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A deadly meal: fatal ingestion of porcupinefish (*Diodon holocanthus* Linnaeus, 1758) by loggerhead turtles (*Caretta caretta* (Linnaeus, 1758)) in the Atlantic Ocean

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ABSTRACT

Context. Natural causes of sea turtle mortality can significantly affect populations. Defensive mechanisms of prey species, such as porcupinefish (Diodontidae family), may pose risks to predators such as loggerhead turtles (*Caretta caretta* (Linnaeus, 1758)). **Aims.** This study aimed to investigate the stranding records of loggerhead turtles to identify porcupinefish ingestion as a cause of mortality. **Methods.** Between 2015 and 2025, a total of 30 stranded loggerhead turtles were recorded along the coasts of Rio Grande do Norte and Ceará States, in the north-eastern of Brazil. Morphological data and life-stage classification were recorded, and necropsies and macroscopical analysis were conducted to confirm the presence of porcupinefish and evidence of asphyxiation and the presence in other parts of gastrointestinal portions of specimens. **Key results.** Necropsies and macroscopical analysis showed that buccal and oesophageal obstruction in all loggerhead turtles due the morphological adaptations of the fish's defence. The fish were also found in other organs of the gastrointestinal system. This represents the highest recorded mortality from this cause in the north-eastern Atlantic Ocean region. **Conclusions.** Porcupinefish ingestion is a recurring and under-reported cause of loggerhead turtle mortality, principally in the population of the the Atlantic Ocean. Opportunistic feeding may increase risks, particularly for juveniles. **Implications.** Further research is needed to better understand these predator–prey interactions, other ecological drivers and their impact on sea turtle populations. Continued monitoring is crucial for effective conservation strategies.

Keywords: Diodontidae, feeding behaviour, marine conservation, natural mortality, north-eastern Brazil, predation risk, sea turtles, strandings.

Introduction

The feeding biology of sea turtles encompasses a broad spectrum of foraging strategies, reflecting a greater trophic diversity than previously documented (Jones and Seminoff 2013). Dietary composition varies significantly among species, with some exhibiting specialised feeding habits, whereas others demonstrate more opportunistic or generalist behaviours. For instance, green turtles, *Chelonia mydas* (Linnaeus, 1758), undergo an ontogenetic dietary shift, transitioning from omnivorous diets during early life stages to strict herbivory in adulthood (Bjorndal 1997), whereas adult olive ridley turtles, *Lepidochelys olivacea* (Eschscholtz, 1829), exhibit omnivorous habits during juvenile stages, but shift to a predominantly carnivorous diet in adulthood, with benthic animals, such as fish and crustaceans comprising the majority of their prey (Jones and Seminoff 2013; Colman *et al*. 2014; Petitet and Bugoni 2017). By contrast, a strict carnivorous diet is observed in leatherback turtles, *Dermochelys coriacea* (Vandelli, 1761), and loggerhead turtles, *Caretta caretta* (Linnaeus, 1758), whereas hawksbill turtles, *Eretmochelys imbricata* (Linnaeus, 1758), are primarily omnivorous in adulthood, feeding on sponges, other invertebrates and algae (James and Herman 2001; Bolten 2003; Salmon *et al*. 2004; Méndez-Salgado *et al*. 2020). Specifically, the dietary composition of *C. caretta* varies across their ontogenetic stages and includes a diverse range of pelagic and epipelagic prey, such as Hydrozoa, Gastropoda, Crustacea, Polychaeta, Actinopterygii and their eggs (Bolten 2003; Parker *et al.* 2005; Casale *et al.* 2008).

Four of the five sea turtles are globally threatened, as classified by the International Union for Conservation of Nature (Casale and Tucker 2017), primarily owing to anthropogenic activities. Major threats include bycatch in fisheries, ingestion of marine debris, boat collisions, light pollution, and vehicle traffic in nesting sites. These human-induced stressors contribute to severe injuries, increased mortality, and reduced hatchling survival, ultimately affecting population dynamics (Wallace *et al.* 2013; Santos *et al.* 2015; Schuyler *et al.* 2016; Jerdy *et al.* 2017; Farias *et al.* 2019; Machovsky-Capuska *et al.* 2020; Bomfim *et al.* 2021, 2022).

In addition to anthropogenic threats, *C. caretta* also face natural mortality factors. For instance, Oliveira *et al.* (2020) documented the fatal ingestion of a gold-spotted eel (*Myrichthys ocellatus* (Lesueur, 1825)), suggesting potential risks associated with specific prey items. Similarly, Inurria *et al.* (2019) reported a series of mortalities associated with the ingestion of sea urchins. Boylan *et al.* (2017) described cases of intestinal obstruction and perforation of the digestive tract in loggerhead turtles, whose diet was primarily composed of pen shells (*Atrina* spp.) and sea urchins. These cases highlight the role of natural dietary hazards as potential contributors to mortality in *C. caretta* populations, representing an underexplored aspect of their ecology.

Among the marine organisms that may pose a challenge to the survival of sea turtles are the porcupinefish (Diodontidae), a family of fishes that possess a unique set of morphological, chemical and behavioural defensive adaptations. The porcupinefish is characterised by a body covered with rigid spines and their ability to inflate themselves as a predator-avoidance mechanism (Leis 1978; Brainerd 1994; Wainwright *et al.* 1995; Matsuura 2015). The family Diodontidae comprises 15 genera and 19 species distributed globally across tropical and temperate marine environments (Leis 2006; Fricke *et al.* 2026). Although they are commonly found in pelagic zones, many species also inhabit coastal reefs, sandy and muddy substrates, and seagrass meadows (Leis 1978, 2006; Matsuura 2015).

Several studies have documented the ingestion of porcupinefish by different marine taxa, including reef fishes (Randall 1967; Shepherd *et al.* 2019), large pelagic fishes (Manooch *et al.* 1984; Oxenford and Hunte 1999; Potier *et al.* 2007), seabirds (Battley *et al.* 2008) and loggerhead turtles (Hughes 1974; Limpus *et al.* 2008). The aforementioned defensive adaptations of the porcupinefish have been observed to pose a lethal risk to other species, because they may result in gastrointestinal obstruction, perforation or other fatal complications for these predators.

Between 2015 and 2025, numerous strandings of *C. caretta* were documented along the coastlines of Rio Grande do Norte and Ceará States, with a common pathological factor, namely, fatal ingestion of porcupinefish. Although occasional records of this interaction have been reported elsewhere by Limpus *et al.* (2008) for the Pacific Ocean, its frequency and apparent lethality in the Atlantic Ocean are scarcely documented in the scientific literature. In this context, the aim of this study is to report and characterise 30 cases of loggerhead turtle strandings associated with porcupinefish ingestion along the north-eastern portion of Atlantic Ocean.

Materials and methods

Stranding data collection and analysis

Stranding data of *C. caretta* were obtained through a systematic monitoring program conducted between 2015 and 2025 along the coastline of Rio Grande do Norte and Ceará States, in the north-eastern region of Brazil (Fig. 1). This monitoring was conducted through weekly surveys performed by specialists from the Projeto Cetáceos da Costa Branca at the Universidade do Estado do Rio Grande do Norte (PCCB-UERN) and the Centro de Estudos e Monitoramento Ambiental (CEMAM). Additionally, opportunistic records were incorporated into the dataset on the basis of reports from local collaborators, including artisanal fishers, environmental agents, and coastal community members.

All procedures related to rescue, handling and sample collection were conducted in compliance with ethical and legal guidelines established by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Ministério do Meio Ambiente (MMA), through the Sistema de Autorização e Informação em Biodiversidade (SISBIO) (licence numbers: PCCB-UERN/13694-6 and CEMAM/75008-6).

