PAPER IN PRESS

Aquatic Mammals 2022, *48*(6), ###-###, DOI 10.1578/AM.48.6.2022.###

Bubble Bursts, a Potential Foraging Strategy for Bottlenose Dolphins (*Tursiops truncatus*) in Cardigan Bay

Katrin Lohrengel,[1] Claudia M. Afeltra,[1] and Peter G. H. Evans[2, 3]

[1]*Sea Watch Foundation, Paragon House, Wellington Place, Ceredigion SA44 4BH, Wales, UK*
E-mail: katrin.lohrengel@seawatchfoundation.org.uk
[2]*Sea Watch Foundation, Ewyn y Don, Bull Bay, Amlwch, Anglesey LL68 9SD, Wales, UK*
[3]*School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey LL59 2AB, Wales, UK*

Bubble netting in humpback whales (*Megaptera novaeangliae*) is probably the best known and most studied cetacean foraging strategy relying on the emission of bubbles to secure prey (Jurasz & Jurasz, 1979; Wiley et al., 2011; Pirotta et al., 2021). However, some delphinid species, such as bottlenose dolphins (*Tursiops truncatus*; Fertl & Wilson, 1997), Atlantic spotted dolphins (*Stenella frontalis*; Fertl & Würsig, 1995), killer whales (*Orcinus orca*; Similä & Ugarte, 1993; Visser et al., 2008), dusky dolphins (*Lagenorhynchus obscurus*; Trudelle, 2010), and false killer whales (*Pseudorca crassidens*; Zaeschmar et al., 2013), have also been recorded utilising bubbles for communication to facilitate prey capture.

Bottlenose dolphins are known to engage in complex foraging strategies such as sponge feeding (Smolker et al., 1997), kerplunking (Connor et al., 2000; Weiss, 2006), barrier feeding (Weiss, 2006), mud plume feeding (Lewis & Schroeder, 2003), and systematic depredation of recreational fishing lines (Powell & Wells, 2011). These distinct foraging strategies are thought to be driven by both ecological factors and social learning (Wells, 2019), with mother-to-calf transmission the most significant pathway of information transfer (Sargeant & Mann, 2009).

Bottlenose dolphins using bubble bursts during foraging events are relatively poorly documented, with few examples in published literature (Fertl & Wilson, 1997; Zaeschmar et al., 2013) and none in British waters. There are only two semi-resident coastal populations of bottlenose dolphins in the United Kingdom: one in East Scotland, particularly around the Moray Firth (Cheney et al., 2013, 2014, 2018); and one in Cardigan Bay, Wales (Lohrengel et al., 2018). Both populations have been the subject of extensive monitoring efforts; however, unlike other populations, such as in Sarasota Bay (Wells, 2019) and Shark Bay (Smolker et al., 1997; Sargeant & Mann, 2009), there have been no observations of specialised foraging strategies in the UK. As part of long-term monitoring efforts, the Sea Watch Foundation has worked closely with platforms of opportunity such as wildlife tour boats and fishing vessels, incorporating data collected by volunteers or members of the public and via the Sea Watcher app into the main Sea Watch Foundation sightings database. Herein, we describe the occurrence of repeated bubble bursts during attempted prey capture by two bottlenose dolphins as observed from such a platform of opportunity. The video footage was opportunistically taken using a mobile phone camera and reviewed using Quicktime media player (the video footage 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).

During a fishing charter run by Epic Fishing on 28 July 2021 at 1208 h (BST), their boat, M/V *Legend*, was approached by two bottlenose dolphins, a mother and a juvenile, ~300 m off the main pier (Figure 1). Concurrently, Sea Watch observers aboard a visitor passenger boat recorded a sighting of three dolphins (two adults and one juvenile) in the area, describing their behaviour as suspected feeding or foraging. Photographs taken by observers during this sighting were matched with the Sea Watch Foundation bottlenose dolphin catalogue, and the adult with the juvenile was identified as 003-07R or "Berry." The timing of this sighting and colouration of the adult fin suggest the two dolphins in the video may be Berry and her juvenile (nicknamed "Luna"). Berry was first recorded in 2007, and Luna is her third known calf, thought to be born in 2019.

