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## Vomiting Behavior of the Spinner Dolphin (*Stenella longirostris*) and Squid Meals

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### Abstract

We describe and illustrate the vomiting behavior of the spinner dolphin (*Stenella longirostris*), an eliminative behavior poorly known for cetaceans in the wild. The vomiting may be conveniently described in six behavioral phases: opening beak, closing beak (water intake), swallowing water, pausing, opening beak about to void, and voiding offal and water. Spinners vomit after a meal rich in squids, and, therefore, we relate this eliminative behavior to the presumably irritating remains of this meal type (squid beaks). The vomits are a rich and predictable food source for plankton-eating reef fishes.

**Key Words:** *Stenella longirostris*, Delphinidae, eliminative behavior, feeding habits, pelagic squid prey, West Atlantic

### Introduction

From a behavioral viewpoint, spinner dolphins (*Stenella longirostris*, Delphinidae) are among the best-studied cetacean species. Most of the current knowledge about these marine mammals originates from studies on the Pacific populations in Hawaii (Norris & Johnson, 1994); however, little is recorded on eliminative behaviors, such as defecating and vomiting, in this species and other cetaceans as well, particularly in the wild (e.g., Sazima et al., 2003; Shinohara et al., 1999).

At Fernando de Noronha Archipelago, off northeast Brazil in the Equatorial West Atlantic, great concentrations of spinner dolphins are found at the site known as the Baía dos Golfinhos (Dolphins' Bay), regularly visited by groups of up to about 2,000 spinners (Sazima et al., 2003; Silva-Jr. et al., 1996). In the bay, the dolphins engage in several behaviors, such as resting, aerial displays, and social interactions (including parental care and copulation), as well as eliminative behaviors. This situation is particularly favorable for

underwater behavioral studies due both to the local water's clarity and the large numbers of spinners entering the bay year-round (Sazima et al., 2003; Silva-Jr. et al., 1996).

During medium- and long-term studies on the behavior of spinner dolphins (Sazima et al., 2003; Silva-Jr. et al., 1996), we observed that spinners vomit after a meal rich in squid, a common food of these cetaceans in the area of the Fernando de Noronha Archipelago (Silva-Jr. et al., 1996). Herein we describe, illustrate, and comment on the vomiting, and relate this eliminative behavior to the presumably irritating remains of this meal type (i.e., squid beaks). Additionally, we note that the spinner dolphin vomits are a rich and predictable food source for plankton-eating reef fishes (see Sazima et al., 2003).

### Materials and Methods

The observations were made in the Fernando de Noronha National Marine Park (see Maida & Ferreira, 1997, for map and description), off northeast Brazil in the southwest Atlantic. The observational sessions were conducted over 27 days from May to October 2001 and October 2002 at the Baía dos Golfinhos, a 15-25 m deep bay used by spinner dolphins for rest and social interactions (Lodi & Fiori, 1987; Silva-Jr. et al., 1996).

Vomiting behavior was observed directly, photographed, and videotaped during snorkeling. Dolphins were given 1-3 min to habituate to divers before starting observational sessions of 35-70 min (Sazima et al., 2003). Focal animal and all occurrence samplings were used in 1,601 min of direct observation, in which all occurrences of specified actions (e.g., vomiting, offal ingestion by fishes) over a given period were recorded (Altmann, 1974; Lehner, 1979). The best period for the observation of eliminative behaviors, such as vomiting and defecating, was in the morning (Sazima et al., 2003). Photographs and video records of vomiting and defecating spinner

dolphins and reef fishes feeding on offal are on file in the Museu de História Natural da Universidade Estadual de Campinas (ZUEC record collection).

### Results

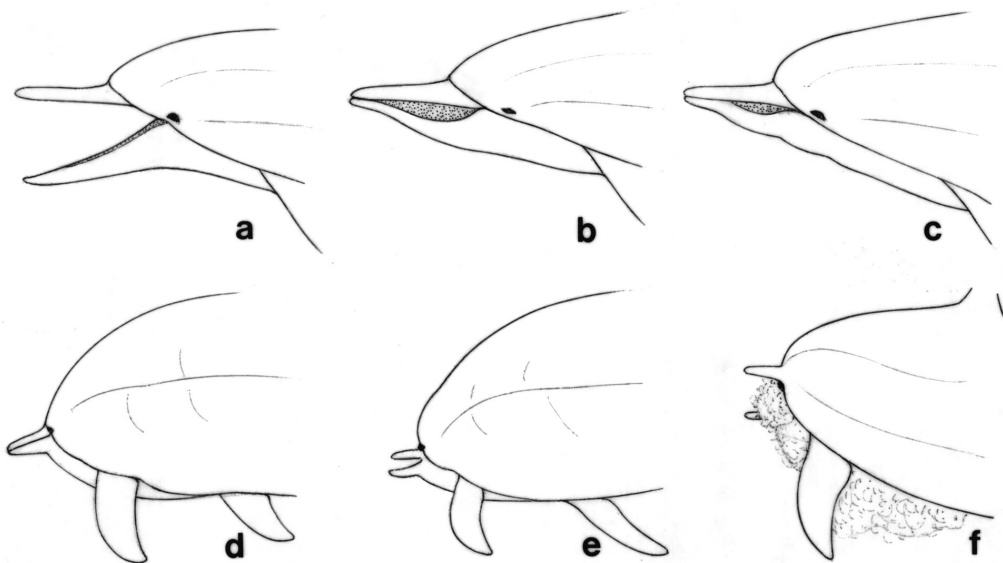
Vomiting behavior of the spinner dolphin may be conveniently described in six distinct phases (Figure 1). Additionally, a forward contortion of the body and lateral movements of the hind-body may occur. The vomiting sequence began with the dolphin opening its beak and allowing water to enter its mouth (Figure 1a). During water intake, the fore and hind-body may form exaggerated arches (see Norris & Johnson, 1994, for illustration of habitual swimming movements). The tongue made a few forward and backward undulating movements, as well as lateral ones. Sometimes the tongue hung out of the mouth, but we were unable to perceive whether these movements were voluntary or due to the water flux. After a while, the dolphin closed its beak (Figure 1b) and began to swallow the water mouthful (Figure 1c). Both of these phases bulged the regions of the throat and mouth floor. Throughout the beak closing and water swallowing phases, the pigmented tissue

