

Intentional beaching by bottlenose dolphins (*Tursiops truncatus*) in the Colorado River Delta, Mexico

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Summary

Bottlenose dolphins (*Tursiops truncatus*) were observed beach-feeding in the Colorado River delta in the northern Gulf of California. While such feeding activity has been well-described for bottlenose dolphins on the Atlantic coast of the United States, our observations represent one of the first reports of beach-feeding by bottlenose dolphins in the Baja California region of the Pacific coastline. A review of the literature shows that reports of beach feeding mostly involve two cetacean species: bottlenose dolphins and killer whales (*Orcinus orca*). Both of these species live in diverse coastal habitats and demonstrate diverse feeding behavior that probably contributes to the evolution of beach-feeding.

Introduction

The behavioral plasticity of the bottlenose dolphin (*Tursiops truncatus*) is demonstrated through flexibility in feeding behavior (Shane, 1990). Foraging strategies are diverse and appear to be influenced by habitat type, prey type and accessibility (Würsig, 1986). Intentional beaching to capture fish chased onto shore ('beach-feeding') is one foraging strategy observed in bottlenose dolphins. Beach-feeding has been observed in the salt marshes of Georgia (Hoese, 1971; Caldwell & The Dolphin Project, 1993), South Carolina (Rigley, 1983; Rigley *et al.*, 1981; Petricig, 1993), Louisiana (Mullin, 1988), and Texas (McHugh, 1989; L. May, pers. comm.). Beach feeding has been reported infrequently in Mexican waters: the lagoons on the Pacific Coast of Baja California Sur (Norris & Dohl, 1980; B. Villa-R., pers. comm.) and on the Gulf of California coast of Baja California Sur (de

la Parra Venegas & Galván Pastoriza, 1985). We have observed and describe bottlenose dolphins beach-feeding in the Colorado River delta in the northern Gulf of California and provide a brief summary review of the literature concerning this behavior.

Methods and observations

In 1986, 1987, and 1988, surveys for vaquitas (*Phocoena sinus*) were conducted using an eight meter boat in the northern Gulf of California (Silber, 1990). On four occasions, surveys were conducted 4–12 km up the Colorado River. At these times, strong flood tides were used to enter the narrow tidal channels that meandered throughout the delta, and ebb tides used to retreat. Bottlenose dolphins were the only marine mammals seen in the river.

Dolphins sighted in the river channels were never more than 200 m from shore. The habitat consisted of shallow (2 m maximum at low tide), very silty waters with rapid tidal currents. The density of dolphins was higher in the river and river delta than in most other areas of the upper Gulf. Dolphin density did not appear to diminish as far as 12 km above the river mouth.

Results

Bottlenose dolphins were observed swimming onto soft mud banks on three occasions (once in 1986 and twice in 1988). Repeatedly, one or more dolphins rushed toward the shallows and lay completely exposed on the shore. Nine beaching episodes were video-recorded (on 8 mm HI-grade tape) and analyzed, but many additional episodes were observed.

All beach-feeding episodes began with an individual dolphin moving parallel to shore, often engaged in circling behavior (probably to herd fish). All video-recorded dolphins beached on their right

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Table 1. Records of intentional strandings by cetaceans for feeding

