



Intestinal eversion in a pelagic shark evokes chase and bite attempts by large-bodied carangid fish

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Abstract

Expelling indigestible objectives through the cloaca is an important cleansing behaviour for several species of higher vertebrates. Although intestinal eversions are short in duration and rarely observed in free-ranging predators such as sharks, exposed intestines are vulnerable to attacks by smaller predators exploiting ejected digested material. Here we describe the first published record of an intestinal eversion in an oceanic whitetip shark (*Carcharhinus longimanus*) followed by chase and bite attempts by rainbow runners (*Elagatis bipinnulata*) in the northern Red Sea, Egypt. This observation provides additional evidence that intestinal eversion occurs in free-ranging sharks and can last for an extended time (> 2 min), likely increasing the potential for attacks by smaller predators.

Keywords Behaviour · *Carcharhinus longimanus* · *Elagatis bipinnulata* · Field observation · Intestinal biting

Introduction

Predators will often consume prey parts which are undigestible or toxic and must be voided (Sims et al. 2000). While most vertebrates use a vomiting reflex to expel ingested particles, amphibians (frogs and toads) and elasmobranchs (sharks and rays) are capable of everting parts of their stomach, or the posterior part of their intestines, as a natural flushing mechanism (Crow et al. 1990, 1991; Sims et al. 2000; Christie 2012). Intestinal rinsing techniques are facilitated by a long pyloric stomach, scroll intestine and by the lack of mesenteries enabling flexibility of these internal

organs (Crow et al. 1990). Intestinal eversions may be widespread and important mechanisms for elasmobranchs, however, these behaviours are scarcely documented in the wild, particularly in large-bodied elasmobranchs in open waters, where observations are logistically challenging (Clark et al. 2008; Wiersma et al. 2015).

Expelled intestinal tissues are potentially vulnerable to attacks by smaller predators, which may not only consume the digesta, but also go after the exposed intestines. In captivity, intestinal bite attacks have resulted in at least nine reported mortalities in blacktip reef sharks (*Carcharhinus melanopterus*, Crow et al. 1991), as well as one mortality in a young-of-the-year sharpnose shark (*Rhizoprionodon terraenovae*, Christie 2012). Such attacks on sharks in captivity are likely related to small tanks with fish being confined in high densities (Crow et al. 1990, 1991). Intestinal eversion followed by chase and bite attempts by predators, has not been observed, to our knowledge, in any free-living elasmobranch in their natural habitat. It is therefore unclear if such strikes are limited to only captive environments.

Pelagic sharks and large-bodied carangids, such as jacks, are opportunistic predators (Cortes 1999; Bonfil et al. 2008; Madigan et al. 2015), but knowledge on potential interactions between these pelagic species are limited. Here, we report a unique field observation of an intestinal eversion by a free-swimming oceanic whitetip shark (*Carcharhinus longimanus*) with subsequent chase and intestinal bite

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attempts by the rainbow runner (*Elagatis bipinnulata*), a large-bodied carangid fish, in the northern Red Sea.

Methods and results

On January 9, 2018 at 1045 h, a female oceanic whitetip shark was observed at the shallow dive site ‘Little Brother’ (26°18′25″ N 34°51′20″ E) in the northern Red Sea, Egypt. The shark circled a group of divers mid water (~5 m below the charter liveboards) and its behaviour was captured on camera (Panasonic GH5 with Nauticam WWL-1 housing). For 28 min, the shark swam calmly accompanied by several pilot fish (*Naucrates ductor*) and its swimming behaviour did not differ from conspecifics in this location. When the shark, no longer accompanied by pilot fish, was sighted by divers at 1113 h, its intestines were protruded. A rainbow runner started chasing the shark, trying to eat the expelled material and bite the sharks’ intestines (Fig. 1a, b; ESM S1). The shark immediately altered its swimming direction and tailbeat frequency, and rapidly escaped the rainbow runner by swimming towards the surface (Fig. 1c, d). At 1115 h, the same individual shark with its intestines still protruding, was re-sighted by divers. This time the shark was chased by two rainbow runners (Fig. 2a; ESM S2). Again, the shark successfully escaped its pursuers by accelerating (Fig. 2b), and with a quick descent into deeper water (Fig. 2c). The intestinal eversion time was estimated to last for 2 min, but since the shark was not resighted after the second chase event, this cleaning process could potentially have lasted longer.

Discussion

Rinsing of the intestines of indigestible objects, mucous and potentially parasites via intestinal eversion has been described for several elasmobranchs in captivity (e.g., Crow et al. 1990, Henningsen et al. 2005, Christie 2012).

In the wild there are only two observations of intestinal eversions in elasmobranchs (Clark et al. 2008; Wiersma et al. 2015). One of the reasons for the rarity of observing such cleansing behaviours may be their duration. While the intestinal eversion and retraction only lasted a few seconds in broadnose sevengill shark (*Notorynchus cepedianus*; Wiersma et al. 2015), the everted intestine of a manta ray (*Mobula birostris*) was visible five times over a period of approximately 1.5 min (Clark et al. 2008). The protrusion of the intestines in our observation was visible over a period of approximately 2 min, likely increasing the potential for attacks by predatory fish.

In captivity, sharks with exposed intestines induced attacks by conspecifics including other elasmobranchs and teleosts in the tank. Such attacks can result in severe injuries and even mortalities (Crow et al. 1991; Henningsen et al. 2005; Christie 2012). While in captivity, the fish density and restricted tank space may enhance the frequency and intensity of these behaviours and subsequent attacks. In the field, only one example of bite attempts on protruded body tissues has been documented, which is also notable, although it was a gastric lavage. In this observation, a Caribbean reef shark (*Carcharhinus perezi*) rapidly everted its stomach (~0.3 s), whereupon a horse-eye jack (*Caranx latus*) quickly moved to the sharks’ protruded stomach trying to catch the released material (Brunschweiler et al. 2005). Despite the differences in protruded tissues, both intestinal and gastric eversions can evoke chase and bite events by wild and large-bodied carangid jacks, a group fish that routinely schools around sharks.

