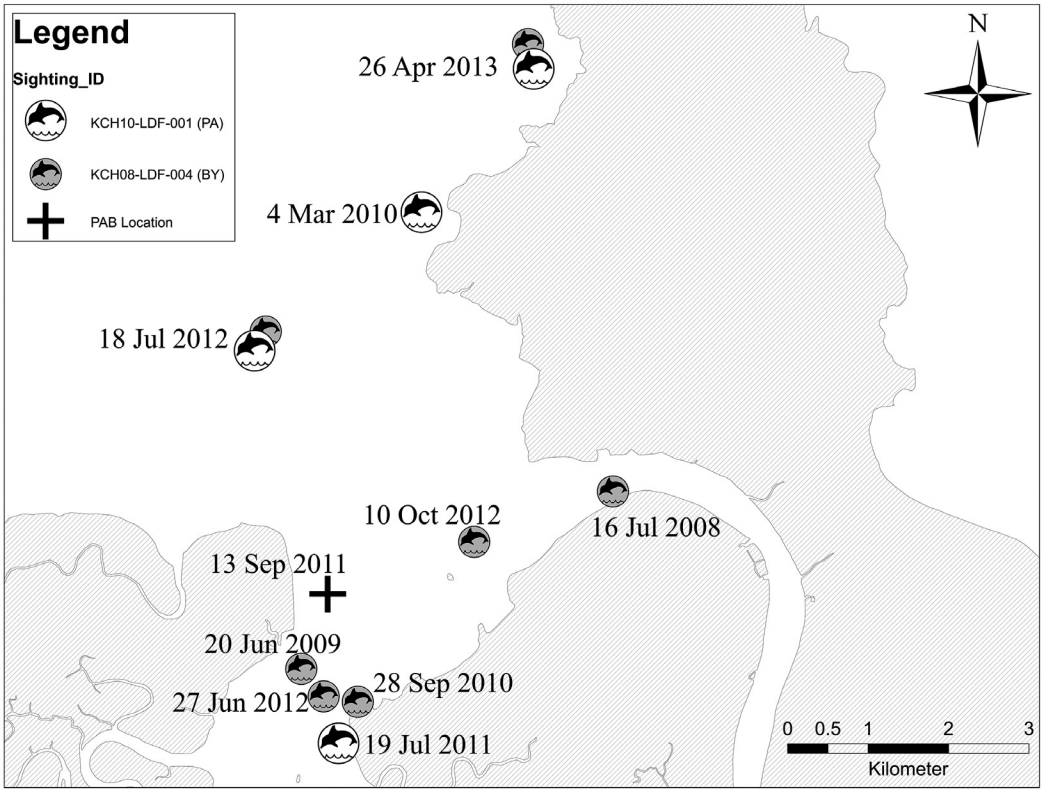

Figure 4. Sighting locations of KCH10-LDF-001 (postmortem attender, PA) and KCH08-LDF-004 (bystander, BY) prior to and after the event on 13 September 2011 in Kuching Bay, Sarawak, East Malaysia

contact, lifting a carcass afloat, or pushing a dead calf down in the water could be driven by emotional distress that could lead to compulsive behaviors. Others propose that PAB with calves is motivated by the disruption of the strong social bond and instinct for maternal care that links a mother to its offspring, especially in highly social animals such as dolphins (Pedrazzi et al., 2022). During the other documented PAB case in Irrawaddy dolphins in Balikpapan Bay, Indonesia, a calf discarded from a gillnet was tended for 4 d by five adult dolphins that even appeared to defend the carcass against a crocodile (Kreb et al., 2020). In a case of PAB observed in Indo-Pacific humpback dolphins in Sanniang Bay, China, the presumed mother supported the calf's body on her back for 4 h without feeding (Cheng et al., 2018). Similarly, Indo-Pacific humpback dolphins were also reported to carry a dead and decomposing calf for up to a week (Porter, 2002).

As two of the bystanders observed during the PAB event reported here had been observed in the same area in previous years, and were seen together for up to 2 y after the event, it is likely that they belong to the same resident Kuching Bay population. This community relies on a small area of habitat for all aspects of their critical life functions such as calving and feeding (Zulkifli Poh, 2013; Peter et al., 2016a). Since 2003, there have been five cases of Irrawaddy dolphin strandings and bycatch reported in Kuching Bay (Sarawak Dolphin Project [SDP], unpub. data, 2003-2022). Three of those were attributed to entanglement in fishing gear, while the two other cases (including the event described here) involved calves floating in the water (SDP, unpub. data, 2003-2022).

The present study shows that the Irrawaddy dolphins have complex social bonds with long-term associations between individuals. Dolphins have highly developed cognitive abilities and strong social bonds (Marino, 2002; Grimm, 2010). These characteristics are likely to be paired with emotions similar to those experienced by humans, including stress, as detected in several species through hormone assays (Nabi et al., 2018; Rolland et al., 2019; Lemos et al., 2021; Liu et al., 2022), as well as grief and loss (Bearzi et al., 2018).

Currently, the Kuching Bay comprises an important fishing ground for local communities.

Small-scale artisanal fisheries and tourism both introduce potential sources of stress, injury, and mortality for Irrawaddy dolphins (Peter et al., 2016b). This study can be the impetus for Kuching Bay to be considered a Marine Protected Area (MPA) by the authorities, where limited take zones and no take zones are introduced to reduce bycatch of marine mammals and also to provide refuge for fisheries resources, which have been shown to benefit fisheries as well as protected species (e.g., Barneche et al., 2018; Marshall et al., 2019).

Presently, there are no laws or guidelines in place in Sarawak to regulate aquatic conduct or vessel speed under any circumstances. Considering that the calf might have died following a blunt force trauma from a boat strike, authorities should consider adopting and enforcing vessel speed restrictions for all types of vessels within the core areas known to host the highest densities of dolphins (Minton et al., 2011, 2013). Boat strikes from whale-watching vessels have been linked to unsustainable rates of mortality (May-Collado et al., 2014; Trejos & May-Collado, 2015; Kassamali-Fox et al., 2020), and speed restrictions have been suggested as a method for reducing strikes. Speeds below 10 kts are associated with lower risks of fatal injury for whales (Conn & Silber, 2013; Currie et al., 2017; Crum et al., 2019) and may be sufficient to allow smaller vessels time to detect and avoid dolphins when they surface. Speed restrictions have been determined to be effective in reducing manatee deaths in Florida in the U.S. (Calleson & Frohlich, 2007; Timmel et al., 2008), and a restriction of 10 kts applied to all vessels using the Kuching Bay could help to reduce the risk of boat strikes in important Irrawaddy dolphin habitat.

This short note demonstrates the importance of collecting detailed photographic and video data as well as carcasses and/or biological samples during the observation of unusual events or behaviors. In this case, the data collected during the event and the postmortem analysis of the carcass allowed greater insight into the social bonds of Irrawaddy dolphins in Kuching Bay, as well as the threats affecting the population. It is hoped that careful description of this event in the scientific realm as well as through more popular media can be used to influence perceptions of the general public and decision makers to enact and support measures that will reduce threats for a species with advanced cognitive capabilities and social and maternal bonds rivalling those of humans.

Note: A supplemental video for this short note 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.

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