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FEEDING HABITS OF THE SEAHORSE *HIPPOCAMPUS PATAGONICUS* (ACTINOPTERYGII: SYNGNATHIFORMES: SYNGNATHIDAE) ON THE SOUTHERN COAST OF BRAZIL

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Abstract. The feeding habits of the seahorse *Hippocampus patagonicus* Piacentino et Luzzatto, 2004 on the southern Brazilian coast was evaluated through the gut content analysis of 82 individuals (28–110 mm in height, HT) obtained through a fish landing monitoring program (July 2011 to November 2012). Results showed that *H. patagonicus* feed mainly on small benthic and pelagic zooplankton organisms, mainly amphipods, decapods post-larvae (megalopa), and isopods. In the warm season (>20°C, from November to April) the diet was dominated by amphipods, and in the cold season (<19°C, from May to October) by decapods post-larvae and isopods. No significant differences were observed on the diet composition of juveniles (<48.5 mm HT) and adults (>48.5 mm HT) and also among sites. The importance of amphipods and decapod larvae as a food source is well known for seahorses, all explained by their highly specialized prey-capture mechanism and foraging behaviour.

Keywords: Crustacea, diet, South-western Atlantic, threatened species

INTRODUCTION

Seahorses are small teleost fishes with highly specialized morphology and life history (Lourie et al. 2016). They are members of the family Syngnathidae, which also includes pipefishes, pipehorses, and seadragons (Nelson et al. 2016). They are distributed worldwide in marine and estuarine shallow waters of tropical and temperate regions of the Pacific, Atlantic, and Indian oceans (Lourie et al. 1999, Vincent et al. 2011). Several species of seahorses were assessed for the IUCN Red List of Threatened Species and are currently considered threatened as result of habitat loss and degradation, overfishing (bycatch), aquarium trade, and collection for medicinal and religious purposes (Anonymous 2018).

Information available on the feeding habits of seahorses from field-based studies (Tipton and Bell 1988, Kanou and Kohno 2001, Teixeira and Musick 2001, Woods 2002, Kendrick and Hyndes 2005, Castro et al. 2008, Felício et al. 2006, Kitsos et al. 2008, Storero and González 2008, Valladares et al. 2016) indicates an opportunistic and specialized predatory strategy, based primarily on plankton and small crustaceans. Since seahorses are slow swimmers and usually anchor themselves to a substrate, such kind of evasive prey is captured by an unusual prey-capture behaviour known as pivot feeding (de Lussanet and Muller 2007). This feeding strategy consists in a rapid upward rotation of the head toward the prey whilst slurping (Gemmell et al. 2013). The long snout generates a flow of water that draws the prey into the mouth (suction), and this process differs from what is typically observed in suction-feeding teleost fishes (Van Wassenbergh and Aerts 2008). The suction-feeding strategy in seahorses has been linked to the possession of a pipette-like feeding structure (Bergert and Wainwright 1997) and associated morphological specializations (Van Wassenbergh et al. 2011, 2013), including a well-developed acute visual system (Lee and O'Brien 2011).

In the presently reported study, we evaluated the diet composition of *Hippocampus patagonicus* Piacentino et Luzzatto, 2004 in the southern coast of Brazil, and its variability due to a stage of development, sites and season. The seahorse *H. patagonicus* is the southernmost seahorse in the South Atlantic Ocean (Piacentino and Luzzatto 2004, González et al. 2014), listed as 'Vulnerable' on the IUCN Red List of Threatened Species (Wei et al. 2017).

MATERIAL AND METHODS

Specimens of *Hippocampus patagonicus* were obtained through a fish landing monitoring program that targets the bycatch of the industrial trawl fishery on the

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southern Brazilian coast, in three landing sites in the State of Rio Grande do Sul: Torres (29°20′S, 49°43′W), Tramandaí (29°59′S, 50°08′W), and Rio Grande (32°01′S, 52°05′W) (Fig. 1). Sites were visited monthly from July 2011 to November 2012. The incidental capture of seahorses occurred between the 10 and 25 m isobaths.

