Zoologischer Anzeiger 274 (2018) 34–45

Contents lists available at ScienceDirect

Zoologischer Anzeiger

journal homepage: www.elsevier.com/locate/jcz

Zoologischer Anzeiger

The ecology and developmental changes of meristic characters of the medusa *Malagazzia carolinae* (Hydrozoa: Leptothecata) from subtropical Southwestern Atlantic estuaries

Miodeli Nogueira Júnior [a,*], Lorena Silva Nascimento [b]

[a] Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, Cidade Universitária, João Pessoa, 58051-900, Brazil
[b] Laboratório de Zooplâncton, Centro de Estudos do Mar, Universidade Federal do Paraná, s/n, Pontal do Paraná, Paraná, 83255-976, Brazil

ARTICLE INFO

Article history:
Received 20 December 2017
Received in revised form 17 March 2018
Accepted 19 March 2018
Available online 20 March 2018
Corresponding Editor: Martin V. Sorensen

Keywords:
Medusa
Morphology
Ontogeny
Abundance
Population dynamics
South atlantic

ABSTRACT

In the present study we show that the meristic marginal characters of the hydromedusa *Malagazzia carolinae* changes through its ontogeny. We additionally present background-data on abundance and size composition spatial temporal dynamics of this poorly-known medusa from five subtropical Brazilian estuaries (~24–26.5°S). Data presented are important to improve taxonomy of the group and to track life-history strategies. The number of marginal structures varies considerably: tentacular bulbs ranged between 0 and 7, rudimentary bulbs between 0 and 12 and statocysts between 1 and 22 on each quadrant and their numbers tended to increase with bell diameter. *Malagazzia carolinae* was nearly absent from the open shallow shelf, and among the five estuaries sampled it was more common and abundant inside Babitonga and Guaratuba Bays, where a well-defined distribution was found, with peaks in January mostly in the inner sectors (mean 8–10 ind. 10 m^{-3}). Although sampled in wide hydrographic conditions, *M. carolinae* was mostly found in intermediate salinities (21–26) and temperatures (22–29 °C), suggesting it is well adapted to thrive in estuarine subtropical and tropical systems.

1. Introduction

There are currently eight species known for the genus *Malagazzia* (Schuchert, 2016), and number of marginal structures are commonly used as important characters to distinguish the different species (Akiyama et al., 2013; Bouillon et al., 1991; Kramp, 1961). *Malagazzia carolinae* was originally described by Mayer (1900) as *Oceania carolinae*, from Charleston Harbor, South Carolina, USA, and 24–36 tentacular bulbs, 48 rudimentary bulbs and 64 statocysts are considered typical for this medusa (Akiyama et al., 2013; Bouillon, 1999; Kramp, 1961; Mayer, 1900, 1910). However, the number of repeated structures is often highly variable through ontogeny in hydromedusa (Nogueira Júnior et al., 2016; Kramp, 1953; Russell, 1953). This may generate taxonomic doubts, particularly regarding young or not fully developed individuals of species which have not been characterized through the range of their variability. In the present study, we explore the meristic variability in the marginal structures of the hydromedusa *M. carolinae*, particularly testing their relationship with bell diameter, in order to better characterize the morphology of the species and the taxonomy of the genus.

Malagazzia carolinae is common and abundant in many regions of the world (e.g. Du et al., 2011; Larson, 1982). It is a typical inshore medusa (Larson, 1982), particularly associated to brackish water environments such as estuaries and river mouths (Navas-Pereira, 1980, 1984; Vannucci and Navas, 1973). Yet, baseline data on abundance, size composition and seasonal dynamics, along with relationship with hydrographical parameters are mostly missing. This is particularly true for the southwestern Atlantic, where such general abundance and life-history basic information, which is paramount to track population fluctuations and to understand life-history strategies (Boero et al., 2008), is historically missing for most estuarine hydromedusa species (Nogueira Júnior et al., 2018; Zamponi and Genzano, 1994). Thus, we additionally describe the abundance, size composition and seasonal and spatial dynamics of this medusa species, from different subtropical Brazilian estuaries (~23.9–26.3°S), particularly testing for the relationship with hydrographical parameters (temperature and salinity) and differences between locations.

