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Research Article

On some rare Oplophoridae (Caridea, Decapoda) from the South Mid-Atlantic Ridge

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ABSTRACT. The Mid-Atlantic Ridge (MAR) divides the Atlantic Ocean longitudinally into two halves, each with a series of major basins delimited by secondary, more or less transverse ridges. Recent biological investigations in this area were carried out within the framework of the international project Mar-Eco (Patterns and Processes of the Ecosystems of the Mid-Atlantic Ridge). In 2009 (from October, 25 to November, 29) 12 benthic sampling events were conducted on the R/V Akademik Ioffe, during the first oceanographic cruise of South Atlantic Mar-Eco. As a result we report some rare Oplophoridae species collected during the cruise. This family includes 73 species occurring strictly on the meso- and bathypelagic zones of the oceans. Five Oplophoridae species were sampled: *Acanthephyra acanthitelsonis* Bate, 1888; *A. quadrispinosa* Kemp, 1939; *Heterogenys monnioti* Crosnier, 1987; *Hymenodora glacialis* (Buchholz, 1874) and *Kemphyra corallina* (A. Milne-Edwards, 1883). Among these, *H. monnioti* and *K. corallina* are considered extremely rare, both with very few records. Of the sampled species, only *A. quadrispinosa* and *H. glacialis* were previously recorded to southwestern Atlantic, so the Oplophoridae fauna of the South MAR seems more related with the fauna from the eastern Atlantic and Indian oceans.

Keywords: Oplophoridae, Caridea, Decapoda, systematics, Mid-Atlantic Ridge.

Sobre algunos Oplophoridae (Caridea, Decapoda) raros de la Cordillera Meso-Atlántica Sur

RESUMEN. La Cordillera Meso-Atlántica (CMA) divide el Océano Atlántico en dos partes, cada una con varias cuencas delimitadas por cadenas de montañas transversales. Recientemente se han efectuado investigaciones biológicas en esta región en el marco del proyecto internacional Mar-Eco (Patterns and Processes of the Ecosystems of the Mid-Atlantic Ridge). Entre octubre y noviembre de 2009 se obtuvo 12 muestras bentónicas durante el primer crucero oceanográfico del Mar-Eco del Atlántico Sur. Durante este crucero se encontraron algunas especies raras de la familia Oplophoridae. Esta familia incluye 73 especies que ocurren estrictamente en las zonas meso- y batipelágicas de los océanos. Se colectaron cinco especies de Oplophoridae: *Acanthephyra acanthitelsonis* Bate, 1888; *A. quadrispinosa* Kemp, 1939; *Heterogenys monnioti* Crosnier, 1987; *Hymenodora glacialis* (Buchholz, 1874) y *Kemphyra corallina* (A. Milne-Edwards, 1883). De éstas, *H. monnioti* y *K. corallina* son consideradas muy raras, ambas con escasos registros. Solamente *A. quadrispinosa* y *H. glacialis* se han registrado previamente en el Atlántico sudoccidental; así la fauna de Oplophoridae de la CMA Sur parece más relacionada con la fauna del Atlántico este y océano Índico.

Palabras clave: Oplophoridae, Caridea, Decapoda, sistemática, Cordillera Meso-Atlántica.

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INTRODUCTION

The seamounts are biologically distinctive habitats of the open ocean exhibiting a number of unique features (Rogers, 1994). One of the most well-known oceanographic effects of seamounts is the formation of eddies of water associated with upwelling of nutrient rich waters, leading to increasing productivity. Due to restricted food supplies in open-oceans, seamounts and the water column above them serve as important habitats, feeding grounds and sites of reproduction for many open-ocean and deep-sea species (Rogers, 1994; Probert, 1999). In general, seamounts appear to support a highly diverse fauna, but these effects were never studied in seamounts chains.