Location	Substrate	Prey	Reference
Bottlenose dolphins (<i>Tursiops truncatus</i>)			
May River, South Carolina	mud	mullet (<i>Mugil</i> sp.)	Rigley (1983), Rigley <i>et al.</i> (1981)
Hilton Head, South Carolina	mud	mullet (<i>Mugil</i> sp.)	Petricig (1993)
Duplin River, Georgia	mud	unid. fish	Hoese (1971)
Georgia coast	mud	small unid. fish	Caldwell & The Dolphin Project (1993)
Lydia Ann Channel, Corpus Christi, TX	mud	mullet (<i>Mugil</i> sp.)	L. May, pers. comm.
St., Bernard Parish, LA	mud	unid. fish	Mullin (1988)
Pacific coast of Baja, California Sur	mud	unid. fish	Norris & Dohl (1980)
Gulf of California coast, Baja California Sur	mud	unid. fish	Villa-R, pers. commn.
Gulf of California	mud	unid. fish	de la Parra Venegas & Galván, Pastoriza (1985)
Sado Estuary, Portugal*	sand	unid. fish	this study
Atlantic coast of Mauritania	sand/mud	mullet (<i>Mugil</i> sp.)	dos Santos & Lacerda (1987)
		mullet (<i>Mugil</i> sp.)	Busnel (1973)
Killer whale (<i>Orcinus orca</i>)			
Svinoyarvik, Faroes Islands	Flat skerries	Common eider (<i>Somateria molissima</i>)	Bloch & Lockyer (1988)
Sørvagsfjörður, Faroes Islands	Flat skerries	Common eider (<i>Somateria molissima</i>)	Bloch & Lockyer (1988)
Sørvagsfjörður, Faroes Islands	Flat skerries	Grey seals (<i>Halichoerus grypus</i>)	Bloch & Lockyer (1988)
Punta Norte, Argentina	Pebble beach	Elephant seal (<i>Mirounga leonina</i>)	Lopez & Lopez (1985), Hoelzel (1991)
Punta Norte, Argentina	Pebble beach	South American sea lion (<i>Otaria flavescens</i>)	Lopez & Lopez (1985)
Possession Island, Crozet Archipelago	sand	Elephant seal (<i>Mirounga leonina</i>)	Guinet (1991, 1992), Guinet & Jouventin (1990), Guinet & Bouvier (1995)
Possession Island, Crozet Archipelago	bank	King penguin (<i>Aptenodytes patagonicus</i>)	Guinet (1992)
Humpback dolphin (<i>Sousa plumbea</i>)			
Ilha Margaruque, Bararuto, Archipelago off Mozambique		bonefish (<i>Albusla vulpes</i>)	Peddemors & Thompson (1994)

*Fish thrown on beach and dolphins then beach to feed.

sides. Although feeding was always suspected, only twice was a dolphin seen capturing fish (unidentified species, roughly 10 cm in length) it had chased onto shore. To return to the water, the beached dolphin turned clockwise (by forcibly moving its head and fluke-kicking) on six of the nine video-recorded episodes; counter-clockwise on three. Subsequently, the same or another dolphin would execute the same manoeuvre. On one occasion, the dolphin turned clock-wise and when it was parallel to the water, did not slide off the bank, but instead circled again on the mud. It could not be determined from the video whether fish were on the bank during this episode.

Discussion

Intentional beach-feeding or attempted beach-feeding (when prey ingestion has not been observed) has been reported in few sites world-wide (Table 1). The reports involve three cetacean species: bottlenose dolphins, killer whales (*Orcinus orca*), and Indo-Pacific humpback dolphins (*Sousa plumbea*).

In all cases, the prey were marine-associated or marine-obligate species. In cases involving bottlenose dolphins the prey were fish, suspected or confirmed to be mullet (*Mugil* sp.). In all instances involving killer whales, pinnipeds and birds, were the prey. Two accounts of killer whales pursuing

atypical prey, a man and a dog, during beaching episodes also have been reported (Würsig, 1989; Norris & Prescott, 1961, respectively).

In most cases, mud or a sandy beach was the substrate. The softness of the substrate may be of special importance to bottlenose dolphins, which have been reported to move fish past oyster beds for beach-feeding (Rigley *et al.*, 1981). In all cases, the slope of the beaching area was gradual, making return to the water easier. In all descriptions, killer whales came onto land on their ventral surface; bottlenose dolphins beached on their sides. The difference in exiting the water is probably related to the body shape and size. In most instances, including the majority of our observations, bottlenose dolphins performed right-handed exits (e.g. Hoese, 1971; Rigley, 1983; Petricig, 1993).

Beach-feeding by bottlenose dolphins probably developed as an extension of pursuing schools of fish in shallow water against mud banks (Leatherwood, 1975; Hamilton & Nishimoto, 1977). It may represent a variation on the use of barriers (e.g. other dolphins) and interfaces (e.g. air-water or water-shore) to corral prey (e.g. Norris & Dohl, 1980; Würsig, 1986). Dos Santos & Lacerda (1987) describe dolphins throwing mullet on beaches and then partially stranding to retrieve and eat them. Condry *et al.* (1978) report a killer whale that apparently accidentally beached itself trying to pursue an elephant seal (*Mirounga leonina*) pup close to shore on Marion Island. Additionally, Commerson's dolphins (*Cephalorhynchus commersonii*) have apparently beached accidentally after herding pejerrey (*Austroantherina* sp.) close to shore (Angot, 1954; Goodall *et al.*, 1988).

