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## The first occurrence of the Order Mormonilloida (Copepoda) in the Tropical Southwest Atlantic Ocean

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### ABSTRACT

This communication is the first report of the occurrence of the order Mormonilloida (*Mormonilla phasma*) in the tropical Southwestern Atlantic Ocean. Female individuals were found in surface waters from the shelf break state of Rio Grande do Norte (Northeastern Brazil) and between depths of 60 and 100 m in the epipelagic layer around the St. Peter and St. Paul Archipelago (equatorial Atlantic). This finding extends the vertical limits for this species.

**Key words:** Copepod, equatorial, Mormonilloida, *Mormonilla phasma*, oceanic island, zooplankton.

### INTRODUCTION

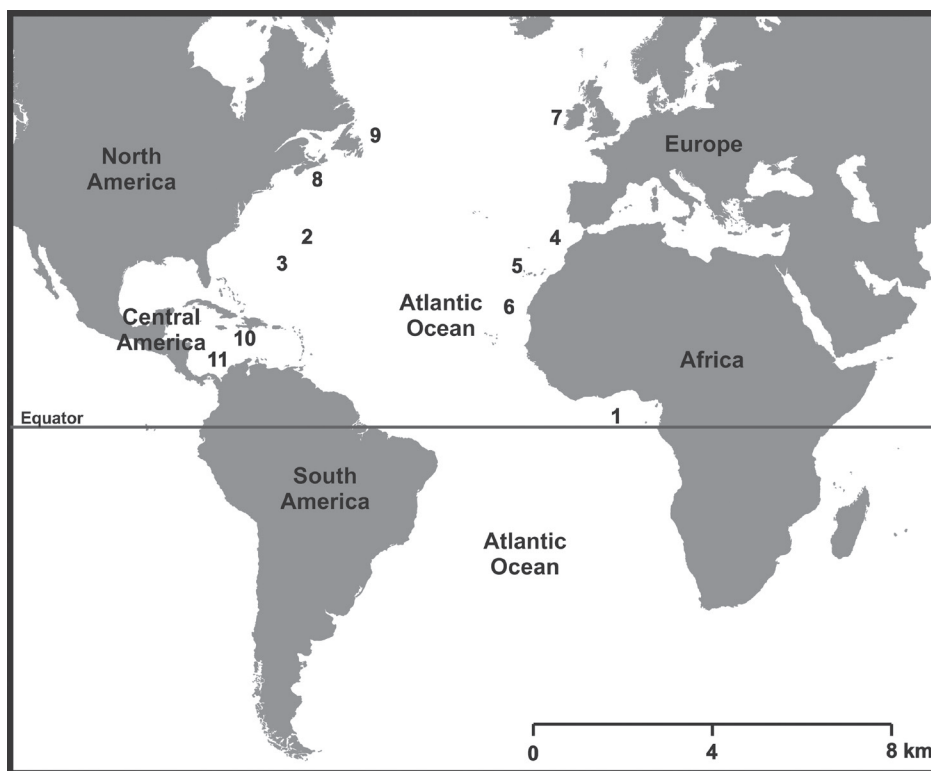
The genus *Mormonilla* was initially described by Giesbrecht in 1891 and placed in a separate family, Mormonillidae. Due to the combination of the characters of superorders Podoplea and Gymnoplea that the group presented, its position in the classification of Copepoda, long remained uncertain (Boxshall 1979). After several attempts to define the best classification, Boxshall (1979) proposed the elevation of the family to ordinal level, thereby creating the order Mormonilloida.

The order Mormonilloida includes two genera, *Mormonilla* and *Neomormonilla*, comprising five species. The genus *Mormonilla* has two species, *M.*

*minor* Giesbrecht, 1891 and *M. phasma* Giesbrecht, 1891, which are widely distributed in oceanic waters between depths of 400 and 4000 m (Boxshall 2001). Boxshall and Halsey (2004) emphasize that approximately 90% of the population is concentrated between depths of 400 and 700 m in the shallow zone of the mesopelagic environment. These authors suggest that specimens may occasionally occur in shallow hauls from a depth of 300 m.