The Mid-Atlantic Ridge (MAR) is a seamount chain that divides the Atlantic Ocean longitudinally into two halves, each with a series of major basins, delimited by secondary more or less transverse ridges. The Ridge extends above the 2000 m contour along most of its length and has a major influence on the circulation of near-bottom water masses (Levin & Gooday, 2003). The most important transverse ridges are, the Walvis Ridge on the southeastern MAR and the Rio Grande Rise, on the opposite side of the MAR. The Walvis Ridge extends for thousands of miles, rising from oceanic depths of more than 5 km to reach peak depths of less than 1 km (Linden, 1980). The ridge stretches southwest to northeast between the MAR and the continental margin of south-west Africa and separates the Angola basin in the north from the Cape Basin in the south (Linden, 1980). The Walvis Ridge and the Rio Grande Rise, are commonly treated as a combination, probably originated from hotspot volcanism. However, they are morphologically completely different and their origin is still controversial (Linden, 1980).

The whole region, with such a diverse and peculiar nature, probably nests a diverse and interesting deep-sea fauna. This expectation has prompted recent biological investigations on the southern Mid Atlantic Ridge, including the Walvis Ridge area, within the framework of the international project Mar-Eco. One of the most important goals of the South Atlantic Mar-Eco is to relate the Western and Eastern Atlantic MAR faunas, evaluating the effects of the Walvis Ridge and the Rio Grande Rise as bridges.

The present study reports on some rare species of Oplophoridae Dana, 1852. The family includes 73 species distributed in 10 genera (Fransen & De Grave, 2009). The members of this family are considered pelagic and occur strictly on the meso- and bathypelagic zones of the oceans.

Morphological adaptations for pelagic life such as natatory exopods, which occur in all species, and lightly calcified, almost membranous exoskeleton of some genera are evidence of the habitat they occupy (Bauer, 2004). Among the papers dealing with oplophorids, many deal with the southwestern Atlantic (Bate, 1888; Barnard, 1950; Crosnier & Forest, 1967, 1973) and few of them with the south-western Atlantic (Cardoso & Young, 2005; Cardoso, 2006). However none of them has ever considered the South Mid Atlantic Ridge oplophorids.

MATERIALS AND METHODS

The Mar Eco project (Patterns and Processes of the Ecosystems of the Northern Mid-Atlantic) is part of the Census of Marine Life which aims to assess and explain the diversity, distribution, and abundance of marine life. Mar Eco objectives aims to enhance our understanding on the occurrence, distribution and ecology of animals and animal communities along the Mid-Atlantic Ridge, being supported by the Sloan Foundation (http://www.mar-eco.no/sci/__data/page/805/ Finalscienceplan.pdf).

Sampling was done during the first oceanographic cruise of Mar Eco South from 25 October to 29 November of 2009 on the R/V Akademik Ioffe. A total of 12 benthic sampling sites, using a Sigsbee trawl, were conducted, five in the South Equatorial MAR Sector (SEMS), two in the Tropical MAR Sector (TMS) and five in the Walvis Ridge Sector (WRS). Despite the pelagic habit of Oplophoridae they were caught probably during the trawl movements in the water column.

The specimens were fixed in ethanol 70%, identified, drawn, redescribed and deposited at the Crustacea collection of Museu Nacional/Universidade Federal do Rio de Janeiro (MNRJ). To identify one species comparative material from National Museum of Natural History (NMNH) was examined. Measurements presented are from carapace length.

RESULTS

Family Oplophoridae Dana, 1852

Genus *Acanthephyra* A. Milne-Edwards, 1881

Acanthephyra acanthitelsonis Bate, 1888 (Fig. 1)

Acanthephyra acanthitelsonis Bate, 1888: 745, pl. 125, fig. 3; Kemp, 1939: 574; Barnard, 1950: 668; Chace, 1947: 16; 1986: 9; Crosnier & Forest, 1967: 1129; 1973: 31, figs.7a-7b.