With the exception of Indo-Pacific humpbacked dolphins, beach-feeding has been reported in geographically separated populations of the same species. The species that have been regularly observed beach-feeding share traits that may be linked to the common use of an unusual feeding strategy. Both killer whales and bottlenose dolphins occupy a wide range of habitats (Leatherwood & Reeves, 1983) including coastal areas. Coastal delphinids tend to be opportunistic feeders, demonstrating great diversity in feeding behavior which is adapted to diverse habitats (Wells *et al.*, 1980; Würsig, 1986). Bottlenose dolphins and killer whales also are highly social mammals, which probably facilitates the learning of novel behavior. Observational learning and participation has been noted for various types of feeding behavior by bottlenose dolphins, including mud bank feeding (Rigley, 1983). It has been suggested that killer whale youngsters develop feeding habits through imitation of the mother's feeding behavior (Guinet, 1991), not unlike many terrestrial mammals. There is probably cultural transmission of feeding

techniques and knowledge about locations, which become local traditions and are learned by successive generations. Diverse coastal habitats, diverse feeding behavior, and sociality probably contribute to the evolution of beach-feeding.

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References

- Angot, M. (1954) Observations sur les mammifères marins de l'archipel de Kerguelen avec une étude détaillée de l'éléphant de mer *Mirounga leonina* (L.). *Mammalia*, **18**, 1–111.
- Bloch, D. & Lockyer, C. (1988) Killer whales (*Orcinus orca*) in Faroese waters. In *North Atlantic killer whales* (eds J. Sigurjónsson and S. Leatherwood) pp. 55–64. *Rit Fiskideildar, Journal of the Marine Research Institute*, vol. 11. Reykjavik.
- Busnel, R. G. (1973) Symbiotic relationship between man and dolphins. *Trans. New York Acad. Sci.* **35**, 113–131.
- Caldwell, M. & The Dolphin Project (1993) Observations of mudding by Georgia bottlenose dolphins. Abstract, 10th Biennial Conference on the Biology of Marine Mammals, 11–15 November, Galveston, TX.
- Condry, P. R., van Aarde, R. J. & Bester, M. N. (1978) The seasonal occurrence and behaviour of killer whales *Orcinus orca*, at Marion Island. *J. Zool., London*, **184**, 449–464.
- dos Santos, M. E. & Lacerda, M. (1987) Preliminary observations of the bottlenose dolphin (*Tursiops truncatus*) in the Sado Estuary (Portugal). *Aquat. Mamm.* **13**, 65–80.
- Goodall, R. N. P., Galeazzi, A. R., Leatherwood, S., Miller, K. W., Cameron, I. S., Kastelein, R. K. & Sobral, A. P. (1988) Studies of Commerson's dolphins, *Cephalorhynchus commersonii*, off Tierra del Fuego,