Our opportunistic observation serves as the first published record of intestinal eversion with subsequent bite attempts in a wild large-bodied shark, and further contributes to the overall knowledge of these scarcely documented behaviours. Our observation of intestinal eversion followed by subsequent chase and intestinal bite attempts suggests that this process occurs in free-ranging as well as captive sharks.

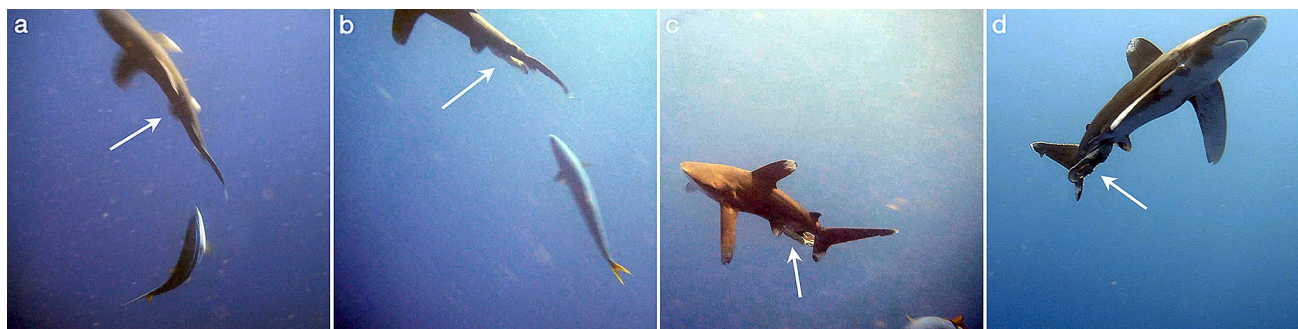


Fig. 1 Rainbow runner (*Elagatis bipinnulata*) chasing an oceanic whitetip shark (*Carcharhinus longimanus*) in an upward swimming event (a, b). The shark escapes the rainbow runner by swimming

towards the surface (c, d). Note the sharks’ intestines are protruded (white arrow). (Pictures © Sabrina Inderbitzi)

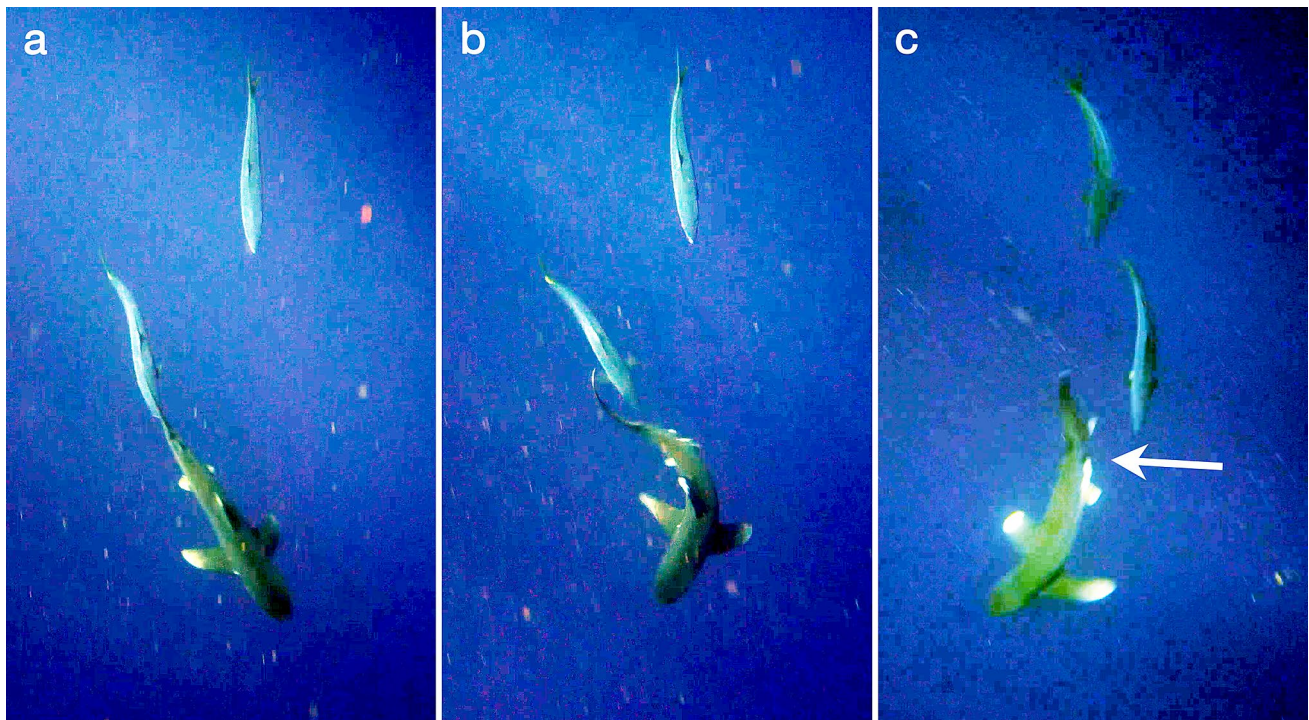


Fig. 2 Two rainbow runners chasing an oceanic whitetip shark (a). The shark escapes through rapid side (b), and descending movements (c). Note the sharks' intestines are protuded (white arrow). (Pictures © Sabrina Inderbitzi)

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