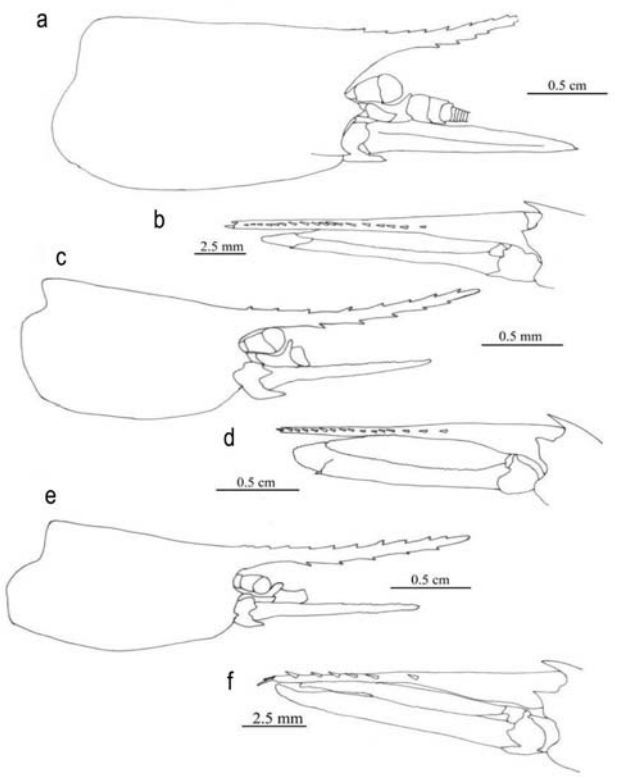

Figure 1. *Acanthephyra acanthitelsonis* Bate, 1888, male (16.1 mm), MNRJ 22567. a) Carapace, lateral view; b) telson and uropods, lateral view; ovigerous female (13.58 mm), USNM 166595; c) carapace, lateral view; male (21.12 mm), USNM 164890; d) telson and uropods, lateral view. *Acanthephyra pelagica* (Risso, 1816), female (11.73 mm), USNM 1123206; e) carapace, lateral view; f) telson and uropods, lateral view.

Material examined: superstation 3, 04°46'49"S, 12°16'15"W, SEMS, 3342 m, 1 male (16.1 mm), MNRJ 22567.

Comparative material: 09°03'N, 49°16'W, north Atlantic, 490 m, coll. Atlantis II, 2 ovigerous females (13.5-13 mm), id. Judkins, USNM 166595; 15°59'S, 02°02´E, south Atlantic, 290 m, coll. Atlantis, 3 males (12.5-21.1 mm), 21 females (9-12.8 mm), USNM 164890.

Diagnosis: rostrum in adults not reaching scaphocerite end, shorter than carapace (brooked at south Atlantic examined specimen); branchiostegal spine strong, flared outwards, with distinct carina extending backwards on to carapace for three times the spine length (Figs. 1a and 1c). Abdomen dorsally carinated on all somites, except on somite 1; somites 3-6 with a posteromesial tooth, that of somite 3 longer than any other. Telson sulcate on dorsal midline, with 13-19 (18 at south Atlantic examined specimen) pairs of dorsolateral spines and two pairs of distal spines (Figs. 1b and 1d) (modified from Kemp, 1939).

Distribution: restrict to central and south Atlantic from 14°N to 28°S: Western: Bahamas; Central: South Equatorial MAR (first record) (Fig. 2); Eastern: Serra Leoa, Gabon, Congo, Angola. From 230-4000 m.

Remarks: this species is included in *A. purpurea* species group (Kemp, 1939) with more than seven species that can be identified mainly by the number of dorsolateral spines of the telson. In this group, the rostrum shape and dentition are of minor taxonomic importance. The material sampled at south Mid Atlantic Ridge agrees with Kemp (1939) diagnosis in all aspects. At 24°S, *Acanthephyra acanthitelsonis* begins to be replaced by a form with 7-11 dorsolateral spines at telson: *A. pelagica* (Risso, 1816). These two species are close related, so comparative material of *A. acanthitelsonis* (Figs. 1c-1d) and also from *A. pelagica* (Figs. 1e-1f) from National Museum of Natural History (NMNH) was examined and figured to facilitate the identification of the south MAR specimens and the future identifications of these species.

All the material of *A. acanthitelsonis* herein examined, from north and south Atlantic, do not vary in the characters mentioned in the identification key of Crosnier & Forest (1973) presenting: smooth dorsal margin at abdominal somites 3-5; abdominal somite 2 without dorsal carina; long and slender rostrum; and 13-19 pairs of dorsolateral spines at telson.