Maturation, sex determination and carcass analysis

Each stranded *C. caretta* specimen underwent morphometric analysis, which included measurement of curved carapace length (CCL) and curved carapace width (CCW), defined by Bolten (1999). This measurement was used to classify individuals into juvenile or adult age groups, with specimens exhibiting a CCL of ≥86.5 cm being classified as adult, on the basis of the estimated mean size of adult female loggerheads nesting in Brazil (Lima *et al.* 2012), whereas specimens below this threshold were classified as juveniles.

Sex determination was conducted whenever external morphological characteristics permitted differentiation. Males were identified on the basis of the presence of secondary sexual traits, including elongated prehensile tails, curvature in the forelimbs, and enlarged claws on the front flippers, as described by Wyneken (2001) and Godley *et al.* (2002).

Given the high ambient temperatures in north-eastern Brazil, which can lead to rapid tissue degradation, histological analyses of gonads were not performed. As mentioned above, these elevated temperatures also hinder a more detailed investigation of external signs of anthropic interaction. To

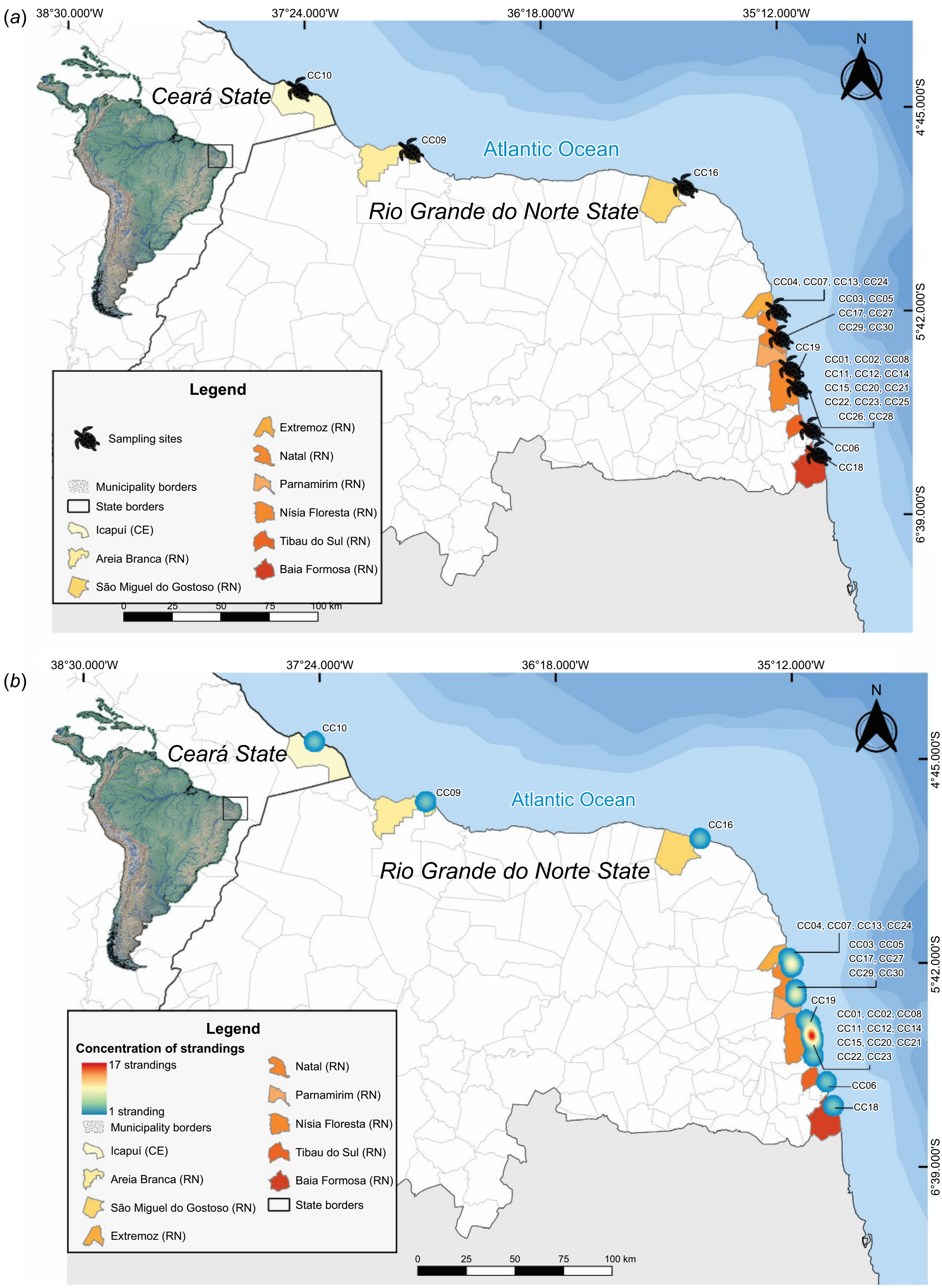

Fig. 1. (*a*) Map and (*b*) heatmap of loggerhead turtle (*Caretta caretta*) stranding records in north-eastern Brazil, specifically in Rio Grande do Norte and Ceará States.

assess the condition of stranded carcasses, decomposition stages were classified according to the Flint *et al.* (2009) decomposition scale, with moderately decomposed individuals (D2 and D3) being selected for necropsy and internal examination. Necropsies were performed to identify potential causes of death, with particular attention to evidence of ingestion of porcupinefish (Diodontidae) as a contributing factor.

Porcupinefish identification

Porcupinefish specimens were recovered from the different portions of gastrointestinal tracts of stranded *C. caretta* individuals. A few specimens of porcupinefish were collected and transferred to the Laboratório de Ictiologia Sistemática e Evolutiva (LISE) at the Universidade Federal do Rio Grande do Norte (UFRN) for taxonomic identification, using specialised ichthyological literature (Leis 1978, 2002, 2006; Figueiredo and Menezes 2000; Oliveira *et al.* 2015). Specimens were deposited in the ichthyological collection of UFRN (Lustosa Costa *et al.* 2019), under voucher numbers UFRN6108 and UFRN6109.

Results

Over a 10-year period (2015–25), a total of 30 *C. caretta* strandings were recorded along the coastline of the Rio Grande do Norte and Ceará States, resulting from a fatal interaction with porcupinefish (Table 1, Fig. 1*a*). The most prevalent strandings were recorded in the Rio Grande do Norte State, with 29 cases along eight municipalities, and one stranding in the Ceará State. The municipality of Nísia Floresta had the highest number of records ($n = 14$, 46.7%), followed by Natal ($n = 7$, 23.3%) and Extremoz ($n = 4$, 13.3%) (Fig. 1*a*, *b*). By contrast, a single stranding ($n = 1$, 3.3% each) was recorded in the municipalities of Tíbau do Sul, Parnamirim, São Miguel do Gostoso, Baía Formosa and Areia Branca. The only stranding outside Rio Grande do Norte State was recorded in Icapuí municipality, in Ceará State ($n = 1$, 3.3%) (Fig. 1*a*, *b*).

The specimens exhibited a median CCL of 84.93 cm (range: 53–103 cm) and a median CCW of 80.5 cm (range: 52–92 cm) (Fig. 2*a*). In total, 15 specimens were classified as adult (50.0%), 14 as juvenile (46.67%), and 1 individual's (3.3%) age could not be determined (Fig. 2*b*, Table 1). Regarding sex, there was a predominance of females, with 19 specimens (63.3%). A single male was identified (3.3%), and for 10 (33.3%) individuals, sex determination was not possible (Fig. 2*c*, Table 1).