One of the fishing boat passengers noticed a salmon (*Salmo salar*) at the side of the boat, beneath the boat's fender adjacent to the hull. The adult dolphin, suspected to be Berry, approached the boat, repeatedly circling close to the fenders, and blew eight bubble bursts within the 1 min of

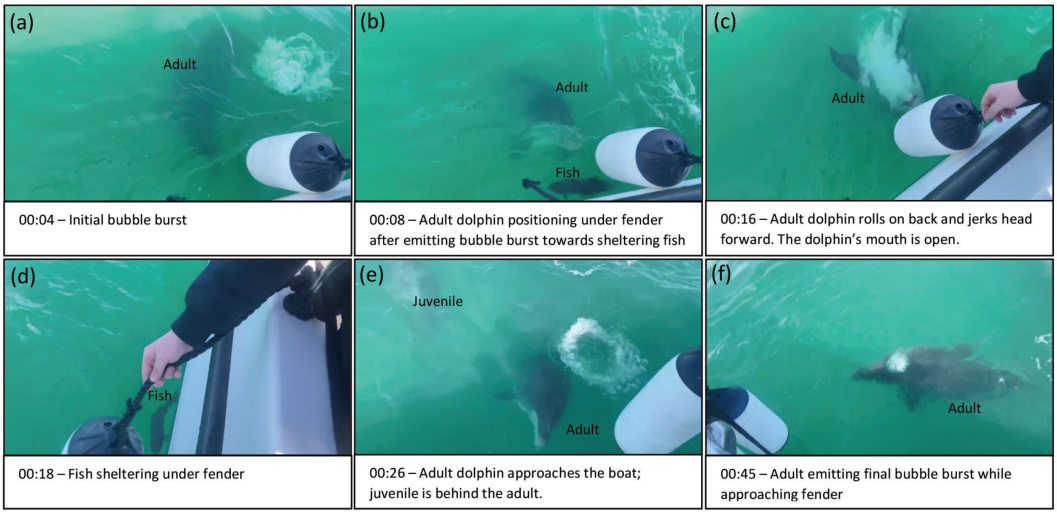

Figure 1. Bottlenose dolphin (*Tursiops truncatus*) approaches the boat emitting bubbles

video footage. The bursts were short (~1 to 2 s duration) and forceful, taking the shape of bubble rings before dispersing at the surface:

1. *00:00-005* – First observed were two bubble bursts emitted within 3 s of each other from the adult dolphin positioning itself underneath the fender and jerking its head several times (Figure 1a).

2. *00:08-00:17* – The adult dolphin, suspected to be Berry, turned away from the boat to surface, and then immediately returned to the boat, emitted a bubble burst (00:12) on approach, rolled on her back, and jerked her head underneath the fender (00:15). Berry then left the boat to surface while emitting a whistle (Figure 1b & c).

3. *00:18-00:21* – The dolphins were no longer in view, but the video revealed the salmon sheltering under the fender at the side of the boat (Figure 1d).

4. *~00:21* – The juvenile dolphin surfaced and seemed to turn towards the side of the boat where the salmon was located.

5. *00:23-00:26* – The adult dolphin thought to be Berry surfaced facing the side of the boat, then submerged blowing a bubble burst while approaching the boat (00:24), and again directly next to the fender (00:26) (Figure 1e).

6. *00:27-00:35* – The adult dolphin thought to be Berry faced away from the boat and surfaced (00:31) about 1 m from the side of the boat; the juvenile dolphin could be seen coming up close to it and surfacing, also facing away from the side of the boat (00:32) at ~2 m away.

7. *00:36-00:49* – The adult dolphin suspected to be Berry surfaced facing the side of the boat, emitted two bubble bursts while approaching the boat (00:38, 00:42), and again once next to the fender (00:45). The juvenile surfaced in the background (0:39, 00:47) about 4 m away and then approached the boat (00:49), appearing underneath the adult briefly (Figure 1f).

8. *00:49-01:00* – The adult dolphin continued to approach the fender, positioning on her side while moving her head, before swimming out of frame where the prey item was eventually captured.