Scott (1893) first recorded the species for the equatorial Atlantic in the Gulf of Guinea. In the database created by Razouls et al. (2005-2012), the species is cited for the Brazil-Argentina geographical area. However, the papers listed in this database suggest the occurrence of the species just off the coast of Africa and in the North Atlantic (Figure 1).

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**Figure 1** - Studies that recorded *Mormonilla phasma* (Mormonilloidea) from the Atlantic Ocean, compiled from Razouls et al. (2005-2012). 1: Equatorial Atlantic (Gulf of Guinea) (Scott 1893), 2: NW Atlantic (Grice 1963), 3: NW Atlantic (off Bermuda) (Deevey and Brooks 1977), 4: NE Atlantic (Morocco, Mauritania) (Vives 1982), 5: NE Atlantic (Canary Is.) (Lozano Soldevilla et al. 1988), 6: NW African Coast (Huys et al. 1992), 7: N Atlantic (Ireland) (Holmes 2001), 8: NW Atlantic (off E Nova Scotia) (Sameoto et al. 2002), 9: NW Atlantic (Ivanenko and Defaye 2006), 10: Caribbean Sea (Morales-Ramirez and Suarez-Morales 2008), 11: NW Atlantic (Colombian Caribbean) (Medellín-Mora and Navas S 2010).

The purpose of this communication is to furnish the first report of the occurrence of the Order Mormonilloidea (*Mormonilla phasma* Giesbrecht, 1891) in the tropical Southwest Atlantic Ocean and to extend its vertical limits for epipelagic waters.

The specimens were collected in two regions of the Brazilian waters: (i) the St. Peter and St. Paul Archipelago (SPSPA) and (ii) the shelf break of the state of Rio Grande do Norte (Potiguar Basin). At the SPSPA, vertical hauls were conducted from 100 m up to the surface in layers of 20 m with an opening-closing plankton net of 200  $\mu$ m mesh size. In the Potiguar Basin, transects were delimited perpendicular to the coastline, with stations located on the 150, 400, 1000 and 2500 m isobaths. At

these stations, horizontal hauls were conducted in the nuclei of the main water masses (Tropical Water, South Atlantic Central Waters, Antarctic Intermediary Water, North Atlantic Deep Water) using a multinet with a 300  $\mu$ m mesh size.

At the SPSPA, 60 samples were analyzed, with individuals of *M. phasma* observed only in three of these samples. Five individuals of *M. phasma* were recorded during the dry season (Sep-Oct 2011), and the density varied from 0.16 to 1.44 ind.  $m^{-3}$  (Table I). The individuals were observed in the 60-80 m and 80-100 m layers downstream and upstream of the SPSPA, respectively (Table I). The oceanic dynamics that act on the SPSPA are subject to the influence of the Equatorial South

TABLE I  
Samples in which *Mormonilla phasma* (Mormonilloida) occurred at  
the Saint Peter and Saint Paul Archipelago and Potiguar Basin (RN).

Study Area	Latitude	Longitude	Water Mass	Depth	Time	Date	No. specimens	Density (ind.m <sup>-3</sup> )
SPSPA	00°55,060 N	29°20,393 W	TW	80-100m	Day	Sep/2011	2	1.44
	00°54,979 N	29°21,076 W	TW	60-80m	Day	Sep/2011	1	0.16
	00°55,060 N	29°20,393 W	TW	80-100m	Night	Oct/2011	2	1.33
Potiguar Basin (RN)	04°47,32 S	036°09,39 W	SACW	260±2m	Day	Nov/2009	1	0.06
	04°46,42 S	036°09,16 W	SACW	365±2m	Day	Dec/2009	10	0.32
	04°46,42 S	036°09,16 W	AIW	810±2m	Day	Dec/2009	7	0.27
	04°36,90 S	036°31,69 W	SACW	350±2m	Day	Nov/2009	5	0.05
	04°39,18 S	036°31,69 W	SACW	410±2m	Day	Nov/2009	3	0.07
	04°39,18 S	036°31,69 W	AIW	925±2m	Day	Nov/2009	46	0.21
	04°39,18 S	036°31,69 W	NADW	1600±2m	Day	Nov/2009	22	0.17
	04°260,34 S	036°25,92 W	NADW	1600±2m	Day	Nov/2009	11	0.10