Owing to the advanced state of decomposition observed in all specimens (above D3), only carcass analyses were performed instead of full necropsies. Carcass analysis showed the presence of porcupinefish in different portions of the gastrointestinal tract of stranded loggerhead turtles. The most frequently detected location was the oral cavity (OC), in 16 specimens (53.3%) (Fig. 3*a*, *b*), followed by the oesophagus (ESO) in 8 specimens (26.67%) (Fig. 3*c*–*e*), and the stomach in 1 specimen (3.33%) (Fig. 3*f*). In five individuals, porcupinefish was found in multiple sections of the gastrointestinal tract simultaneously, including in two specimens, in the OC and stomach (S) (6.67%); two others, in the OC, S and intestine (INT) (6.67%); and one in the OC, ESO, S and INT (3.33%) (Table 1, Fig. 2*d*).

Fish identification

The the porcupinefish involved in lethal interactions with loggerhead turtles were identified as *Diodon holocanthus* Linnaeus, 1758 (Fig. 4) by the colour pattern dominated by large dorsal and dorsolateral blotches (*v.* colour pattern dominated by small dark sports dorsally and laterally in *D. eydouxii* Brisout de Barneville, 1846 and *D. hystrix* Linnaeus, 1758), absence of the spines in the caudal peduncle (*v.* presence of short spines in the caudal peduncle in *D. eydouxii* and *D. hystrix*) and absence of the spots in all fins (*v.* small spots in the base of the all fins).

Discussion

In the Neotropical region, the Diodontidae family comprises eight species (Fricke *et al.* 2026). Within the costal region of Rio Grande do Norte and Ceará, at least three species of the *Diodon* occur, namely, *D. eydouxii* (Oliveira *et al.* 2015; Nóbrega *et al.* 2023), *D hystrix* (Rocha 1948; Feitosa *et al.* 2002; Menezes *et al.* 2003; Garcia Júnior 2006; Freitas and Lotufo 2015; Garcia Júnior *et al.* 2015*a*; Gurjão and Lotufo 2018; Freitas *et al.* 2019; Souza 2022; Gurgel-Lourenço *et al.* 2023) and *D. holocanthus* (Feitosa *et al.* 2002; Araújo *et al.* 2003; Menezes *et al.* 2003; Garcia Júnior 2006; Godinho and Lotufo 2010; Freitas and Lotufo 2015; Garcia Júnior *et al.* 2015*a*, 2015*b*; Gurjão and Lotufo 2018; Freitas *et al.* 2019; Souza 2022; Gurgel-Lourenço *et al.* 2023; Nóbrega *et al.* 2023). The species involved in lethal interactions with loggerhead turtles was identified as the porcupinefish *D. holocanthus*, on the basis of its morphological traits. The absence of spines on the caudal peduncle distinguishes this species, with other species within its geographic range possessing them. Its colouration exhibits a gray to brown base, with large, irregular dark spots located at the base of the dorsal fin; on the upper, in contrast, the other species exhibit a bluish colour pattern, with numerous small dark spots being distributed along the body (Leis 1978).

The morphological traits of the diodontid fishes render porcupinefish nearly inedible to most predators (Leis 1978, 2006; Nelson *et al.* 2016). These fish possess a remarkable ability to inflate their bodies by rapidly ingesting water or air into a ventral diverticulum of the stomach in response to stress (Wainwright *et al.* 1995; Wainwright and Turingan 1997). This defence is complemented by dermal armour of

Table 1. Stranding data collection date, length and width (cm), maturation and sex determination, carcass analysis, and portion of the digestive tract where fish was found in the loggerhead turtles (*Caretta caretta*) analysed in this study.

Specimen	Data collection date	Geographical coordinates (decimal degrees)	Municipality	State	Length and width of carapace (CCL × CCW)	Sex	Age	Portion of digestive tract that fish was found
CC01	06/10/2015	−6.03847, −35.1102	Nísia Floresta	RN	99 × 87.5	F	A	OC
CC02	10/02/2017	−6.03878, −35.1105	Nísia Floresta	RN	88.7 × 83	F	A	S
CC03	15/11/2017	−5.86003, −35.1805	Natal	RN	69 × 70	F	J	OC
CC04	1/12/2018	−5.68092, −35.2142	Extremoz	RN	103 × 92	F	A	OC, S
CC05	1/02/2019	−5.85233, −35.1813	Natal	RN	81 × 75	U	J	OC
CC06	11/07/2019	−6.25306, −35.0378	Tibau do Sul	RN	75 × 72.5	F	J	OC
CC07	31/08/2019	−5.69805, −35.1949	Extremoz	RN	103 × 92	F	A	ESO
CC08	6/11/2019	−6.05606, −35.0979	Nísia Floresta	RN	79 × 76	F	J	ESO
CC09	4/03/2021	−4.95236, −36.9042	Areia Branca	RN	92 × 85	F	A	ESO
CC10	16/11/2021	−4.66855, −37.4227	Icapuí	CE	85 × 81	M	J	OC
CC11	31/08/2022	−6.06572, −35.0989	Nísia Floresta	RN	83 × 77.5	F	J	ESO
CC12	22/09/2022	−6.0418, −35.1104	Nísia Floresta	RN	71.5 × 73	F	J	OC
CC13	30/01/2023	−5.72306, −35.2017	Extremoz	RN	78 × 73	F	J	ESO
CC14	30/03/2023	−5.9875,−35.1139	Nísia Floresta	RN	98 × 91	U	A	ESO
CC15	28/09/2023	−6.01933, −35.1095	Nísia Floresta	RN	88 × 84	F	A	ESO
CC16	21/01/2024	−5.11911, −35.6277	São Miguel do Gostoso	RN	78 × 82	U	J	OC
CC17	03/02/2024	−5.82491, −35.18187	Natal	RN	75 × 72	U	J	OC
CC18	15/02/2024	−6.36603, −35.0061	Baía Formosa	RN	75 × 72	F	J	OC
CC19	29/03/2024	−5.96586, −35.133	Parnamirim	RN	83 × 85	F	J	OC
CC20	15/05/2024	−6.137165, −35.09843	Nísia Floresta	RN	74 × 69	U	U	OC
CC21	03/08/2024	−6.03516, −35.1107	Nísia Floresta	RN	94.5 × 90.2	F	A	OC
CC22	28/08/2024	−6.07637, −35.1007	Nísia Floresta	RN	87 × 80	U	A	OC, ESO, S, INT
CC23	07/09/2024	−6.01768, −35.109	Nísia Floresta	RN	96 × 87	F	A	ESO
CC24	11/09/2024	−5.70993, −35.1975	Extremoz	RN	91 × 82	U	A	OC, S, INT
CC25	19/01/2025	−6.09604, −35.10057	Nísia Floresta	RN	82.4 × 77.2	U	J	OC
CC26	05/05/2025	−6.03462, −35.11063	Nísia Floresta	RN	53 × 52	U	J	OC
CC27	24/05/2025	−5.82333, −35.18178	Natal	RN	80 × 72	F	A	OC
CC28	19/09/2025	−6.00246, −35.10711	Nísia Floresta	RN	88 × 75.2	F	A	OC
CC29	21/09/2025	−5.81685, −35.18178	Natal	RN	98 × 88	F	A	OC, S
CC30	21/11/2025	−5.82311, −35.18192	Natal	RN	100 × 92	U	A	OC, S, INT

A, adult; CCL, curved carapace length; CCW, curved carapace width; J, juvenile; U, undetermined; F, female; M, male; U, undetermined; OC, oral cavity; ESO, oesophagus; S, stomach; INT, intestine.

spines with large bases, or roots, under the skin and short spines usually fixed in erect position by their three-rooted bases (Leis 1978, 2006; Matsuura 2015). This mechanical defence is complemented by a powerful chemical compound, the potent neurotoxin tetrodotoxin (TTX). This toxin is present in particularly high concentrations in the porcupinefish's internal organs (Noguchi *et al.* 2006; Ravi *et al.* 2016). Once ingested, the TTX inhibits sodium channels, thereby blocking nerve and muscle impulse conduction, which ultimately causes respiratory paralysis and death (Narahashi 2001). The combination of mechanical and chemical defences, renders porcupinefish an exceptionally challenging prey item for most large predators (Brainerd 1994; Oxenford and Hunte 1999; Huveneers *et al.* 2007; Helfman *et al.* 2009; Varghese *et al.* 2013; Bornatowski *et al.* 2014; N'Gouan *et al.* 2021), transforming the fish into a large, round, poisoned, thorny ball, further deterring predation.