* Corresponding author.
E-mail addresses: miodeli@gmail.com (M. Nogueira Júnior), nascimento.s.lorena@gmail.com (L. Silva Nascimento).

https://doi.org/10.1016/j.jcz.2018.03.002
0044-5231/

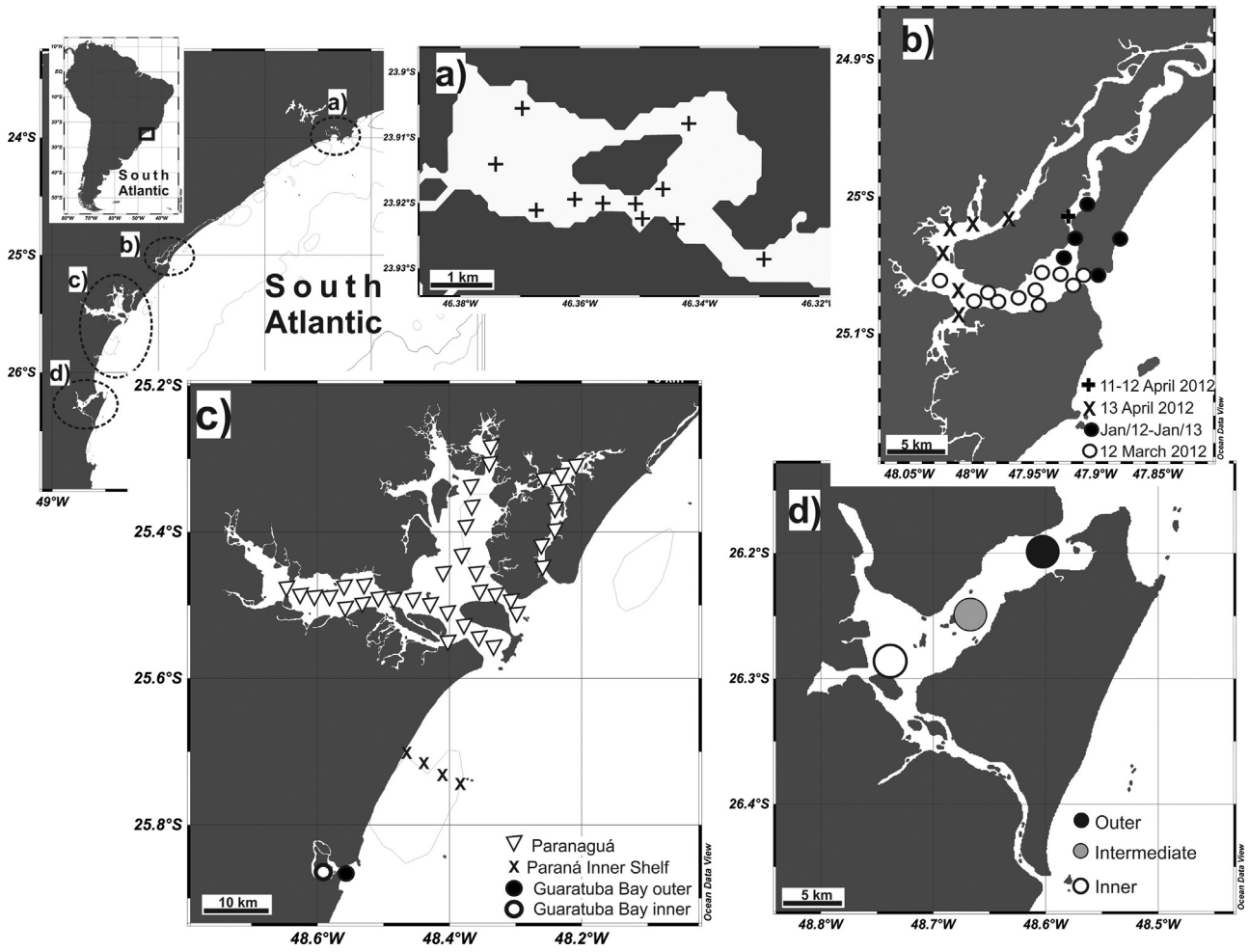

Fig. 1. Map of the South Brazilian Bight showing the areas sampled for *Malagazzia carolinae*; **(a)** Santos Bay, sampled monthly between May 2013 and October 2014; **(b)** Cananéia-Iguape Estuarine System sampled between January 2012 and January 2013; **(c)** Paranaguá Estuarine System sampled seasonally between March 2012 and June 2014, Paraná inner shelf, sampled seasonally between January 2009 and May 2012, and Guaratuba Bay sampled monthly between November 2008 and April 2009; **(d)** Babitonga Bay sampled monthly between August 2009 and July 2010. Different sampling strategies **(b)** or sectors **(c, d)** indicated in the legend of each panel.

2. Material and methods

Malagazzia carolinae medusae from shallow open shelf waters and five subtropical Brazilian estuaries (~23–26°S, 46–48°W; Fig. 1) were analyzed from different sampling programs in a total of 848 zooplankton samples.

i) Monthly surveys were performed at Santos Bay (23.9°S, 48.3°W; Fig. 1a) between May 2013 and October 2014. On each occasion 11 stations were sampled twice, during ebb and flood tide, totaling 396 stations. Zooplankton was sampled during daylight on each station using a cylindrical-conical plankton net with 55 cm of mouth diameter and 300 μm mesh-size.

ii) At the Cananéia-Iguape Coastal System (25°S, 48°W) five stations (Fig. 1b) were sampled every second month during daytime between January 2012 and January 2013 (see Miyashita and Calliari, 2016 for more details on sampling procedures and hydrographic conditions). At each station, a single haul was performed