bordering the upper edge of the lower mandible remained stretched (Figures 1b-c). In very few instances (3 of 57 vomiting records), a dolphin raised its beak or head above the water surface and appeared to gulp air along with the water already taken.

Following the three above-mentioned phases, there was a period of no observable changes in the dolphin's habitual swimming or other behaviors (Figure 1d), which we named herein "pausing." Afterwards, the dolphin opened its beak again (Figure 1e) and began to void offal and water (Figure 1f). The whole vomiting sequence lasted about 8 to 14 s (Table 1) and varied according to the number of water intakes (1-4) and the intervals between intakes prior to actual voiding.

The vomits included squid pieces and beaks, as well as particulate or amorphous material, and water. Every vomitus contained at least two to three squid beaks.

Vomiting was not restricted to a single dolphin, and up to nine vomiting dolphins were recorded per session. We recorded no repeat vomiters (i.e., the same individual vomiting more than once). Additionally, no juvenile up to 1 m in total length was ever recorded vomiting. Vomits per



**Figure 1.** The six phases of vomiting behavior of the spinner dolphin: (a) opening beak, (b) closing beak, (c) swallowing water, (d) pausing, (e) opening beak about to void, and (f) voiding offal and water; note pigmented tissue on upper edge of lower mandible stretching throughout closing beak and swallowing water phases. Based on selected frames of a videotaped sequence made at close quarters (ZUEC tape #16).

observational session ranged from 1 to 9 (mean =  $3.8 \pm 2.1$  SD,  $n = 57$ ). We were unable to assess the frequency of this behavior (number of vomits per number of dolphins). Squids' beaks identified from vomits belonged mostly to species of Ommastrephidae and Cranchiidae.

**Table 1.** Duration of the six phases of vomiting behavior of the spinner dolphin, based on a videotaped sequence made at close quarters

Behavioral phase	Duration (s)
Opening beak (water intake)	0.667
Closing beak	1.033
Swallowing water	0.767
Pausing	4.500
Opening beak (to void)	0.201
Voiding offal and water	1.033

The vomits and feces of the spinner dolphin were sought as food by plankton-eating reef fish species, particularly the black durgon (*Melichthys niger*, Balistidae). Dolphins that opened their beaks were promptly and insistently sought after and followed by the durgons, even if the spinners soon withdrew out of the reach of the fish due to the swimming speed difference between the two species.

### Discussion

Spinner dolphins vomited only after a meal rich in squid, a common food of these cetaceans at the study site (Silva-Jr. et al., 1996). Both Ommastrephidae and Cranchiidae are pelagic squid families (e.g., Voss et al., 1992; Wormuth, 1998), an expected prey type for this oceanic-foraging dolphin (Würsig et al., 1994). Because all vomits contained squid beaks, we surmise that the beaks caused discomfort and/or irritation (most probably of mechanical origin) to the dolphins' digestive tracts and that the water intake and vomiting are behaviors by which it gets rid of the nuisance. Vomiting in humans is a result of peripheral stimuli from visceral organs due to exogenous and endogenous substances that accumulate during irritation or inflammation of the stomach (Andrews & Hawthorn, 1988). In dolphins and other mammals, the mechanisms inducing vomiting may be similar. What we call pausing may be a period during which the water probably caused physiological and/or mechanical changes within the stomach and facilitated voiding by increasing the volume of the stomach contents. The swallowed water possibly created visceral afferent impulses which activated the so-called vomit center in the

brain and induced the respiratory muscles to contract and expel the stomach contents (Argenzio, 1993).

No vomiting behavior was recorded for the Hawaiian populations of spinner dolphins, possibly due to their feeding primarily on fishes (Würsig et al., 1994). Thus, sporadic ingestion of irritating objects (squid beaks) would result in their vomiting only occasionally.

The spinner dolphins' vomits and feces are fed upon by several reef fish species (Sazima et al., 2003). Therefore, besides getting rid of a nuisance to its digestive tract, the vomiting spinners provide a predictable and rich particulate food source for plankton-eating reef fishes at Fernando de Noronha Archipelago. The black durgons apparently learned that a dolphin is about to void based on the first observable phase of the vomiting sequence (beak opening), since dolphins that opened their beaks were promptly sought after and followed by the durgons, even if the cetaceans voided later and out of the reach of the fish, or did not void at all.

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