Once ingested, porcupinefish can be inflated within the predator's oral cavity and oesophagus. This impedes the predator from swallowing or expelling the fish, leading to asphyxiation (Battley *et al.* 2008). This phenomenon has been documented across various marine vertebrates, with the

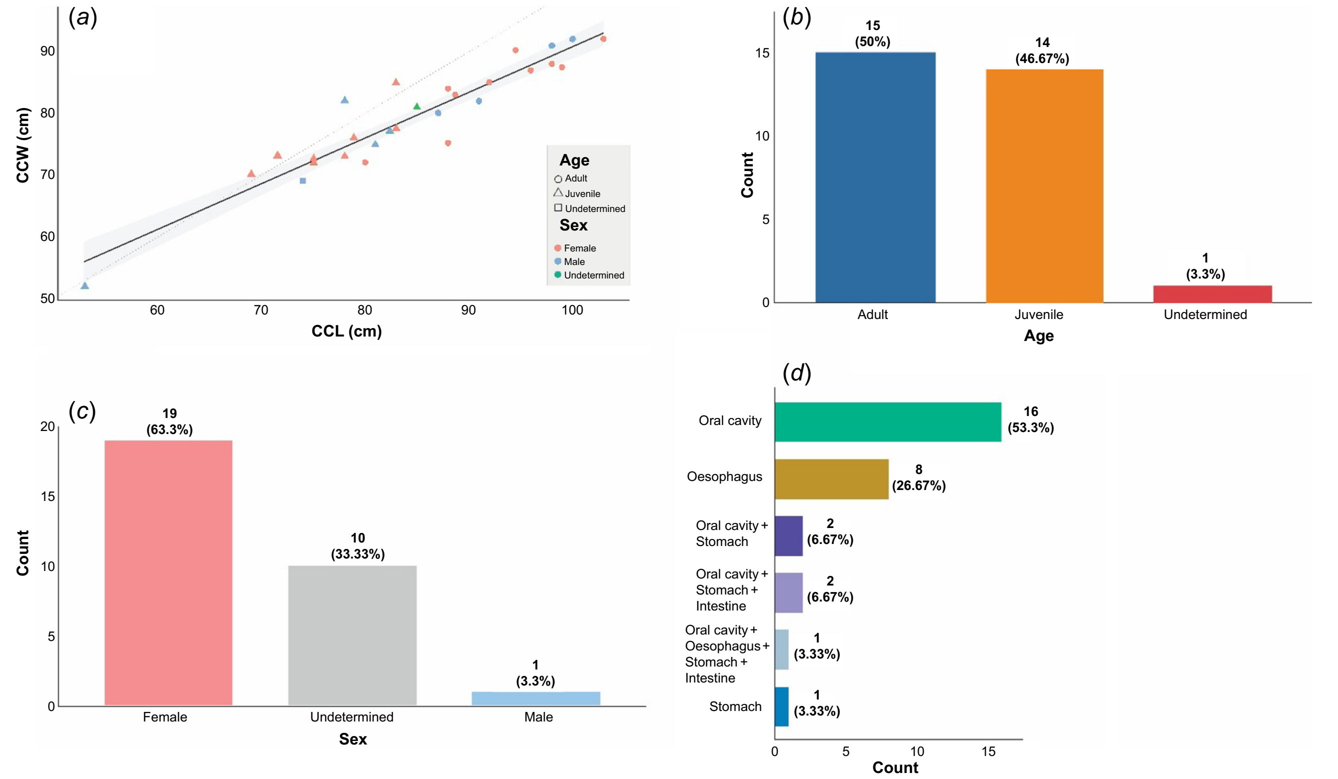

Fig. 2. Morphometric, demographic, and dietary findings of stranded loggerhead turtles (*Caretta caretta*) in north-eastern Brazil. (*a*) Carapace width (CCW) *v.* curved carapace length (CCL) in stranded loggerhead turtles (*C. caretta*), categorised by age class and sex. (*b*) Size-class distribution based on CCL. (*c*) Sex distribution of specimens. (*d*) Frequency of porcupinefish (*Diodon holocanthus*) occurrence in different sections of the gastrointestinal tract.

deaths of species such as southern royal albatross (*Diomedea epomophora* Lesson, 1825), in New Zealand at the Pacific Ocean, with a porcupinefish (*Allomycterus jaculiferus* (Cuvier, 1818)) stuck in the buccal cavity of the carcass. Similarly, Byard *et al.* (2010) documented the carcass of an adult male of bottlenose dolphin (*Tursiops aduncus* (Ehrenberg, 1833)) found in the Gulf St Vincent, Australia, in the Indo-Pacific Ocean, with a porcupinefish lodged in the buccal cavity and oesophagus. Weisberger (2017) reported the case of a dead lemon shark (*Negaprion brevirostris* (Poey, 1868)) washed ashore in the Maldives, with a porcupinefish lodged in its mouth. Similarly, Shepherd *et al.* (2019) reported a carcass of a teleostei yellow spotted trevally (*Carangoides fulvoguttatus* (Forsskål, 1775)) floating at the surface off the eastern coast of Zanzibar, in Indian Ocean, with a porcupinefish (*D. holocanthus*) stuck in its buccal cavity.

Caretta caretta is known to have a diverse diet consisting mainly of crustaceans, molluscs and other hard-bodied invertebrates (Shoop and Ruckdeschel 1982; Lutcavage and Musick 1985; Dodd 1988; Burke *et al.* 1993; Plotkin *et al.* 1993; Lazar *et al.* 2011; Farias 2014). The consumption of porcupinefish, despite its associated risks, may be attributed to the turtle's opportunistic feeding behaviour. The carnivorous sea turtles species are known to favour slow-moving prey, which might explain why they occasionally attempt to feed on porcupinefish, despite the inherent dangers (Witherington *et al.* 2012). The inability of loggerhead turtles to expel an inflated porcupinefish highlights a vulnerability in their feeding strategy, because the risk of asphyxiation due to mechanical obstruction is significant. This interaction reflects the complex dynamics of marine ecosystems, where predator–prey relationships may result in unexpected consequences.

The first recorded instance of loggerhead turtle ingestion of a porcupinefish occurred in South Africa, with a female turtle washing ashore with a porcupinefish lodged in its oesophagus (Hughes 1974). A second documented case was reported by Limpus *et al.* (2008) in the Indo-Pacific region, where mechanical obstruction in the throat and oesophagus, likely caused by porcupinefish ingestion, was identified as the cause of death in a loggerhead turtle. The present study has provided a comprehensive report of loggerhead turtle fatalities associated with porcupinefish ingestion in the Atlantic Ocean. A similar event was reported in 2015 in Olinda, Pernambuco State, as noted by a local journalistic source. However, this was not a scientific report and warrants further investigation.