Although there were two bottlenose dolphins present in this video, only the adult emitted bubble bursts. The third dolphin that was observed in the vicinity of the boat by observers was not involved in this observation. The bursts were not emitted in the direction of the juvenile but always on approach to the boat and the prey item. Following the boat approach and bubble bursts, the adult was seen positioning itself underneath the fender, rolling on its side and upside down, and forcefully jerking its head several times.

Several hypotheses have been proposed for the bottlenose dolphins' use of bubble bursts during foraging events: keeping schooling prey together, displacing prey, or as a social cue to conspecifics (Fertl & Wilson, 1997). In other contexts, bubble

PAPER IN PRESS

bursts have been associated with social interactions (particularly aggression), responses to objects, or as an expression of interest or excitement (Moreno & Macgregor, 2019). Given the context of this encounter, the bubble bursts are likely to have served to displace the prey from an inaccessible location; to display excitement, agitation, or interest; or to attract the attention of the juvenile.

From the video, it is clear that the dolphins were unable to access the fish in its location directly under the fender. Emission of bubble bursts in the direction of inaccessible prey has been reported in killer whales (Visser, 1999, 2005; Visser et al., 2008), while Weddell seals (*Leptonychotes wedellii*) have been documented to use bubbles to flush fish out from underneath the sea ice (Stone, 1998). It is possible that the adult dolphin was attempting to use bubble bursts to displace the fish from its protective position beside the boat's hull. However, although all bubble bursts were emitted during the approach to the fender, they were not always aimed directly at the fish. A similar behavior employing bubble formation has been observed by one of the authors (PGHE); these were utilised by a minke whale (*Balaenoptera acutorostrata*) in the presence of shoaling herring next to the vessel.

Alternatively, the bubble bursts may be an indication of excitement or interest. In two cases, bubble bursts were followed by head jerks that are often associated with aggressive displays in bottlenose dolphins (Mann & Smuts, 1999; Scott et al., 2005), and it is possible that the visible but inaccessible prey was eliciting an excitement response. It is also possible that these movements were attempts to "head scan" for the fish using echolocation (Diercks et al., 1971; Wei et al., 2021), although no clicks were heard at the time. While the purpose of the bubble bursts in this video is not entirely conclusive, it provides a rare insight into foraging behaviour in Cardigan Bay bottlenose dolphins, recording a previously unknown behaviour in this well-studied population.

It is also possible that the adult bottlenose dolphin was attempting to draw the juvenile's attention to the prey with its positioning and bubble emissions. Bottlenose dolphins have been shown to cooperatively hunt—in some cases, with each dolphin taking on distinctive roles such as the "driver" and the "barrier" dolphin (Gazda et al., 2005). The bubbles may have served as a combination of these two factors, attracting the juvenile's attention and serving as the first part of a "flush and ambush," a cooperative hunting approach employed by species such as Harris hawks (*Parabuteo unicinctus*; Bednarz, 1988).

Acknowledgments

Our sincere thanks to Hannah Davies and Epic Fishing for allowing us to use this footage. Thanks also to Jonathan Evans from Dolphin Spotting Boat Trips for his continued support of the Sea Watch Foundation's monitoring efforts by allowing our interns to collect data from his boats, and a special thanks to all our hard-working volunteers and interns, particularly Meghan Clarkson and Sam Aizlewood who recorded the sighting on this particular date. Thank you also to the helpful suggestions of the reviewers and editors.

Literature Cited

Bednarz, J. C. (1988). Cooperative hunting Harris' hawks (*Parabuteo unicinctus*). *Science*, *239*(4847), 1525-1527. https://doi.org/10.1126/science.239.4847.1525

Cheney, B. I., Graham, M., Barton, T. R., Hammond, P. S., & Thompson, P. M. (2018). *Site conditioning monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2014-2016* (Scottish Natural Heritage Research Report No. 1021).

