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New records of Cephalopods from Ascension Island (central Atlantic) found in yellowfin tuna stomachs

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The squid *Hyaloteuthis pelagica* (Bosc, 1802) and the octopus, *Ocythoe tuberculata* Rafinesque, 1814 have been recorded from Ascension Island for the first time. Both species were found in yellowfin tuna stomachs caught from inshore coastal waters (within 5 km). The specimens were in good condition with distinguishing features still apparent, signifying very recent ingestion. Morphological features were examined, photographs taken and specimens stored for use as part of an on-going study investigating dietary habits of yellowfin tuna.

Key words: Ascension Island, Cephalopoda, Ocythoidae, Ommastrephidae, *Thunnus albacares*

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INTRODUCTION

Ascension Island (7°55'S, 14°25'W) is situated in the central South Atlantic Ocean near the mid-Atlantic ridge. The nearest land is the Island of St. Helena, located 1,100 km to the southeast, while Africa, its nearest continental land mass, is approximately 1,500 km away (Lubbock 1980). Ascension Island harbours globally important marine biodiversity, representing a unique assemblage of western and eastern Atlantic flora and fauna (Lubbock 1980; Wirtz et al. 2014). Molluscs have been identified from Ascension Island in several studies (Rosewater 1975; Padula et al. 2014; Brown et al. 2016), however, only two records of cephalopods have been reported; *Callistoctopus macropus* (Brown et al. 2016) and *Octopus vulgaris* (Rosewater 1975).

Large pelagic predators, such as tuna and billfishes, can be efficient biological samplers for collecting information, particularly on mesopelagic prey such as cephalopods, which would otherwise be difficult to sample from open ocean marine ecosystems. They also offer greater diversity of cephalopod specimen collection than sampling gear, due to the predators' opportunistic feeding behaviour (Smale 1996; Ménard et al. 2007; Staudinger et al. 2013). Descriptions of dietary habits also provide useful information on species composition, distribution, abundance and ecology of cephalopods occurring within the predators' foraging range (Smale 1996; Potier et al. 2005; Cherel et al. 2007; Ménard et al. 2007).

The football octopus (*Ocythoe tuberculata*) is the sole representative of the monotypic family Ocythoidae, a pelagic octopod family, females of

which are known to have a true swim bladder allowing them to achieve neutral buoyancy (Packard & Wurtz 1994; Caballero-Alfonso et al. 2009; Salman & Akalin 2012). It is known to inhabit temperate seas yet may also be found in warm oceanic waters (subtropical) of the Atlantic, Indo and Pacific Oceans (Cardoso & Paredes 1998). In the North-east Atlantic, this species has been recorded from the Azores and Canary Island archipelagos (Cardoso 1991), and in the South Atlantic it has been reported off South Africa (Roper & Sweeney 1975; Kobyliansky et al. 2010). Very little is known about the biology and behaviour of *O. tuberculata* due to the paucity of wild-captured animals, resulting in limited literature available (Salman & Akalin 2012). The majority of specimens reported have been found in the stomach of its predators, including yellowfin tuna (Caballero-Alfonso et al. 2009). Pronounced sexual dimorphism occurs in this species with females being significantly larger than males (>35cm mantle length and >3cm mantle length respectively) (Roper & Sweeney 1975).

The glassy flying squid (*Hyaloteuthis pelagica*) is the smallest member of the family Ommastrephidae, reaching a maximum mantle length of 90 mm (Cherel et al. 2007), most likely distributed in all tropical and sub-tropical oceans (Nesis 2003). The biology and ecological role of some of the smaller species of squid, belonging to the Ommastrephidae family, remain poorly understood throughout the world's oceans as they are not considered commercially viable and seldom caught within fisheries (Cherel et al. 2007; Staudinger et al. 2013) however, it is known that *H. pelagica* inhabit subsurface layers (<100 m in depth) at night and during daytime hours they are capable of inhabiting depths of 2000 m, as demonstrated by a single specimen caught between 1,700 and 2,200 m in Hawaiian waters (Young 1978). Lifespan is estimated at half a year, with spawning occurring throughout the year, with some seasonal variability in activity (Jereb et al. 2010).

MATERIAL AND METHODS

Specimens of *H. pelagica* (n=226) and *O. tuberculata* (n=5) were collected from yellowfin tuna, *Thunnus albacares*, stomachs as part of an on-going study investigating dietary habits, food web dynamics and trophic position of yellowfin tuna in Ascension Island's waters.

Stomach content samples from yellowfin tuna were collected opportunistically after landings from recreational and artisanal fishing on Ascension Island from August 2015 to November 2016. The fish were captured by three methods: rod and line fishing with baited hooks, surface trolling with artificial lures and spear (Table 1).

Table 1. Distribution of stomachs collected, from yellowfin tuna containing cephalopod prey, by fishing gear.

Fishing gear	Stomachs collected
Rod & line (bait)	61
Rod & line (lure)	3
Spear	2
Total	66

All fish were caught in Ascension's inshore waters (within 5 km of the island), from surface waters, in maximum depths of 300 m (Table 2).
The stomachs were removed from the abdominal cavity and the fork length (cm) and wet weight (kg) of the fishes were recorded along with total weight of stomach and contents (g). Each stomach was visually assigned a degree of fullness on a scale of 0-4 (0=0%, 1=25%, 2=50%, 3=75%, 4=100%) based on the distension of the stomach due to the presence or absence of food.