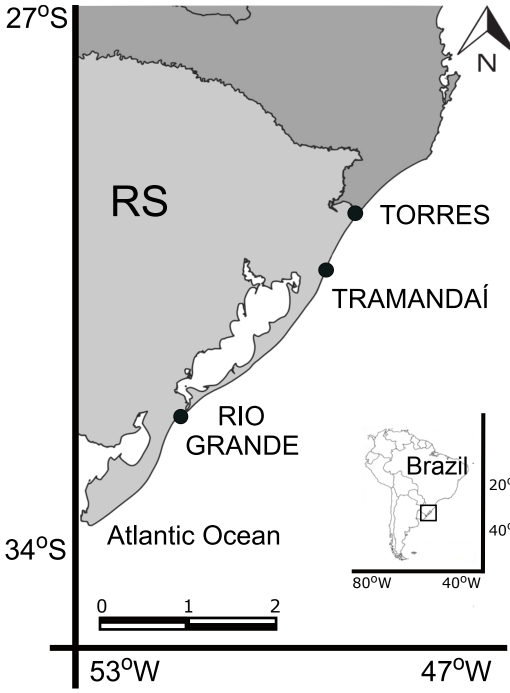

Fig. 1. Location of the three-trawl fishery landing sites (Torres, Tramandaí, and Rio Grande) along the State of Rio Grande do Sul coastal region (Southern coast of Brazil)

Seahorses were stored on ice and transferred to the laboratory where they were kept until examined. In the laboratory, the height (HT) (distance from the top of the coronet to the tip of elongated tail) of each individual was measured to the nearest 0.01 mm using a digital calliper and then they were dissected under a stereomicroscope (Lourie et al. 2004). Individuals were classified in two stages of development: juvenile (<48.5 mm) and adult (>48.5mm), according to the presence and development state of brood pouch (Foster and Vincent 2004) and the macroscopic evaluation of gonads, using a macroscopic staging system based on gonad size, colour, vascularization, and the presence of identifiable oocytes (Brown-Peterson et al. 2011). The digestive tract was removed, sectioned at the constriction (sphincter) that separates the foregut (stomach) from the midgut (intestine) (Yip et al. 2014), and transferred to 70% ethanol for conservation. After that, the stomachs were dissected for food items analyses.

Food items were counted and identified to the lowest possible taxonomic level according to specific literature (Chapman 2007), and classified into two major categories: benthic (organisms that live in or near the marine substrate) and pelagic preys (organisms that live in the pelagic zone, characterized by adaptations that make possible buoyancy and motility). Diet composition was then estimated by the frequency of occurrence (FO%, percentage of stomachs in which a food item occurs considering all stomachs examined) and the numeric frequency (FN%, the percentage participation of each item in relation to the total abundance of preys) methods (Hyslop 1980).

Variations on the diet composition according to the stage of development (juvenile, adult), sites (Torres, Tramandaí, and the Rio Grande), and seasons (cold, warm) were assessed with permutational multivariate analyses of variance (PERMANOVA). Cold (<19°C, from May to October) and warm (>20°C, from November to April) seasons were characterized based on temperature historical data (January 1964 to August 2015) provided by INMET (National Institute of Meteorology). PERMANOVA (999 permutations under a reduced model) were performed by the PRIMER v. 6.1.13 ® with PERMANOVA + 1.0.3 add-on package software*, using stomachs as replicates and the stage of development, sites and seasons as fixed factors. A similarity matrix was constructed using the Bray–Curtis coefficient based on the standardized and transformed ($\log X + 1$) values of the abundance of food items.

RESULTS

A total of 82 individuals (25 juveniles and 57 adults) of *Hippocampus patagonicus* were measured, ranging from 28 to 110 mm HT (mean ± standard deviation = 56.6 ± 17.6 mm). Only 57 (69.5%) stomachs contained prey items, and the vacuity rate (proportion of empty stomachs) was therefore 30.5%. Among the stomachs with content, 22 (38.6%) belong to juveniles (HT mean ± SD = 40.4 ± 7.7 mm) and 35 (61.4%) to adults (HT mean ± SD = 66.8 ± 13.9 mm, 14 females and 21 males). Identifiable prey items included organisms representing Crustacea (Amphipoda, Isopoda, Tanaidacea, Copepoda, Decapoda, and Ostracoda), Annelida, Foraminifera, and Nematoda. Algae fragments were recorded in small quantities and most probably represent accidental ingestion during prey capture. PERMANOVA analysis revealed significant differences between seasons (Pseudo-F = 2.99, P = 0.04, Unique perms = 985), but no differences were observed between sites (Pseudo-F = 1.55, P = 0.11, Unique perms = 998) and stages of development (Pseudo-F = 0.97, P = 0.39, Unique perms = 999). According to the frequency of occurrence and the numeric frequency of food item, in the warm season, the diet recorded in 42 stomachs was dominated by amphipods, mostly Dexaminidae and unidentified Gammaridea, and in the cold season (N = 15) by Decapoda megalopa and Dendobranchiata, and also Isopoda (*Gnathia*) (Table 1).