Cheney, B., Corkrey, R., Durban, J. W., Grellier, K., Hammond, P. S., Islas-Villanueva, V., Janik, V. M., Lusseau, S. M., Parsons, K. M., Quick, N. J., Wilson, B., & Thompson, P. M. (2014). Long-term trends in the use of a protected area by small cetaceans in relation to changes in population status. *Global Ecology and Conservation*, *2*, 118-128. https://doi.org/10.1016/j.gecco.2014.08.010

Cheney, B., Thompson, P. M., Ingram, S. N., Hammond, P. S., Stevick, P. T., Durban, J. W., Culloch, R. M., Elwen, S. H., Mandleberg, L., Janik, V. M., Quick, N. J., Islas-Villanueva, V., Robinson, K. P., Costa, M., Eisfeld, S. M., Walters, A., Phillips, C., Weir, C. R., Evans, P. G. H., Anderwald, P., . . . Wilson, B. (2013). Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters. *Mammal Review*, *43*, 71-88. https://doi.org/10.1111/j.1365-2907.2011.00208.x

Connor, R., Heithaus, M. R., Berggren, P., & Miksis, J. (2000). "Kerplunking": Surface fluke-splashes during shallow-water bottom foraging by bottlenose dolphins. *Marine Mammal Science*, *16*(3), 646-653. https://doi.org/10.1111/j.1748-7692.2000.tb00959.x

Diercks, K. J., Trochta, R. T., Greenlaw, C. F., & Evans, W. E. (1971). Recording and analysis of dolphin echolocation signals. *The Journal of the Acoustical Society of America*, *49*(6A), 1729-1732. https://doi.org/10.1121/1.1912569

Fertl, D., & Wilson, B. (1997). Bubble use during prey capture by a lone bottlenose dolphin (*Tursiops truncatus*). *Aquatic Mammals*, *23*(2), 113-114.

Fertl, D., & Würsig, B. (1995). Coordinated feeding by Atlantic spotted dolphins (*Stenella frontalis*) in the Gulf of Mexico. *Aquatic Mammals*, *21*(1), 3-5.

Gazda, S. K., Connor, R. C., Edgar, R. K., & Cox, F. (2005). A division of labour with role specialization in group-hunting bottlenose dolphins (*Tursiops truncatus*) off Cedar Key, Florida. *Proceedings of the Royal Society B: Biological Sciences*, *272*(1559), 135-140. https://doi.org/10.1098/rspb.2004.2937

Jurasz, C. M., & Jurasz, V. P. (1979). Feeding modes of the humpback whales, *Megaptera novaeangliae*, in southeast Alaska. *Scientific Reports of the Whales Research Institute Tokyo*, *31*, 69-83.

Lewis, J. S., & Schroeder, W. W. (2003). Mud plume feeding, a unique foraging behavior of the bottlenose dolphin in the Florida Keys. *Gulf of Mexico Science*, *21*(1), 9. https://doi.org/10.18785/goms.2101.09

Lohrengel, K., Evans, P. G. H., Lindenbaum, C. P., Morris, C. W., & Stringell, T. B. (2018). *Bottlenose dolphin monitoring in Cardigan Bay 2014-2016* (NRW Evidence Report No. 191). Natural Resources Wales, Bangor. 162 pp.

Mann, J., & Smuts, B. (1999). Behavioral development in wild bottlenose dolphin newborns (*Tursiops* sp.). *Behaviour*, *136*(5),529-566.https://doi.org/10.1163/156853999501469

Moreno, K., & Macgregor, R. (2019). Bubble trails, bursts, rings, and more: A review of multiple bubble types produced by cetaceans. *Animal Behavior and Cognition*, *6*, 105-126. https://doi.org/10.26451/abc.06.02.03.2019

Pirotta, V., Owen, K., Donnelly, D., Brasier, M. J., & Harcourt, R. (2021). First evidence of bubble-net feeding and the formation of "super-groups" by the east Australian population of humpback whales during their southward migration. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *31*(9), 2412-2419. https://doi.org/10.1002/aqc.3621

Powell, J. R., & Wells, R. S. (2011). Recreational fishing depredation and associated behaviors involving common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. *Marine Mammal Science*, *27*(1), 111-129. https://doi.org/10.1111/j.1748-7692.2010.00401.x