The reports from Limpus *et al.* (2008) provided important insights detailing biological information on loggerhead turtle

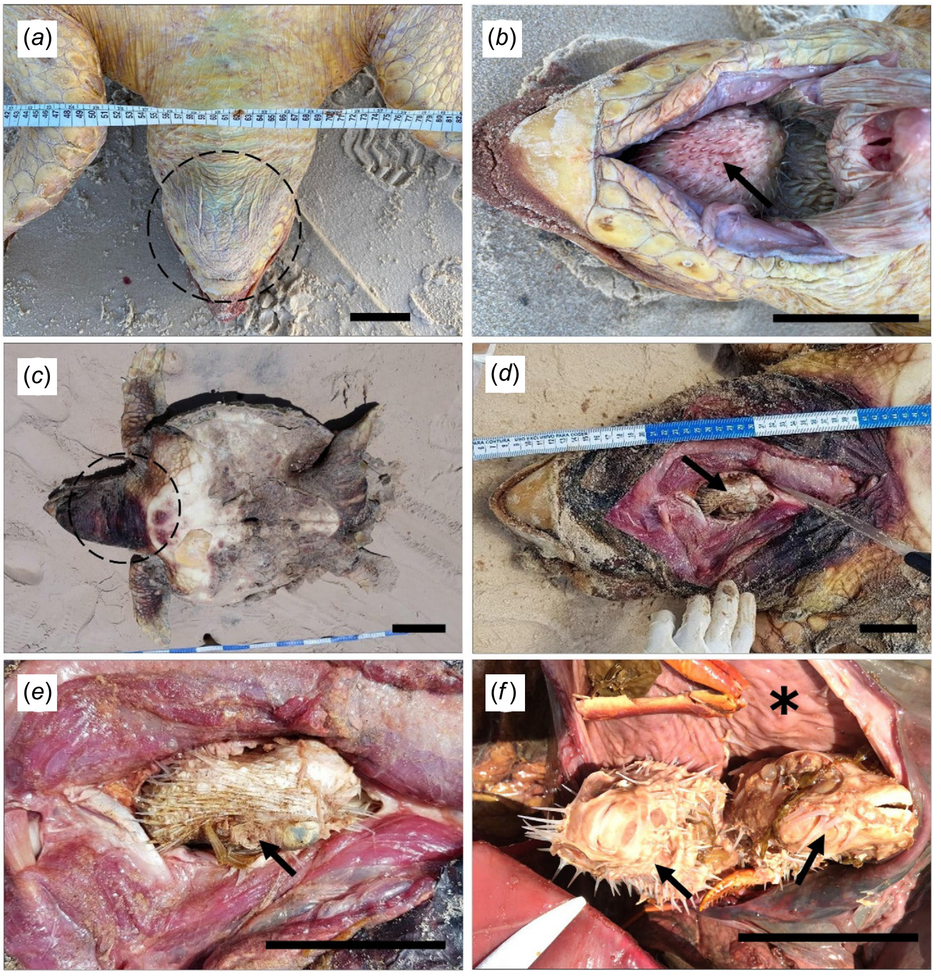

Fig. 3. Records of stranded loggerhead turtles (*Caretta caretta*) analysed in this study. (*a*, *b*) Evidence of porcupinefish (*Diodon holocanthus*) in the oral cavity (OC). (*c*) Hematoma in the neck region, suggesting a hemorrhagic process caused by the presence of the porcupinefish in the OC and oesophagus (ESO). (*d*, *e*) Evidence of porcupinefish in the ESO. (*f*) Presence of two specimens of *D. holocanthus* in the stomach (S).

fatalities attributed to mechanical obstruction caused by porcupinefish ingestion. In their study, four male and one female loggerhead turtles were recorded between February and December 2000, all with similar fatal injuries. In our study, we observed that both female and juvenile turtles were involved in porcupinefish-related fatalities; however, given the small sample size, we avoid drawing statistical conclusions about age or sex patterns.

It is essential to recognise that predation does not always result in the successful capture of prey, despite the evolutionary pressures that shape predator–prey interactions (Humphreys and Ruxton 2020). The concept of the 'dicey dinner dilemma' illustrates an asymmetric selection pressure between prey and predator, potentially allowing prey species to evolve morphological and toxicological defences to minimise mortality risks (Dawkins and Krebs 1979; Humphreys and Ruxton 2020). The asymmetric interaction may initiate a coevolutionary arms race, particularly when dangerous prey, such as the porcupinefish, evolve more effective defences, and predators, including loggerhead turtles, evolve strategies to cope with these risks.

Although the ingestion of porcupinefish by loggerhead turtles has been previously recorded (Limpus *et al.* 2008; Shepherd *et al.* 2019), our data suggested that the frequency of such interactions may be more frequent in the Atlantic Ocean than previously reported. Limpus *et al.* (2008) hypothesised that loggerhead turtles may feed on porcupinefish carcasses entangled in fishing nets, a behaviour that is likely to be more common in areas with extensive fishing activity. Shepherd *et al.* (2019) proposed that loggerhead turtles might engage in intentional predation on small-sized porcupinefish, particularly in areas where juvenile fish are abundant. On the basis of our findings, it is reasonable to assume that loggerhead turtles may have previously encountered small porcupinefish without incident. However, subsequent interactions, particularly with larger, inflated individuals, may result in fatal outcomes.

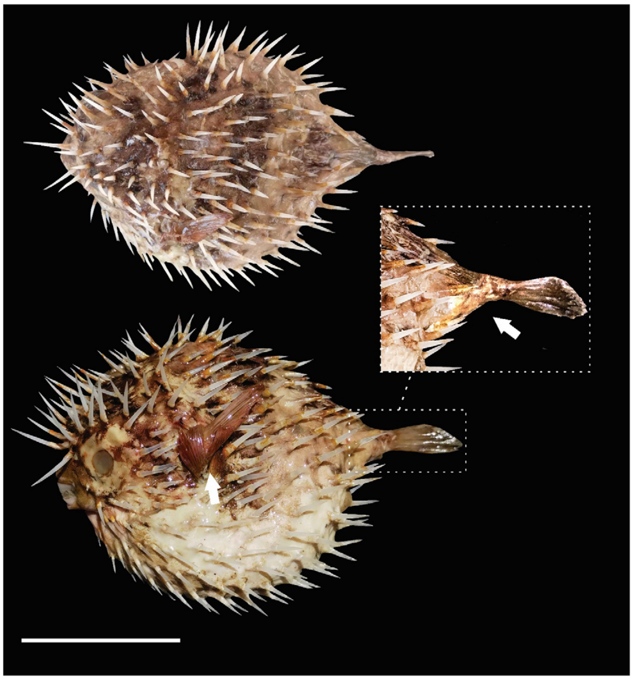

Fig. 4. *Diodon holocanthus*. White arrows indicate, absence of the spines in caudal peduncle and spots in the pectoral fin. Scale bar: 5 cm.

The alarming frequency of loggerhead turtle fatalities associated with porcupinefish ingestion in north-eastern Brazil highlights the urgent need for further ecological investigations into this novel interaction. Because loggerhead turtles are known to migrate long distances along the Brazilian coast (Lemke *et al*. 2006; Marcovaldi *et al*. 2006, 2010), the occurrence of these fatalities in the north-eastern region of Brazil may indicate an expansion of their habitat use, warranting deeper exploration of the ecological drivers of this phenomenon.