Stream (ESS) and Sub-Equatorial Current (SEC) (Araújo and Cintra 2009). The ESS flows East-West; the SEC flows eastbound over the equator, just beneath the surface (Stramma 1991). The SEC splits in the immediate vicinity of Cape St. Roque to produce the Northern Brazil Current (NBC) and the Brazil Current (BC) (Richardson and Walsh 1986). At Potiguar Basin, 105 individuals of *M. phasma* were recorded in eight samples of the total of 28 analyzed. All specimens collected were females, with a density varying between 0.05 and 0.32 ind. m<sup>-3</sup> ( $0.16 \pm 0.10$  ind. m<sup>-3</sup>) (Table I). The individuals were collected between 260 and 1600 m, with the higher concentrations occurring from 365 to 810 m (Table I). The females of this species are considered to be small-particle feeders (Boxshall 1985). The males, characterized by reduced feeding appendages and modified antennules, are interpreted as nonfeeding (Huys et al. 1992) and are extremely rare (Böttger-Schnack 1996). Specimens were deposited in the Crustacea collections of the Museu Oceanográfico Petrônio Alves Coelho (MOUFPE), Federal University of Pernambuco (MOUFPE No. 15123 - 15133).

*M. phasma* is considered to be restricted to the bathypelagic (Böttger-Schnack 1996) or mesopelagic zones (Boxshall and Halsey 2004, Ivanenko and

Defaye 2006). However, the specimens collected at the SPSPA were found between 60 and 100 m. As far as we know, this record represents the first time that this species has been obtained at such a shallow depth in tropical waters. Although the genera *Mormonilla* (*M. minor*) and *Neomormonilla* (*N. polaris*) have been observed in shallow cold waters near the North Pole (Deevey and Brooks 1977, Ivanenko and Defaye 2006), this pattern has not been found for tropical or subtropical waters, where the surface temperature is high (> 25°C). Shimode et al. (2006) observed in Sagami Bay (Japan) that *M. phasma* has not been collected in layers above 100 m and that the species most often occurs between 200 and 1000 m. Longhurst (1985), studying the tropical Pacific Ocean, notes the occurrence of *Mormonilla* just under 100 m. In the Potiguar Basin, the specimens, in most cases, were observed just above the maximum limit of 300 m suggested by Boxshall and Halsey (2004).

The presence of this species above 100 m at the SPSPA may be related to upwelling events in the area. Araújo and Cintra (2009) emphasize that the interaction of the abrupt topography of the SPSPA with the northern branch of the South Equatorial Current (nSEC) causes the production of vortices, thermohaline circulation disturbances and potential

mechanisms of local upwelling. The presence at the surface of deep-water species (*Phaenna spinifera*, *Heterorhabdus papillifer*, *Pleurommama abdominalis*, *P. gracilis* among others) at the SPSPA indicates the occurrence of upwelling events (Diaz et al. 2009, Melo et al. 2012).

The first record of *M. phasma* in Chilean waters confirmed that the species was restricted to deep water (Hidalgo et al. 2010).

Although this first record of the occurrence of *M. phasma* for the tropical Southwest Atlantic Ocean is most likely due to the lack of taxonomic reports of copepods from the meso- and bathypelagic zones in this region, this study highlights an increase in the amplitude of the vertical distribution of *M. phasma* to above 100 m, an important factor for the ecology of the species. In addition, the low densities observed in both regions ( $< 2 \text{ ind. m}^{-3}$ ) demonstrate that *M. phasma* occurs in small populations in the Southwest Atlantic Ocean, even in deeper water ( $\sim 1600 \text{ m}$ ).

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#### RESUMO

Esta nota é o primeiro registro da ocorrência de *Mormonilla phasma* (Copepoda) no Sudoeste do Oceano Atlântico Tropical. Indivíduos fêmeas foram encontrados em águas superficiais na quebra da plataforma do estado do Rio Grande do Norte (Nordeste do Brasil) e entre 60 e 100 m de profundidade, na

camada epipelágica ao largo do Arquipélago de São Pedro e São Paulo (Atlântico Equatorial). Este achado estende o limite vertical da espécie.

**Palavras-chave:** Copépodes, equatorial, Mormonilloidea, *Mormonilla phasma*, ilha oceânica, zooplâncton.

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