Sargeant, B. L., & Mann, J. (2009). Developmental evidence for foraging traditions in wild bottlenose dolphins. *Animal Behaviour*, *78*(3), 715-721. https://doi.org/10.1016/j.anbehav.2009.05.037

Scott, E. M., Mann, J., Watson-Capps, J. J., Sargeant, B. L., & Connor, R. C. (2005). Aggression in bottlenose dolphins: Evidence for sexual coercion, male-male competition, and female tolerance through analysis of tooth-rake marks and behaviour. *Behaviour*, *142*(1), 21-44. https://doi.org/10.1163/1568539053627712

Similä, T., & Ugarte, F. (1993). Surface and underwater observations of cooperatively feeding killer whales in northern Norway. *Canadian Journal of Zoology*, *71*(8), 1494-1499. https://doi.org/10.1139/z93-210

Smolker, R., Richards, A., Connor, R., Mann, J., & Berggren, P. (1997). Sponge carrying by dolphins (Delphinidae, *Tursiops* sp.): A foraging specialization involving tool use? *Ethology*, *103*(6), 454-465. https://doi.org/10.1111/j.1439-0310.1997.tb00160.x

Stone, R. (1998). First glimpse at hidden life of seals. *Science*, *279*(5351), 657. https://doi.org/10.1126/science.279.5351.657

Trudelle, L. A. (2010). *Dusky dolphin bubble emissions during foraging: Potential functions* (Master's internship report). Texas A & M University, Galveston, for Centre d'Océanologie de Marseille, Université Aix-Marseille II, Marseille, France.

Visser, I. N. (1999). Benthic foraging on stingrays by killer whales (*Orcinus orca*) in New Zealand waters. *Marine Mammal Science*, *15*(1), 220-227. https://doi.org/10.1111/j.1748-7692.1999.tb00793.x

Visser, I. N. (2005). First observations of feeding on thresher (*Alopias vulpinus*) and hammerhead (*Sphyrna zygaena*) sharks by killer whales (*Orcinus orca*) specialising on elasmobranch prey. *Aquatic Mammals*, *31*(1), 83-88. https://doi.org/10.1578/AM.31.1.2005.83

Visser, I. N., Smith, T. G., Bullock, I. D., Green, G. D., Carlsson, O. G. L., & Imberti, S. (2008). Antarctic peninsula killer whales (*Orcinus orca*) hunt seals and a penguin on floating ice. *Marine Mammal Science*, *24*(1), 225-234. https://doi.org/10.1111/j.1748-7692.2007.00163.x

Wei, C., Hoffmann-Kuhnt, M., Au, W. W. L., Ho, A. Z. H., Matrai, E., Feng, W., Ketten, D. R., & Zhang, Y. (2021). Possible limitations of dolphin echolocation: A simulation study based on a cross-modal matching experiment. *Scientific Reports*, *11*, 6689.

Weiss, J. (2006). Foraging habitats and associated preferential foraging specializations of bottlenose dolphin (*Tursiops truncatus*) mother-calf pairs. *Aquatic Mammals*, *32*(1), 10-19. https://doi.org/10.1578/AM.32.1.2006.10

Wells, R. S. (2019). Common bottlenose dolphin foraging: Behavioral solutions that incorporate habitat features and social associates. In B. Würsig (Ed.), *Ethology and behavioral ecology of odontocetes* (pp. 331-344). Springer. https://doi.org/10.1007/978-3-030-16663-2_15

Wiley, D., Ware, C., Bocconcelli, A., Cholewiak, D. M., Friedlaender, A. S., & Thompson, M. (2011). Underwater components of humpback whale bubble-net feeding behaviour. *Behaviour*, *148*(5-6), 575-602. https://doi.org/10.1163/000579511X570893

Zaeschmar, J. R., Dwyer, S. L., & Stockin, K. A. (2013). Rare observations of false killer whales (*Pseudorca crassidens*) cooperatively feeding with common bottlenose dolphins (*Tursiops truncatus*) in the Hauraki Gulf, New Zealand. *Marine Mammal Science*, *29*(3), 555-562. https://doi.org/10.1111/j.1748-7692.2012.00582.x