Long-term beach monitoring programs play a vital role in detecting unusual mortality events and underscore targeted conservation actions. The results presented here suggest that loggerhead turtles may occasionally ingest porcupinefish, possibly because of mistaken recognition as prey or in a oportunistic feeding behaviour, which can result in lethal consequences. By investigating these interactions, a better understanding can be gained of how dietary habits, prey availability and foraging behaviour contribute to such fatal encounters, enabling the development of measures to mitigate their occurrence. Additionally, addressing potential threats such as habitat degradation, overfishing, and pollution is essential for the long-term conservation of loggerhead turtles and the health of marine ecosystems in the region.

References

Araújo ME, Joca IR, Ribeiro MFS (2003) Ectoparasitas de peixes marinhos capturados no litoral cearense. *Arquivos de Ciências do Mar* **36**, 137–142. [In Portuguese]

Battley PF, Moore PJ, Moore SJ (2008) Southern royal albatross (*Diomedea epomophora*) dies from ingesting a porcupine fish. *Notornis* **55**, 207–208. doi:10.63172/731841jrcvqx

Bjorndal KA (1997) Foraging ecology and nutrition of sea turtles. In 'The biology of sea turtles'. (Eds PL Lutz, JA Musick) pp. 199–231. (CRC Press: Boca Raton, FL, USA)

Bolten AB (1999) Techniques for measuring sea turtles. In 'Research and management techniques for the conservation of sea turtles'. (Eds KL Eckert, KL Bjorndal, FA Abru-Grobois, M Donnelly) pp. 110–114. (IUCN SSC Marine Turtle Specialist Group: Washington, DC, USA)

Bolten AB (2003) Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. In 'The biology of sea turtles. Vol. II'. (Eds P Lutz, J Musick, J Wyneken) pp. 243–258. (CRC Press: Boca Raton, FL, USA)

Bomfim AC, Farias DSD, Silva FJL, Rossi S, Gavilan SA, Santana VGS, Pontes CS (2021) Long-term monitoring of marine turtle nests in northeastern Brazil. *Biota Neotropica* **21**(3), e20201159. doi:10.1590/1676-0611-bn-2020-1159

Bomfim AC, Farias DSD, Silva FJL, Rossi S, Gavilan SA, Santana VGS, Pontes CS (2022) Impact of the socioeconomic activities on sea turtle conservation in the Potiguar Basin, north-eastern Brazil (2010–2019). *Marine and Freshwater Research* **73**, 637–650. doi:10.1071/MF21246

Bornatowski H, Braga RR, Abilhoa V, Corrêa MFM (2014) Feeding ecology and trophic comparisons of six shark species in a coastal ecosystem off southern Brazil. *Journal of Fish Biology* **85**, 246–263. doi:10.1111/jfb.12417

Boylan SM, Valente ALS, Stacy BA, Wyneken J (2017) Digestive system. In 'Sea turtle health & rehabilitation'. (Eds CA Manire, TM Norton, BA Stacy, CJ Innis, CA Harms) pp. 337–365. (J Ross Publishing: Plantation, FL, USA.)

Brainerd EL (1994) Pufferfish inflation: functional morphology of postcranial structures in *Diodon holocanthus* (Tetraodontiformes). *Journal of Morphology* **220**, 243–261. doi:10.1002/jmor.1052200304

Burke VJ, Standora EA, Morreale SJ (1993) Diet of juvenile Kemp's ridley and loggerhead sea turtles from Long Island, New York. *Copeia* **1993**(4), 1176–1180. doi:10.2307/1447107

Byard RW, Tomo I, Kemper CM, Gibbs SE, Bossley M, Machado A, Hill M (2010) Unusual causes of fatal upper aerodigestive tract obstruction in wild bottlenose dolphins (*Tursiops aduncus*). *Forensic Science, Medicine, and Pathology* **6**, 207–210. doi:10.1007/s12024-010-9143-3

Casale P, Tucker AD (2017) Loggerhead turtle *Caretta caretta* (amended version of 2015 assessment). In 'The IUCN Red List of Threatened Species 2017'. e.T3897*A*119333622. (International Union for Conservation of Nature and Natural Resources) Available at https://www.iucnredlist.org/species/3897/119333622

Casale P, Abbate G, Freggi D, Conte N, Oliverio M, Argano R (2008) Foraging ecology of loggerhead sea turtles *Caretta caretta* in the central Mediterranean Sea: evidence for a relaxed life history model. *Marine Ecology Progress Series* **372**, 265–276. doi:10.3354/meps07702

Colman LP, Sampaio CLS, Weber MI, Castilhos JC (2014) Diet of olive ridley sea turtles, *Lepidochelys olivacea*, in the waters of Sergipe, Brazil. *Chelonian Conservation and Biology* **13**, 266–271. doi:10.2744/CCB-1061.1

Dawkins R, Krebs JR (1979) Arms races between and within species. *Proceedings of the Royal Society of London – B. Biological Sciences* **205**(1161), 489–511. doi:10.1098/rspb.1979.0081

Dodd CK (1988) Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus, 1758). Biological Report 88. US Fish and Wildlife Service.

Farias DSD (2014) Tartarugas Marinhas da Bacia Potiguar/RN: diagnóstico, biologia alimentar e ameaças. MSc dissertation, Universidade do Estado do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil. [In Portuguese]

Farias DSD, Alencar AEB, Bomfim AC, Fragoso ABL, Rossi S, Moura GJB, Gavilan AS, Silva FJL (2019) Marine turtles stranded in northeastern Brazil: composition, spatio-temporal distribution, and anthropogenic interactions. *Chelonian Conservation and Biology* **18**, 105–111. doi:10.2744/CCB-1309.1

Feitosa CV, Pimenta DAS, Araújo ME (2002) Ictiofauna recifal dos Parrachos de Maracajaú (RN) na área dos flutuantes: inventário e estrutura da comunidade. *Arquivo de Ciências do Mar* **35**, 39–50. [In Portuguese]

Figueiredo JL, Menezes NA (2000) 'Manual de peixes marinhos do Sudeste do Brasil. VI. Teleostei (5).' (Museu de Zoologia da USP: São Paulo, Brazil) [In Portuguese]

Flint M, Patterson-Kane JC, Mills PC, Limpus CJ (2009) 'A veterinarian's guide to sea turtle postmortem examination and histological investigation.' (The University of Queensland: Brisbane, QLD, Australia)

Freitas JEP, Lotufo TMC (2015) Reef fish assemblage and zoogeographic affinities of a scarcely known region of the western equatorial Atlantic. *Journal of the Marine Biological Association of the United Kingdom* **95**(3), 623–633. doi:10.1017/S0025315414001404

Freitas JEP, Araujo ME, Lotufo TMC (2019) Composition and structure of the ichthyofauna in a marine protected area in the western equatorial Atlantic: a baseline to support conservation management. *Regional Studies in Marine Science* **25**, 100488. doi:10.1016/j.rsma.2018.100488

Fricke R, Eschmeyer WN, Van der Laan R (Eds) (2026) Eschmeyer's catalog of fishes. (The California Academy of Sciences) Available at http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp

Garcia Júnior J (2006) Inventário das espécies de peixes da costa do Estado do Rio Grande do Norte e aspectos zoogeográficos da ictiofauna recifal do Oceano Atlântico. MSc dissertation, Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil. [In Portuguese]

Garcia Júnior J, Nóbrega MF, Oliveira JEL (2015*a*) Coastal fishes of Rio Grande do Norte, northeastern Brazil, with new records. *Check List* **11**(3), 1–24. doi:10.15560/11.3.1659