DISCUSSION

The presently reported study revealed that *Hippocampus patagonicus* feed largely on small benthic and pelagic zooplankton organisms, mainly amphipods, decapod post-larvae (megalopa), and isopods. The high

* Clarke K.R., Gorley R.N. 2006. PRIMER version 6: User Manual/Tutorial, Plymouth: Primer-E Ltd.

Table 1

Diet composition of *Hippocampus patagonicus* from South Atlantic expressed in frequency of occurrence (FO%) and numeric percentage (FN%)

Higher taxa	Food item	*N*	Ecological category	Season			
				Warm	Warm	Cold	Cold
				FO%	FN%	FO%	FN%
CRUSTACEA	Crustacea gen sp.	54	?	40.82	27.72	12.5	10.34
Class Malacostraca	Aoridae gen sp.	3	B	2.04	0.54	12.5	6.90
Order Amphipoda	Hyalidae gen sp.	2	B	4.08	1.09	—	—
Suborder Gammaridea	Isaeidae gen sp.	1	B	2.04	0.54	—	—
	Dexaminidae gen sp.	56	B	24.49	30.43	—	—
	Ischyroceridae gen sp.	6	B	10.2	3.26	—	—
	Ampithoidae gen sp.	4	B	2.04	2.17	—	—
Suborder Hyperiidea	*Lestrigonus* spp.	24	P	6.12	12.50	12.5	3.45
Order Isopoda	*Munna* spp.	1	B	2.04	0.54	—	—
	Gnathia spp.	11	B	2.04	0.54	12.5	34.48
Order Tanaidacea	Paratanaidae gen sp.	1	B	2.04	0.54	—	—
Order Decapoda	megalopa	22	P	14.29	5.98	50.0	37.93
	Dendrobranchiata gen sp.	8	P	10.2	3.26	25.0	6.90
Class Maxillopoda							
Subclass Copepoda	Harpacticoida gen sp.	3	B	4.08	1.63	—	—
Class Ostracoda	Ostracoda gen sp.	1	B	2.04	0.54	—	—
ANNELIDA	Polychaeta gen sp.	1	B	2.04	0.54	—	—
FORAMINIFERA	*Cribroelphidium* cf. *poeyanum*	2	B	2.04	1.09	—	—
NEMATODA	Nematoda gen sp.	1	B	2.04	0.54	—	—
	VEGETAL	11	?	20.41	5.98	—	—

N = total abundance of prey, B = benthic, P = pelagic.

consumption of amphipods was also reported by Storero and González (2008) for *H. patagonicus* in its southernmost known population of Argentina (Santo Antonio Bay), and also for others seahorses species (Burchmore et al. 1984, Teixeira and Musick 2001, Woods 2002, Kendrick and Hyndes 2005, Kitsos et al. 2008, Gurkan et al. 2011, Yip et al. 2014). In fact, amphipods are one of the most common prey items of many benthic-feeding fishes (Wakabara et al. 1982). They are a diverse and abundant group of peracaridean crustaceans that inhabit a variety of benthic substrata (Thomas 1993), and their density and geographic distribution are highly influenced by hydrodynamic conditions (Rodrigues et al. 2012, Maria et al. 2016).

According to Storero and González (2008), *H. patagonicus* feed on a broad spectrum of crustacean's organisms, mainly amphipods (Gammaridae and Caprellidae) and planktonic larvae of decapods (particularly, Brachyura and Caridea). Even considering that the identity of preys varied considerably between our study and those of Storero and González (2008), such variations in the dietary composition appear to be related to the prey availability.

Contrary to our expectations, the diet composition of *H. patagonicus* did not differ significantly among the three landing sites, even though the distribution and spatial variability of zooplankton organisms along the Brazilian coast are highly influenced by local and regional hydrodynamic conditions (Lopes 2007). We believe that this result was influenced by the taxonomic resolution of prey categories on the analyses (Pombo et al. 2013), since amphipods and decapod post-larvae were incompletely identified because of the degree of digestion, and also by the overlap of industrial trawl fishing grounds in southern Brazil.

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