with a conical plankton net (90 μm mesh-size; 40 cm mouth diameter), in a total of 26 samples. On 12 March 2012, eleven stations were sampled with a cylindrical-conical plankton net with 1 m mouth diameter and 300 μm mesh-size. On 11 and 12 April 2012, a single station was sampled every two hours between 09:00 and 17:00 h. At each sampling time, three hauls were made with a cylindrical-conical plankton net with mouth diameter of 50 cm and 160 μm mesh-size, for a total of 30 samples. Additionally, one haul was made with a conical plankton net with mouth diameter of 30 cm and 60 μm mesh-size, totaling 10 samples. On 13 April 2012, six additional stations were sampled with a cylindrical-conical plankton net with mouth diameter of 50 cm and 160 μm mesh size.

iii) Five sampling campaigns were performed at Paranaguá Estuarine System (25.5°S, 48.4°W; Fig. 1c), encompassing three summers (13–16 March 2012; 21–22 February 2013; 28–29 March 2014) and two winters (23–24 August 2013 and 18–19 June 2014). On each campaign 37 stations were sampled in a total of 185 stations. Plankton samplings were performed with a cylindrical-conical plankton net with 50 cm mouth diameter, 200 μm mesh-size (see Nascimento, 2016 and Salvador and Bersano, 2017 for more details on sampling procedures and hydrographic conditions).

iv) Open shallow shelf waters of Paraná State (~25.6°S, 48.5°W; Fig. 1c), were surveyed in eleven seasonal cruises between January 2009 and May 2012 (January and March 2009; April, June, September and December 2010; April, July and October 2011; and February and May 2012). Each cruise sampled four stations located between 3 and 11 km offshore (10–16 m depth). Some stations could not be sampled at a few cruises due to bad weather conditions, totaling 40 stations. At each station, zoo-