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Drone Observations of a Mother–Calf Humpback Whale (*Megaptera novaeangliae*) Pair Synchronous Feeding in the Bay of Fundy, Canada

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Drones, or Unmanned Autonomous Vehicles, have become a commonly used and powerful tool in capturing observations of wild marine mammals (Torres et al., 2018; Fiori et al., 2019). Herein, we present the first drone-documented case of parallel lunge feeding by a mother–calf humpback whale (*Megaptera novaeangliae*) pair in the Bay of Fundy within the Gulf of Maine. The behavior observed suggests that the calf is using mimicry to learn the complex lunge feeding behavior. This anecdotal observation adds to the current paucity of recorded social learning events in humpback calves.

On 4 September 2021, during field research in the Bay of Fundy aboard the M/V *Osprey* (a 14 m research vessel), we encountered a small aggregation of humpback whales feeding on the Grand Manan Banks (Figure 1). The Grand Manan Banks are a known feeding ground for multiple marine

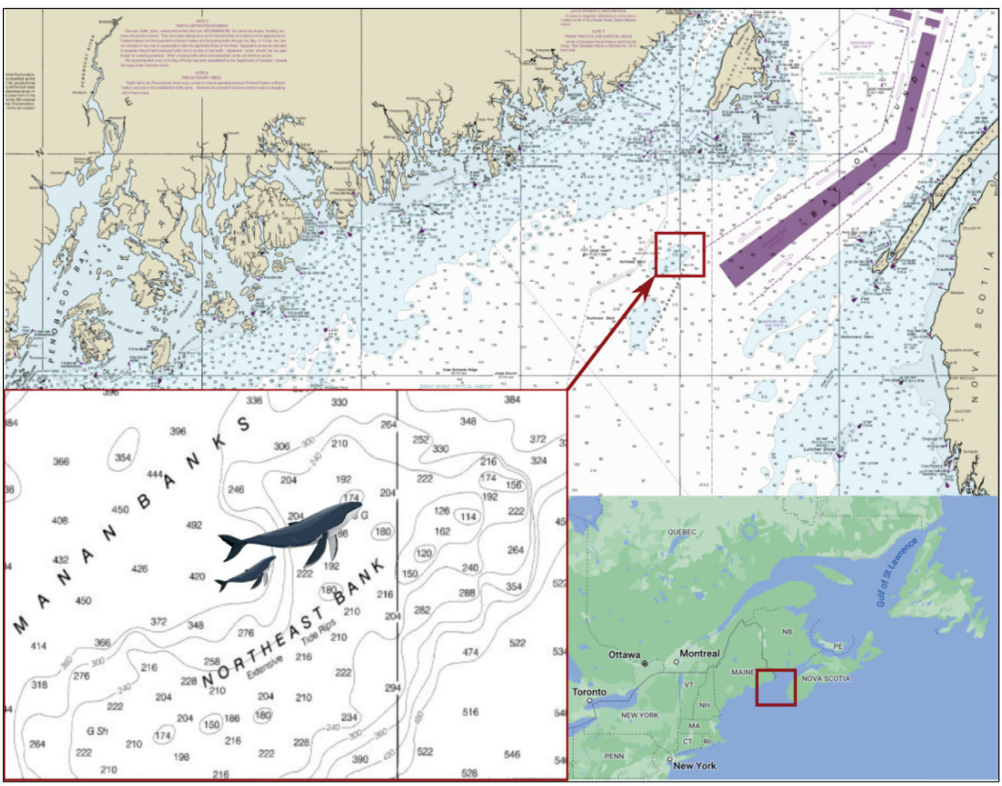

Figure 1. Location of observation in the eastern Gulf of Maine (based on NOAA Chart #13260). *Inset left:* Northeast Bank of the Grand Manan Banks (NOAA Chart #13392). *Inset right:* Region of northwestern Atlantic.

mammal species (Arnold & Gaskin, 1972; Woodley & Gaskin, 1996; Ingram et al., 2007). This sighting included three humpback whales identified as "Lascaux" (*North Atlantic Humpback Whale Catalog* #na08308), Lascaux's calf of 2021 (no catalog number yet), and "Tongs" (#na00837). During the lunge feeding observation, Tongs was more than two body lengths away from the mother–calf pair and did not appear to influence their behavior.

