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# Hazards in hanging gardens: A report on failures of recognition by green turtles and their conservation implications

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ABSTRACT

Marine species are experiencing unprecedented global impacts due to anthropogenic debris. Many recent studies have pointed out the hazards associated with marine litter ingestion, especially plastic debris – the most abundant and ubiquitous items in coastal and oceanic environments worldwide. In this study we provide the first in situ evidence of consumption of non-discarded synthetic rope fragments by green turtles. We explored the environmental risks to this endangered species associated with the grazing and consumption of anthropogenic debris in zones of human activity. Efforts to combat debris ingestion and reduce anthropogenic debris discharged into the world's oceans should be a priority for decision-makers and will need to involve multiple-approaches and the adoption of more environmentally friendly products and practices by the international community.



## 1. Introduction

The Green turtle (*Chelonia mydas*) is a globally endangered species registered in the IUCN Red List and also in the CITES treaty (Appendix I). This cosmopolitan chelonian has a complex life cycle and has exhibited gradual, or often dramatic, ontogenetic shifts in its diet and habitat use behavior. This could bring influences on food webs dynamics and structures and ecosystem services (Arthur et al., 2008; Morais et al., 2014; Jardim et al., 2015).

Although recent species conservation efforts have had positive effects on the status and number of sea turtle populations, threats to these chelonians are still very real, and include climate change, sea level alterations, hunting, bycatching, and marine pollution (Hawkes et al., 2009; Hamann et al., 2010). Marine litter, also called marine debris, is composed of materials that have been deliberately or accidentally discarded in coastal and marine environments (UNEP, 2009).

There are marine litter ingestion records for all seven sea turtle species (NOAA, 2014). Understanding how and why sea turtles are ingesting anthropogenic debris are key elements to understand the food web dynamics, species-habitat relationships, and marine animal health. Owing to the difficulties involved in observing marine species while feeding, little is currently known about how and why turtles and other marine animals ingest anthropogenic debris, giving rise to an array of hypotheses such as their consumption as a function of debris frequency in the environment (reflecting the opportunistic feeding habits of those animals), the association of natural food items with debris, or the resemblance of debris to natural prey items (Hamann et al., 2010; Schuyler et al., 2014a; Nelms et al., 2015).

The hypothesis of "plastic jellyfish" ingestion by sea turtles is well-supported as those flexible and translucent items resemble typical prey items such as jellyfish (Mrosovsky, 1981; Schuyler et al., 2012, 2014a). It remains unclear, however, why sea turtles ingest other types of anthropogenic debris, although different sea turtle species have different lifestyles and feeding preferences that would be expected to influence the probability, types, and amounts of debris they ingest (Schuyler et al., 2014a,b; Hayashi and Nishizawa, 2015).

We report here that feeding at algae-encrusted ropes may lead green turtles to ingest synthetic fragments from non-discarded objects. We also discuss the necessity of influencing decision-making processes related to endangered species conservation in light of the increasing hazards associated with the physical and chemical impacts of marine pollution.

## 2. Material and Methods

We were able to observe the feeding behavior of green turtles at algae-encrusted ropes during opportunistic observations at two sites used for the mooring and maintenance of boats near the city of Salvador,

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Bahia State, in northeastern Brazil (12°58′S, 38°30′W and 12°58′S, 38°31′W). We used the "ad libitum" technique (Altmann, 1974), which is adequate for recording opportunistic events, at observation distances of 3 to 5 m on a boat mooring platform.

We collected information covering the following parameters: species identifications, behavior, total feeding time (min), numbers of individuals, and the estimated curved carapace length (CCL).

At the conclusion of the feeding events, we inspected the ropes during free dives and also raised the submerged portions to assess any damage and wear caused by turtle feeding. We used the methodology described by Carson (2013) for plastic items bitten by fish on the evaluations of the ropes after the feeding events.

Additionally, algal samples were collected for taxonomic identification, and digital photographs were taken to document the visual observations. The algal species were processed and identified in the laboratory using specialized bibliographies (Joly et al., 1969; Nunes, 1998).

## 3. Results

On April 21, 2011, between 12:31 and 12:45h, we observed a juvenile individual of *Chelonia mydas* (approximately 40 cm CCL) swimming near moored boats (Fig. 1a).

Feeding activity initiated when the turtle hovered approximately 0.5-1.0 m below the water surface to graze at an algae-encrusted rope.

The turtle made repeated and ample bites on the rope, grazing on the target algae using its serrated beak.