From the 26 specimens of *A. acanthitelsonis* examined at NMNH, two were sampled at north Atlantic and 24 at south Atlantic. The telson was entire in 23 from the 24 south Atlantic specimens and in the two north Atlantic specimens. The number of dorsolateral spines at telson in these 25 specimens was within the range established by Kemp (1939) for this species (13-19). In the south Atlantic material, two males with 15 and one male with 13 pairs of dorsolateral spines; two females with 13, two with 14, two with 15, seven with 16, six with 17 and one with 19 pairs of dorsolateral spines; were observed, and in the north Atlantic material, one ovigerous female with 16 and one with 17 pairs of dorsolateral spines were observed.

Acanthephyra quadrispinosa Kemp, 1939

Acanthephyra batei Stebbing, 1905: 107, pl. 24B (not *A. batei* Faxon, 1895).

Acanthephyra quadrispinosa Kemp, 1939: 576; Barnard, 1950: 668, fig. 124g; Chace, 1986: 26, figs.

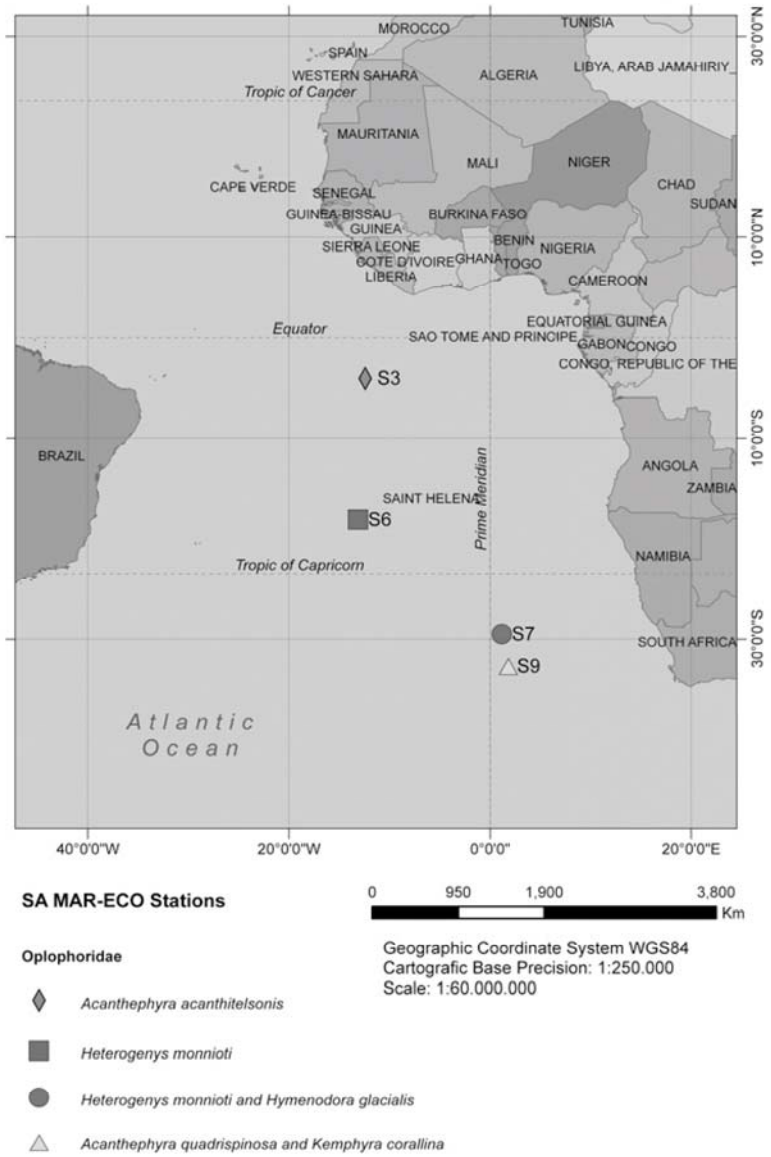

Figure 2. Distribution map of Oplophoridae sampled by the first South Atlantic Mar-Eco cruise.

