Fish feed on faeces and vomits of New Zealand fur seals: marine mammals bring nutrients from open to inshore waters

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New Zealand fur seals (Arctocephalus forsteri) forage mostly in open waters at night and spend parts of the day in coastal sheltered sites, where they may play, rest and eliminate wastes. We recorded the purple wrasse (Notolabrus fucicola) feeding on faeces and vomits of these pinnipeds at Fortescue Bay in the Tasman Peninsula, Australia. This behaviour allows the wrasse to get nutrients from open waters that otherwise would not be available. Thus, it is suggested that the fur seals have the role of transferring nutrients from open waters to inshore reefs and provide them as particulate food to fish. This functional role is apparently recorded for only one species of marine mammal so far, the spinner dolphin (Stenella longirostris), in tropical oceanic waters.

Keywords: Otariidae, wastes, Labridae, coprophagy, nutrient transfer, Australia

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INTRODUCTION

Fish faeces, especially of carnivorous species, are a rich and habitual food source for several fish species in the Pacific (Bailey & Robertson, 1982; Robertson, 1982). Marine mammals are mostly carnivorous (Reeves et al., 2002) and their faeces also are a rich source of nutrients to reef fish (Sazima et al., 2003, 2006) and possibly other organisms as well. As most dolphins and pinnipeds feed on open waters and rest and eliminate wastes (faeces and vomits) in inshore waters (Reeves et al., 2002), they may play a significant role in the transference of nutrients from open to coastal waters, by providing these as particulate food to reef fish. However, fish use of wastes released by marine mammals is recorded only for the spinner dolphin (Stenella longirostris) in the tropical Western Atlantic (Lodi, 1998; Sazima et al., 2003, 2006).

Here we record the purple or banded wrasse (Notolabrus fucicola) feeding on faeces and vomits of New Zealand fur seals (Arctocephalus forsteri) in the Tasman Peninsula, Australia. Based on this observation, we present further support to the idea that marine mammals transfer food from open waters to reef fish, and that this functional role is present both in tropical and temperate waters.

MATERIALS AND METHODS

Field observations were made at the Fortescue Bay (43°08'14"S 148°06'18"W) in the Tasman Peninsula, Australia, during a total of 2 hours 30 minutes while SCUBA diving on 23 and 25 March 2008. The bottom at the study site is composed of rocks and cobbles with kelp coverage. Depth ranged 8–15 m; underwater visibility was 15 m and water temperature 15°C. Sizes of seals and wrasses are estimates of total length (TL) in cm; and sizes of particles in faeces and vomit are actual measurements or estimates in mm. The behaviour of seals and fish was video-recorded and photographed. The four best photographs are filed at the Museu de Zoologia, Universidade Estadual de Campinas (ZUEC).

RESULTS

Two instances of fish feeding on faeces of seals and one instance of feeding on vomit were recorded. In one record of fish feeding on faeces, a seal about 120 cm TL rose in the water column, spread its hind fins and about three seconds later started to defaecate (Figure 1). While doing so it twisted its body sideways, and swam using mostly its fore fins. About 2–3 seconds after a cloud of liquid faeces and suspended particles (the largest ones about 3–10 mm) began to sink slowly, a group of about 15 wrasses (20–40 cm TL) immediately rose from the rocky bottom and started to feed on the particles (Figure 2). The fish moved toward the particles when these were clearly visible and about 2 m below the water surface. After about 20 seconds, only a fine sediment cloud remained and the fish retreated to the bottom. The other record of fish feeding on faeces was very similar to the one described above, but the fur seal was about 140 cm TL. In the only record of fish feeding on a vomit, a seal regurgitated while gliding in the water column and a group of 27 wrasses (20–40 cm TL) immediately rose from the bottom and started to feed on the
largest particles (about 3–8 mm) from the vomit (Figure 3). This particular seal was noticed about 2 seconds after it vomited, and thus we were unable to observe whether it displayed any behaviour which could be indicative that vomiting would follow, such as swallowing water—a behaviour that precedes vomiting in spinner dolphins, *Stenella longirostris* (Silva Jr et al., 2004). Moreover, we were not able to observe whether the fish approached the seal before it started to vomit, as recorded for *S. longirostris* (Silva Jr et al., 2004).

**DISCUSSION**

Several species of fur seals (Otariidae) feed on fish and squids in the water column over deep waters, and forage mostly at twilight and night (Gentry, 2009). The New Zealand fur seal is no exception judging from its diet and diving behaviour (e.g. Carey, 1992; Reeves et al., 2002; Page et al., 2005; Ling, 2009). As New Zealand fur seals and spinner dolphins may gather in great numbers, sometimes thousands of individuals (Silva Jr et al., 2005; Ling, 2009) at traditional coastal sites where they may eliminate wastes when back from feeding excursions (Reeves et al., 2002), their faeces and vomits may provide a predictable and abundant source of nutrients to the fish that dwell at these sites (Sazima et al., 2002, 2006; Silva Jr et al., 2007). Reef fish are usually strongly associated to the reef structure, and rarely forage in open waters (Choat & Bellwood, 1991; Kuiter 2000). Additionally, most reef fish recorded to feed on wastes of marine mammals are small to medium-sized (about 8–40 cm TL) planktivores, omnivores or benthic carnivores, that would not be able to feed on the same sources of nutrients used by fur seals and dolphins (fish and squids) even if those were available on coastal waters. As a consequence, some reef fish benefit directly from the excretory behaviour of marine mammals as they have access to nutrients that otherwise would be unavailable to them (Silva Jr et al., 2005; Sazima et al., 2006). Similarly to the spinner dolphin, New Zealand fur seals are able to gather nutrients in open waters, process, and provide them as particulate food to reef fish in inshore waters (Silva Jr et al., 2005; 2007). Spinner dolphins and New Zealand fur seals thus seem to play similar ecological roles, but in reefs in different latitudes (tropical and temperate).

The portions of wastes that are not promptly used by reef fish that swim in mid-water sink to the reef bottom and then become available to benthic fish and invertebrates. Thus, part of the nutrients brought in by fur seals from open waters may be used by several organisms that dwell in coastal reefs. Presently, a functional role similar to that here attributed to fur seals is played by spinner dolphins (Sazima et al., 2003) and a few planktivorous reef fish species that feed away from the reef at night and return to the reef during the day, where they defaecate (Marnane & Bellwood, 2002).

The purple wrasse is a benthic carnivore that feeds mainly on crustaceans, molluscs and polychaetes (Denny & Schiel, 2001). Thus, it may come as a surprise that this wrasse picks particles in the water column and feeds on fur seals’ wastes. The fish species recorded to feed on faeces and vomits of dolphins, for example, are planktivores or carnivores that forage both on the bottom and in the water column. Therefore, foraging on drifting particles in dolphins’ wastes is a relatively short and simple behavioural switch for these fish (Sazima et al., 2003). The case of the purple wrasse feeding in the water column may be considered as a more complex behavioural switch. However, several benthic species have the ability to change their usual feeding behaviour and pick particles in the water column when an ephemeral and rich feeding resource is available (Sazima & Sazima, 2001; Krajewski & Bonaldo, 2006). Additionally, wrasses are renowned for their foraging plasticity (e.g. Sazima et al.,...


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