After feeding, the green turtle remained relatively motionless, apparently resting, and then raised its head before quickly submerging and then moving out of sight.

A second event was registered on May 14, 2013, between 11:13 and 11:30h. On this occasion, a young turtle (approximately 50 cm CCL) spent part of its time swimming close to the surface (Fig. 1b) but also descending in the water column to depths where it was no longer visible from the surface, before quickly returning to the surface to breathe.

The turtle was observed approaching a nylon mooring rope while near the surface and then grazing at that object (Fig. 1c).

While grazing at the underside of the rope, the young turtle's behavior was similar to the previous feeding event; the turtle sometimes raised its head (Fig. 1d) and paused to rest, and then resumed its feeding activities. This individual would frequently take strong bites of algae, shaking the rope and leaving visible marks on it.

During this feeding event, a boat moored on a nearby platform started its engine, apparently startling the animal, and it swam away.

Two algae species were identified in the samples: *Cladophora* sp. (Cladophoraceae) and *Bryopsis pennata* (Bryopsidaceae).

The observed feeding by green turtles at algae-encrusted ropes followed their usual behavior of using their serrated beak to crop and/or break off clumps of algae while grazing.

We observed that the algae were taken with forceful and ample bites that exposed nylon rope filaments.

Most bites taken by the juvenile green turtles left grazing marks that could be clearly seen from the surface as well as underwater (while diving).

The ropes did not appear to be very old, but demonstrated considerable damage from the feeding events, with the removal of strand material.

These observations indicate that green turtles can accidentally ingest synthetic fragments when grazing on algae-encrusted mooring ropes.

## 4. Discussion

The present study provides the first *in situ* evidence of the consumption of synthetic rope fragments by green sea turtles while grazing at algae-encrusted mooring ropes.

These opportunistic observations represent an important step in exploring diverse aspects of the environmental impacts of anthropogenic debris on endangered species and the potential risks associated with algae grazing in zones of human activity. They also provide an opportunity to encourage companies to develop bio-friendly products and adopt proactive environmental stewardship practices in marine activities.

Several papers have reported the forage in shallow water bays by green turtles near zones of human occupation, increasing their exposure to human activities (Seminoff et al., 2002a; Hazel et al., 2009; Carman et al., 2014). Among the varied anthropogenic impacts on shallow water environments are the generation and inadequate disposal of wastes resulting in large accumulations of marine litter (Barnes et al., 2009).

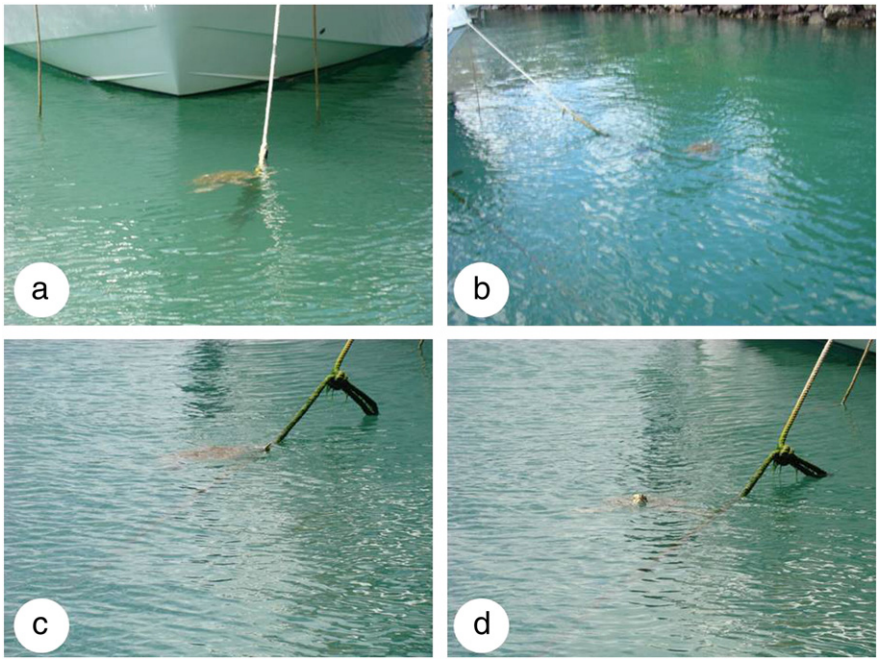


**Fig. 1.** a-d. Green turtle feeding behavior at algae-encrusted ropes.