Bait fish used was noted and any evidence of regurgitation after capture also kept with corresponding sample. Stomach contents were stored frozen at -20°C until further analysis. In the fisheries laboratory stomachs were thawed and drained of excess stomach fluid. The total weight (g) of contents was recorded and the prey

Table 2. Geographic coordinates of yellowfin tuna catches, containing cephalopod prey, from Ascension Island.

Location name	Latitude	Longitude	Stomachs collected
English Bay	-7.8939	-14.3835	2
Georgetown	-7.9252	-14.4138	53
Pipeline	-7.9353	-14.4223	4
Red Rock	-7.8943	-14.3947	1
TTR	-7.9057	-14.4065	3
White Rock	-7.8957	-14.3979	3

items were grouped into categories by phylum (fish, crustaceans, molluscs etc.) and identified to the lowest possible taxonomic level using a Zeiss stemi DV4 (8x to 32x magnification) dissecting microscope and reference literature held in the Ascension Island Conservation & Fisheries Dept. library. Stomach content analysis methodology was adapted from several previous studies (Potier et al. 2005; Rohit et al. 2010; Hosseini & Kaymaram 2016).

Cephalopod prey items were identified using external, and where appropriate, internal morphological features of intact specimens. Specimens from both species reported here were in good condition, with identifying features still apparent, signifying very recent ingestion.

Morphological features were examined and photographs taken. Cephalopod specimens were either fixed in 10% formalin solution and then stored in 70% EtOH or stored frozen at -20°C, for inclusion in subsequent stable isotope analysis.

Mantle length was measured to the nearest 1 mm and body weight to the nearest 0.01 g using an AE Adam balance.

RESULTS

In total, 66 yellowfin tuna stomachs contained cephalopod prey and were subsequently included in this study. Yellowfin tuna fork length (FL) ranged from 66.5 cm to 168 cm, with mean FL at 103 cm ±15.49 (±SD). Weight (W) ranged from 5 kg to 72.6 kg, with mean W at 19.7 kg (±9.36).

Ocythoe tuberculata (n=5) Mantle length, ML, ranged from 11 mm to 23 mm, with mean ML of 16.8mm ±4.81 (±SD). Weight, W, ranged from 0.39 g to 1.46 g, with mean W of 1.08 g (±0.46). One specimen was identified as a juvenile female (ML = 23 mm, W = 1.46 g). Specimens exhibited the following features; arms II and III were much shorter than I and IV. The head was also more spherical than in other octopus species and it had two ventral pores at the base of arm IV, a funnel locking apparatus and, in females, a swim bladder (Packard & Wurtz 1994). Specimens of *O. tuberculata* were found in yellowfin tuna stomach contents in October - November 2015 and in November 2016.

Hyaloteuthis pelagica (n=226) had suckers on the tip of the tentacular clubs in four rows, and the mantle showed bluntly pointed terminus and displayed nineteen large round light organs on the ventral surface. Also it had a funnel locking apparatus with a t-shape groove, indicative of ommastrephids (Jereb et al. 2010). ML ranged from 23 mm to 80 mm, with mean ML of 52 mm ±14.08 (±SD). W ranged from 1.04 g to 10.13 g with mean of 4.09 g (±2.40). Specimens of *H.*

pelagica were found in yellowfin tuna stomachs in every month; from August 2015 to November 2016.

DISCUSSION

This study is the first, to our knowledge, to note the occurrence of *O. tuberculata* and *H. pelagica* at Ascension Island, central Atlantic Ocean.

Ocythoe tuberculata is known to inhabit temperate waters, yet also thought to extend its range into subtropical waters in the Atlantic Ocean (Cardoso & Paredes 1998), however, it appears this study is the first record to confirm this.

Tuna species are known to have a high metabolic rate and digest prey items quickly (Allain 2002). Olson & Boggs (1986) measured gastric evacuation in captive yellowfin and found that prey with high lipid content (large fish e.g. mackerel, *Scomber japonicus*) were evacuated at a much slower rate than smaller fish and cephalopods, due to lower lipid contents.

Given the locations of yellowfin tuna catches in Ascension Island's inshore waters (Table 2) and the undigested state of *O. tuberculata* found in the stomach contents, it is apparent that the specimens had been consumed very recently and in close proximity to Ascension Island.

Hyaloteuthis pelagica is an important prey item in the central Atlantic, for yellowfin tuna and other commercially important pelagic fish species, as demonstrated by Cherel et al. (2007) and Ménard et al. (2007). Preliminary results also show this is true for yellowfin tuna frequenting Ascension's waters (K.J. Downes unpubl. data). Given the wide distribution of *H. pelagica*, it is not unexpected that the species would be found at Ascension Island, where they constitute a major part of yellowfin tuna diet.

However, these new records highlight the need for further investigation, and the importance of addressing knowledge gaps of cephalopod species occurring within inshore and offshore areas surrounding Ascension Island in the central Atlantic. Future study of marine food webs will also be an important tool, to aid understanding and gain additional insight into the role and significance of cephalopods as prey in Ascension waters.

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