Garcia Júnior J, Mendes LF, Sampaio CLS, Nóbrega MF, Oliveira JEL (2015*b*) 'Biodiversidade marinha da Bacia Potiguar/RN: Peixes da Plataforma', 1st edn (Museu Nacional: Rio de Janeiro, Brazil) [In Portuguese]

Godinho WO, Lotufo TMC (2010) Local *v.* microhabitat influences on the fish fauna of tidal pools in north-east Brazil. *Journal of Fish Biology* **76**(3), 487–501. doi:10.1111/j.1095-8649.2009.02501.x

Godley BJ, Broderick AC, Frauenstein R, Glen F, Hays GC (2002) Reproductive seasonality and sexual dimorphism in green turtles. *Marine Ecology Progress Series* **226**, 125–133. doi:10.3354/meps226125

Gurgel-Lourenço RC, Medeiros LS, Pinto LM, Sousa WA, Pereira FB, Ramos TPA, Lima SMQ, Sánchez-Botero JI (2023) Fish fauna from the estuaries of Ceará state, Brazil: a checklist in support of conservation of the Brazilian semiarid coast. *Check List* **19**(1), 63–90. doi:10.15560/19.1.63

Gurjão LM, Lotufo TMC (2018) The importance of Ceará state to the Brazilian marine ornamental fish exports. A importância do estado do Ceará para as exportações brasileiras de peixes ornamentais marinhos. *Arquivos de Ciências do Mar* **51**(1), 75–92. [In English, with title, abstract and keywords in English and Portuguese] doi:10.32360/acmar.v51i1.33495

Helfman GS, Collette BB, Facey DE, Bowen BW (2009) 'The diversity of fishes: biology, evolution, and ecology.' (Wiley)

Hughes GR (1974) The sea turtles of south-east Africa. I. Status, morphology and distribution. Report number 36. Oceanographic Research Institute Investigational, Durban, South Africa.

Humphreys RK, Ruxton GD (2020) The dicey dinner dilemma: asymmetry in predator–prey risk-taking, a broadly applicable alternative to the life-dinner principle. *Journal of Evolutionary Biology* **33**(3), 377–383. doi:10.1111/jeb.13585

Huveneers C, Otway NM, Gibbs SE, Harcourt RG (2007) Quantitative diet assessment of wobbegong sharks (genus *Orectolobus*) in New South Wales, Australia. *ICES Journal of Marine Science* **64**, 1272–1281. doi:10.1093/icesjms/fsm111

Inurria A, Arencibia A, Calabuig P, Gómez M, Déniz S, Orós J (2019) Mortality associated with ingestion of sea urchins in loggerhead sea turtles (*Caretta caretta*): a case series. *PLoS ONE* **14**, e0221730. doi:10.1371/journal.pone.0221730

James MC, Herman TB (2001) Feeding of *Dermochelys coriacea* on medusae in the Northwest Atlantic. *Chelonian Conservation Biology* **4**, 202–205.

Jerdy H, Werneck MR, da Silva MA, Ribeiro RB, Bianchi M, Shimoda E, de Carvalho ECQ (2017) Pathologies of the digestive system caused by marine debris in *Chelonia mydas*. *Marine Pollution Bulletin* **116**, 192–195. doi:10.1016/j.marpolbul.2017.01.009

Jones TT, Seminoff JA (2013) Feeding biology: advances from field-based observations, physiological studies, and molecular techniques. In 'The biology of sea turtles'. (Eds J Wyneken, KJ Lohmann, JA Musick) pp. 211–248. (CRC Press)

Lazar B, Gračan R, Katić J, Zavodnik D, Jaklin A, Tvrtković N (2011) Loggerhead sea turtles (*Caretta caretta*) as bioturbators in neritic habitats: an insight through the analysis of benthic molluscs in the diet. *Marine Ecology* **32**(1), 65–74. doi:10.1111/j.1439-0485.2010.00402.x

Leis JM (1978) Systematics and zoogeography of the porcupinefishes (*Diodon*, Diodontidae, Tetraodontiformes), with comments on egg and larval development. *US Fishery Bulletin* **76**, 535–567.

Leis JM (2002) Diodontidae. Porcupinefishes. In 'The living marine resources of the Western Central Atlantic. Volume 3: bony fishes, part 2 (Opistognathidae to Molidae), sea turtles and marine mammals. FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication Number 5'. (Ed. KE Carpenter) pp. 2007–2013. (Food and Agriculture Organization of the United Nations: Rome, Italy) Available at https://openknowledge.fao.org/handle/20.500.14283/y4162e

Leis JM (2006) Nomenclature and distribution of the species of the porcupinefish family Diodontidae (Pisces, Teleostei). *Memoirs of Museum Victoria* **63**, 77–90. doi:10.24199/j.mmv.2006.63.10

Lemke D, Frazier JG, Douglas DC, *et al.* (2006) Satellite telemetry of loggerheads in Brazil. In 'Proceedings of the twenty-third annual symposium on sea turtle biology and conservation', 17–21 March 2003, Kuala Lumpur, Malaysia. (Comp. NJ Pilcher) NOAA Technical Memorandum NMFS-SEFSC-536, pp. 230–233. (NOAA)

Lima EP, Wanderlinde J, Almeida AT, Lopez G, Goldberg DW (2012) Nesting ecology and conservation of the loggerhead sea turtle (*Caretta caretta*) in Rio de Janeiro, Brazil. *Chelonian Conservation and Biology* **11**, 249–254. doi:10.2744/CCB-0996.1

Limpus CJ, Limpus DJ, Horton M, Ferris L (2008) Loggerhead turtle mortality from attempted ingestion of porcupine fish. *Marine Turtle Newsletter* **120**, 1–3.

Lustosa Costa SY, Petean FF, Araújo TFP, Medeiros LS, Barros-Neto LF, Paiva REC, Bennemann ABA, Abrantes YG, Lira MGS, Lima SMQ (2019) Coleção Ictiológica da Universidade Federal do Rio Grande do Norte: um relevante acervo de peixes da Caatinga e áreas adjacentes. *Boletim da Sociedade Brasileira de Ictiologia* **129**, 146–153. [In Portuguese]

Lutcavage M, Musick JA (1985) Aspects of the biology of sea turtles in Virginia. *Copeia* **1985**(2), 449–456. doi:10.2307/1444857

Machovsky-Capuska GE, Andrades R, Santos RG (2020) Debris ingestion and nutritional niches in estuarine and reef green turtles. *Marine Pollution Bulletin* **153**, 110943. doi:10.1016/j.marpolbul.2020.110943

Manooch CS III, Mason DL, Nelson RS (1984) Food and gastrointestinal parasites of dolphin *Coryphaena hippurus* collected along the southeastern and Gulf coasts of the United States. *Bulletin of the Japanese Society of Scientific Fisheries* **50**(9), 1511–1525. doi:10.2331/suisan.50.1511

Marcovaldi MA, Sales G, Thomé JCA, *et al.* (2006) Sea turtles and fishery interactions in Brazil: identifying and mitigating potential conflicts. *Marine Turtle Newsletter* **112**, 4–8.