A licensed drone operator (coauthor TAS) flew a DJI Phantom 4 with a 12.4 MP camera over the mother–calf pair, collecting 4K (4,096 × 2,160) video at an altitude of 34 m and a 90° angle to the water's surface. Approximately 3 min into the recorded video, we opportunistically recorded the mother and calf exhibiting synchronous lunge feeding (at 44.2712°N, 67.0344°W; Figure 2). Prey sampling was not conducted concurrently, but based on the video images and common humpback prey sources in the Bay of Fundy, the food source was likely northern krill (*Meganyctiphanes norvegica*).

We reviewed the video frame-by-frame in *iMovie* (Version 10.3.4) on a 4K resolution monitor to optimize event details. Our video sequence initially reveals Lascaux approaching a patch of clearly visible krill from below, at an oblique angle, in a clockwise motion on her side (left side up). As her mouth opens and the gular or ventral feeding pouch expands, she rotates counterclockwise, just below the surface, until she is dorsal side up. Her calf is seen swimming ventrally to the left of its mother in a similar aspect and direction. The calf performs a gulp maneuver twice, the second time more vertically toward the surface as Lascaux completes her foraging sequence. The calf's lunge is slightly delayed to the mother's by 2 to 3 s but

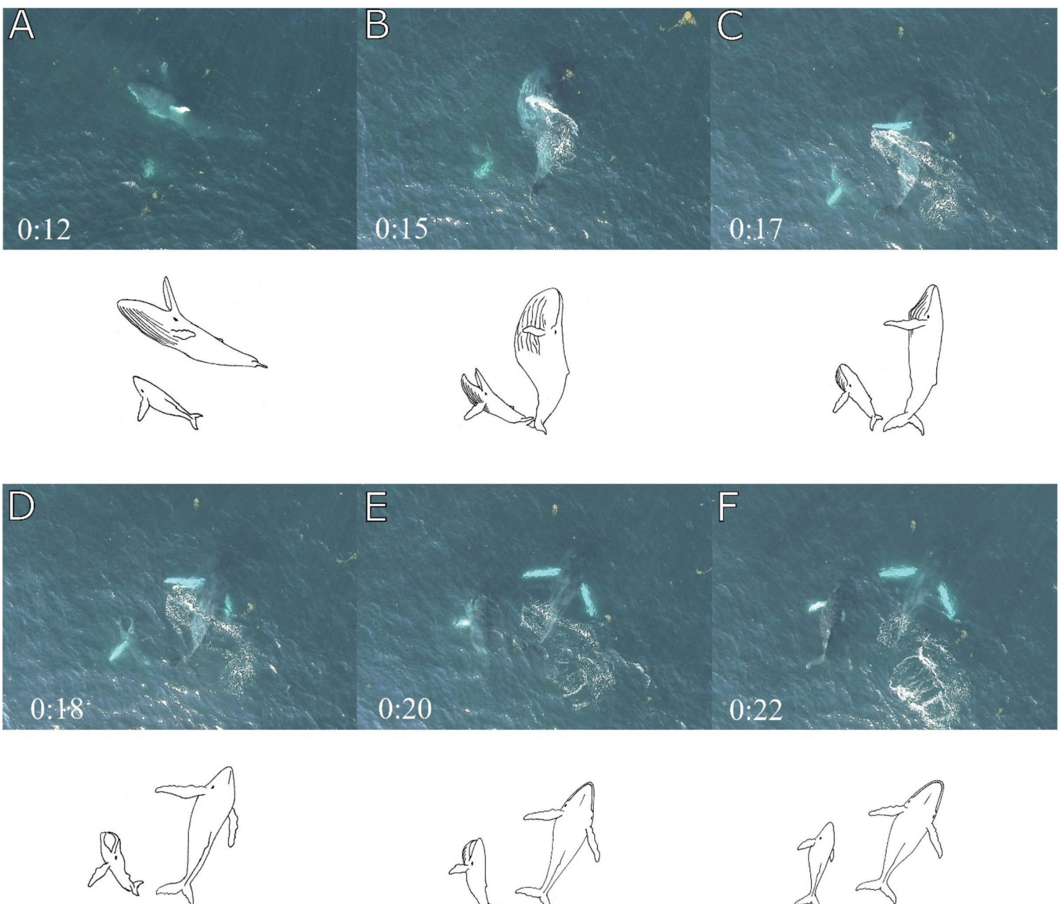

Figure 2. Sequence of mother–calf humpback (*Megaptera novaeangliae*) pair lunge feeding on krill with (A) calf slightly delayed behind mother, (B) calf's first gulp event, (C) calf completing first gulp event, (D) calf's second gulp event, (E) calf's distended gular pouch visible, and (F) foraging sequence end. For each panel, an additional graphic clarifies the whales' positions.

clearly mimics the mother's actions in aspect of approach, three-dimensional body disposition, and choreography of the gulp sequence (Figure 2).

Our observation shows the calf duplicating its mother's behavior in a manner suggestive of socially learned imitation/mimicry under the conventions proposed by Whiten & Ham (1992). While we cannot be certain that the calf is filtering food, its gular pouch is distended, its activity is synchronous with the mother's feeding maneuver, and the calf made two attempts vs one execution by the mother, which potentially indicates practice of this behavior by the calf. The krill patch cohesiveness is disrupted by the mother's lunge (see Figure 3 & Supplemental Video; the Supplemental Video for this paper 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), which we hypothesize offers a potential benefit to the practicing calf.