- 1976–1984, with a review of information on the species in the South Atlantic. *Report of the International Whaling Commission*, Special Issue 9, 3–70.
- Guinet, C. (1991) Intentional stranding apprenticeship and social play in killer whales (*Orcinus orca*). *Can. J. Zool.* **69**, 2712–2716.
- Guinet, C. (1992) Comportement de chasse des orques (*Orcinus orca*) autour des îles Crozet. *Can. J. Zool.* **70**, 1656–1667.
- Guinet, C. & Bouvier, J. (1995) Development of intentional stranding hunting techniques in killer whale (*Orcinus orca*) calves at Crozet Archipelago. *Can. Jnl. Zool.* **73**, 27–33.
- Guinet, C. & Jouventin, P. (1990) La vie sociale des “baleines tueuses”. *La Recherche* **21**, 508–510.
- Hamilton, P. V. & Nishimoto, R. T. (1977) Dolphin predation on mullet. *Florida Scientist* **40**, 251–252.
- Hoelzel, A. R. (1991) Killer whale predation on marine mammals at Punta Norte, Argentina: food sharing, provisioning, and foraging strategy. *Behav. Ecol. Sociobiol.* **29**, 197–200.
- Hoese, H. D. (1971) Dolphin feeding out of water in a salt marsh. *J. Mammal.* **52**, 222–223.
- Leatherwood, S. (1975) Some observations of feeding behavior of bottle-nosed dolphins (*Tursiops truncatus*) in the northern Gulf of Mexico and (*Tursiops cf. T. Gilli*) off southern California, Baja California, and Nayarit, Mexico. *Mar. Fish. Rev.* **37**, 10–16.
- Leatherwood, S. & Reeves, R. R. (1983) *Sierra Club handbook of whales and dolphins*. Sierra Club: San Francisco. 302 pp.
- Lopez, J. C. & Lopez, D. (1985) Killer whales (*Orcinus orca*) of Patagonia, and their behavior of intentional stranding while hunting nearshore. *J. Mammal.* **66**, 181–183.
- McHugh, M. B. (1989) Population numbers and feeding behavior of the Atlantic bottlenose dolphin (*Tursiops truncatus*) near Aransas Pass, Texas. Master's thesis, University of Texas, Austin 96 pp.
- Mullin, K. D. (1988) Comparative seasonal abundance and ecology of bottlenose dolphins (*Tursiops truncatus*) in three habitats of the north-central Gulf of Mexico. Ph.d Dissertation, Mississippi State. 135 pp.
- Norris, K., S. & Dohl, T. P. (1980) The structure and functions of cetacean schools. In *Cetacean behavior: mechanisms and functions* (ed. L. M. Herman) pp. 211–261. John Wiley and Sons: New York.
- Norris, K. S. & Precott, J. H. (1961) Observations on Pacific cetaceans of Californian and Mexican waters. *Univ. Cal. Publ. Zool.* **63**, 291–402.
- de la Parra Venegas, R. & Galván Pastoriza, B. E. (1985) Observaciones del Tursion costero del Pacifico en el sistema Topolobampo-Ohuira, Sinaloa, (Con notas acerca de comportamiento, ritmo respiratorio e identificación individual). Proceedings, X Reunión Internacional Sobre Mamíferos Marinos. 24–27 March, La Paz Mexico, pp. 137–160.
- Peddemors, V. M. & Thompson G. (1994) Beaching behaviour during shallow water feeding by humpback dolphins *Sousa plumbea*. *Aquat. Mamm.* **20**, 65–67.
- Petricig, R. O. (1993) Diel patterns of “strand feeding” behavior by bottlenose dolphins in South Carolina salt marshes. Abstract, 10th Biennial Conference on the Biology of Marine Mammals, 11–15 November, Galveston, TX.
- Rigley, L. (1983) Dolphins feeding in a South Carolina salt marsh. *Whalewatcher*, Summer: 3–5.
- Rigley, L., Vandyke, V. G., Cram, P. & Rigley, I. (1981) Shallow water behavior of the Atlantic bottlenose dolphin (*Tursiops truncatus*). *Proc. Pennsylvania Acad. Sci.* **55**, 157–159.
- Shane, S. H. (1990) Comparison of bottlenose dolphin behavior in Texas and Florida, with a critique of methods for studying dolphin behavior. In *The bottlenose dolphin* (eds S. Leatherwood & R. R. Reeves) pp. 541–558. Academic Press: San Diego.
- Silber, G. K. (1990) Occurrence and distribution of the vaquita, *Phocoena sinus*, in the northern Gulf of California. *Fish. Bull.* **88**, 339–346.
- Wells, R. S., Irvine, A. B. & Scott, M. D. (1980) The social ecology of inshore odontocetes. In *Cetacean behavior: mechanisms and functions* (ed. L. M. Herman) pp. 263–317. John Wiley and Sons: New York.
- Würsig, B. (1986) Delphinid foraging strategies. In *Dolphin cognition and behavior: a comparative approach* (eds R. J. Schusterman, J. A. Thomas & F. G. Wood) pp. 347–359. Lawrence Erlbaum Assoc: Hillsdale, NJ.
- Würsig, B. (1989) Ein Schwertwal griff mich an. *Tier*, March 1989, p. 24.