Marcovaldi MA, Lopez GG, Soares LS, *et al.* (2010) Satellite-tracking of female loggerhead turtles highlights fidelity behavior in northeastern Brazil. *Endangered Species Research* **12**, 263–272. doi:10.3354/esr00308

Matsuura K (2015) Taxonomy and systematics of tetraodontiform fishes: a review focusing primarily on progress in the period from 1980 to 2014. *Ichthyological Research* **62**, 72–113. doi:10.1007/s10228-014-0444-5

Méndez-Salgado E, Chacón-Chaverri D, Fonseca LG, Seminoff JA (2020) Trophic ecology of hawksbill turtles (*Eretmochelys imbricata*) in Golfo Dulce, Costa Rica: integrating esophageal lavage and stable isotope (δ^{13}C, δ^{15}N) analysis. *Latin American Journal of Aquatic Research* **48**, 114–130. doi:10.3856/vol48-issue1-fulltext-2230

Menezes NA, Buckup PA, Figueiredo JL, Moura RL (2003) 'Catálogo das espécies de peixes marinhos do Brasil', 1st edn. (Museu de Zoologia de Universidade de São Paulo: São Paulo, SP, Brazil) [In Portuguese]

Narahashi T (2001) Pharmacology of tetrodotoxin. *Journal of Toxicology: Toxin Reviews* **20**, 67–84. doi:10.1081/TXR-100102537

Nelson JS, Grande T, Wilson MVH (2016) 'Fishes of the World.' (Wiley: Hoboken, NJ, USA)

Nóbrega MF, Garcia Junior J, Oliveira MA, Lins Oliveira JE (2023) Continental slope fishes of the Potiguar Basin off northeast Brazil in the Equatorial Atlantic ocean. *Deep-Sea Research – I. Oceanographic Research Papers* **192**, 103937. doi:10.1016/j.dsr.2022.103937

Noguchi T, Arakawa O, Takatani T (2006) TTX accumulation in pufferfish. *Comparative Biochemistry and Physiology – D. Genomics and Proteomics* **1**, 145–152. doi:10.1016/j.cbd.2005.10.006

N'Gouan KC, Konan KJ, Edia OE (2021) Diet of the silky shark *Carcharhinus falciformis* (Müller & Henle, 1839) in waters off Côte d'Ivoire (West Africa). *Annual Research & Review in Biology* **36**, 59–69. doi:10.9734/arrb/2021/v36i830411

Oliveira JEL, Nóbrega MF, Garcia-Júnior J, Sampaio CLS, Di Dario F, Fischer LG, Mincarone MM (2015) 'Biodiversidade marinha da Bacia Potiguar/RN: Peixes do Talude Continental', 1st edn. (Museu Nacional: Rio de Janeiro, Brazil) [In Portuguese]

Oliveira REM, Pires JML, Batista JS, *et al.* (2020) Death of a loggerhead sea turtle (*Caretta caretta*) from ingestion of an eel (*Myrichthys ocellatus*). *Veterinární medicína* **65**, 415–420. doi:10.17221/83/2020-VETMED

Oxenford HA, Hunte W (1999) Feeding habits of the dolphinfish (*Coryphaena hippurus*) in the eastern Caribbean. *Scientia Marina* **63**, 303–315. doi:10.3989/scimar.1999.63n3-4317

Parker DM, Cooke WJ, Balazs GH (2005) Diet of oceanic loggerhead sea turtles (*Caretta caretta*) in the central North Pacific. *Fishery Bulletin* **103**, 142–152.

Petitet R, Bugoni L (2017) High habitat use plasticity by female olive ridley sea turtles (*Lepidochelys olivacea*) revealed by stable isotope analysis in multiple tissues. *Marine Biology* **164**, 134. doi:10.1007/s00227-017-3163-4

Plotkin PT, Wicksten MK, Amos AF (1993) Feeding ecology of the loggerhead sea turtle *Caretta caretta* in the northwestern Gulf of Mexico. *Marine Biology* **115**, 1–5. doi:10.1007/BF00349379

Potier M, Marsac F, Cherel Y, Lucas V, Sabatié R, Maury O, Ménard F (2007) Forage fauna in the diet of three large pelagic fishes (lancetfish, swordfish and yellowfin tuna) in the western equatorial Indian Ocean. *Fisheries Research* **83**, 60–72. doi:10.1016/j.fishres.2006.08.020

Randall JE (1967) Food habits of reef fishes of the West Indies. *Studies in Tropical Oceanography* **5**, 665–847.

Ravi L, Manu A, Chocalingu R, *et al.* (2016) Genotoxicity of tetrodotoxin extracted from different organs of *Diodon hystrix* puffer fish from south east Indian coast. *Research Journal of Toxins* **8**, 8–14. doi:10.3923/rjt.2016.8.14

Rocha FD (1948) Subsídio para o estudo da fauna cearense. (Catálogo das espécies animais por mim coligidas e notadas). *Revista do Instituto do Ceará* **62**, 102–138. [In Portuguese]

Salmon M, Todd Jones T, Horch KW (2004) Ontogeny of diving and feeding behavior in juvenile seaturtles: leatherback seaturtles (*Dermochelys coriacea* L.) and green seaturtles (*Chelonia mydas* L.) in the Florida current. *Journal of Herpetology* **38**, 36–43. doi:10.1670/228-01A

Santos RG, Andrades R, Boldrini MA, Martins AS (2015) Debris ingestion by juvenile marine turtles: an underestimated problem. *Marine Pollution Bulletin* **93**, 37–43. doi:10.1016/j.marpolbul.2015.02.022

Schuyler QA, Wilcox C, Townsend KA, Wedemeyer-Strombel KR, Balazs G, van Sebille E, Hardesty BD (2016) Risk analysis reveals global hotspots for marine debris ingestion by sea turtles. *Global Change Biology* **22**, 567–576. doi:10.1111/gcb.13078

Shepherd B, Pinheiro HT, Rocha LA (2019) Sometimes hard to swallow: attempted feeding on a porcupinefish results in death of both predator and prey. *Western Indian Ocean Journal of Marine Science* **18**, 87–89. doi:10.4314/wiojms.v18i2.9

Shoop CR, Ruckdeschel CA (1982) Increased turtle standings in the southeast United States: a complicating factor. *Biological Conservation* **23**(3), 213–215. doi:10.1016/0006-3207(82)90076-3

Souza LGX (2022) Peixes marinhos e estuarinos do Ceará e seu estado de conservação. MSc dissertation, Universidade Federal do Ceará, Fortaleza, Brazil. [In Portuguese]

Varghese SP, Somvanshi VS, John ME, Dalvi RS (2013) Diet and consumption rates of common dolphinfish, *Coryphaena hippurus*, in the eastern Arabian Sea. *Journal of Applied Ichthyology* **29**, 1022–1029. doi:10.1111/jai.12166

Wainwright PC, Turingan RG (1997) Evolution of pufferfish inflation behavior. *Evolution* **51**, 506–518. doi:10.1111/j.1558-5646.1997.tb02438.x

Wainwright PC, Turingan RG, Brainerd EL (1995) Functional morphology of pufferfish inflation: mechanism of the buccal pump. *Copeia* **1995**(3), 614–625. doi:10.2307/1446758

Wallace BP, Kot CY, DiMatteo AD, Lee T, Crowder LB, Lewison RL (2013) Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. *Ecosphere* **4**, 1–49. doi:10.1890/ES12-00388.1

Weisberger A (2017) Hard to swallow: shark suffocates on porcupine fish. In *Live Science: News*, 2 December 2017. Available at https://www.livescience.com/61078-shark-suffocates-on-porcupine-fish.html [Verified 8 July 2024]

Witherington B, Hirama S, Hardy R (2012) Young sea turtles of the pelagic *Sargassum*-dominated drift community: habitat use, population density, and threats. *Marine Ecology Progress Series* **463**, 1–22. doi:10.3354/meps09970

Wyneken J (2001) The anatomy of sea turtles. NOAA Technical Memorandum NMFS-SEFSC-470. US Department of Commerce, Miami, FL, USA.

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