Documenting learning *in situ* or capturing the ontogeny of an apex skill—such as learning to capture food—in baleen whale young is a challenge since most activities occur subsurface. It is difficult to know definitively how or when a calf or juvenile mysticete acquires feeding skills. There is one documented instance when researchers, with the use of Dtags over a ~20 h period, were able to document a Southern Ocean humpback whale calf appearing to experiment by mimicking its mother's swimming motion while foraging (Tyson et al., 2012). Whether or not the calf in that study was engaging in lunge feeding was inferred by the recorded swim patterns of below-water lunges, surmised by the rapid increase and decrease of water flow past the built-in hydrophone of the tag. While Tyson et al.'s (2012) findings were not derived from direct observation, the use of thrust as a proxy for feeding—as determined by acoustics—is widely accepted (Goldbogen et al., 2006, 2011); their study did not sample prey, likely Antarctic krill (*Euphausiia superba*), in the water column, but tag data confirm that lunge feeding occurred. Another anecdotal report of a humpback calf appearing to mimic its mother's feeding lunges was recorded from the surface using a handheld digital video recorder by observers on a vessel off New South Wales, Australia (Stamation et al., 2007).

Figure 3. Detailed sequence of the feeding behavior. The composition of the krill is outlined with white dashed lines as surmised from detailed and enhanced video examination. Red arrows indicate the calf's mouth in various stages of attack. Feeding behavior sequence: (1) mother's attack on krill, (2) calf's opening mouth, (3) calf's second opening mouth, and (4) calf's distended gular pouch as sequence ends. For timestamps of each image, see panels A, B, D, and E in Figure 2.

Documentation of such a rarely observed mother–calf pair behavior in the Gulf of Maine provides greater understanding of essential behavioral development in the North Atlantic population of humpback calves. Parallel lunge feeding by the mother and calf is evident from this first such drone-captured documentation. In marine mammal science, drones were initially used for quantification studies such as photogrammetry (Christiansen et al., 2016), population estimates (Goebel et al., 2015), and physiological applications in capturing blow samples (Acevedo-Whitehouse et al., 2010), but they also have great potential for use in behavioral studies (Torres et al., 2018). Drones are a useful tool for providing an aerial view of behaviors not visible from other platforms and for providing substantively more detailed viewing of activities occasionally sighted in part from surface observations. Drones are a complementary tool for studying marine mammals and will aid future research on social learning, including studies that may focus on similar feeding events in humpbacks. While our observation successfully utilized aerial drone technology, caution should always be taken when using drones to limit disturbance and potential harm to marine mammals. This recording demonstrates how drone-captured video can uniquely enrich our understanding of behavioral development in humpback whales.

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