3h, 4t, 7g, 10c, 14; Kensley, 1987: 284; Cardoso & Young, 2005: 21, figs. 14-18.

Material examined: superstation 9, 32°50'55"S, 01°49'52"E, WRS, 1107 m, local station 201, Mar Eco 1040, 1 male (11.6 mm), MNRJ 22566.

Diagnosis: rostrum usually as long as carapace, overreaching scaphocerite, ventral margin straight, with six teeth, dorsal margin with eight teeth; antennal spine present; branchiostegal spine present with distinct carina extending twice the length of the spine. Abdomen dorsally carinated on all somites, except on somite 1; somites 3 to 6 with posteromesial tooth, the one of somite 3 distinctly strong. Telson sulcate on dorsal midline, with four pairs of dorsolateral spines and two pairs of distal spines (modified from Cardoso & Young, 2005).

Distribution: south Atlantic from 32°S to 45°S: Western: Brazil (Espírito Santo and Rio de Janeiro); Eastern: Cape Point, Walvis Ridge (first record) (Fig. 2). Indian and Pacific oceans: from eastern south Africa to 163°W, and from 25°N to 44°S. From 250 to 1700 m.

Remarks: this species, as well as *A. acanthitel-sonis*, is included in *A. purpurea* species group (Kemp, 1939), but it is easily identifiable by the telson with four pairs of dorsolateral spines and the fourth abdominal somite with posteromesial tooth (Cardoso & Young, 2005).

Genus *Heterogenys* Chace, 1986

Heterogenys monnioti Crosnier, 1987 (Fig. 3a)

Heterogenys monnioti Crosnier, 1987: 704, fig. 3.

Material examined: superstation 5, 18°00'38"S, 13°21'21"W, TMS, 2663 m, local station 201, Mar Eco 1023, 1 female (5.6 mm), MNRJ 22562; Superstation 7, 29°27'39"S, 01°08'25"E, WRS, 3721 m, local station 201, Mar Eco 1030, 4 females (10.1-4.9 mm), MNRJ 22563.

Diagnosis: rostrum directed anterodorsally, large at base tapering to tip, short, reaching a maximum of ¾ scaphocerite length, dorsal margin slightly concave, with 7-8 teeth at all rostrum length, ventral margin sinuous with or without 0-3 sub-distal teeth; antennal spine present, branchiostegal spine absent, pterygostomian spine present without carina; hepatic groove present; cervical groove well developed; branchiostegal suture not well developed; eyes with cornea weakly developed, more slender than the ocular peduncle; scaphocerite with short distal spine not overreaching blade; stylocerite short, not overreaching the antennular peduncle first segment distal margin (Fig. 3a). Abdominal somite 3 with long and slender posteromesial tooth overreaching a half of abdominal somite 4 length (Fig. 3a). Telson with four pairs of dorsolateral spines and two pairs of distal spines (modified from Crosnier, 1987).

Distribution: occidental Indian Ocean: from 29°50,9'S, 48°35,5'E to 30°40,2`S, 48°14,1'E; south Atlantic Ocean: Central: Tropical Mid Atlantic Ridge (Fig. 2); Eastern: Walvis Ridge (Fig. 2) (first records in bold). From 2663-4035 m.

Remarks: Chace (1986) created *Heterogenys* as a monotypic genus based on the presence of a posterodorsal tooth on abdominal somite 3 that overreaches abdominal somite 4, abdominal somites 5-6 without posterodorsal tooth, cornea little more than ½ as wide as maximum width of eyestalk and the mandibles with few blunt teeth on the incisor process. All these features were observed in the material examined herein.

With the description of *H. monnioti* by Crosnier (1987) this genus is no longer monotypic. The main difference between this species and *H. microphthalma* (Smith, 1885) is in the rostrum length and shape (Chace, 1985; Crosnier, 1987). The rostrum at *H. microphthalma* is as long as carapace, overreaching the scaphocerite, with 3 dorsal and 8-9 ventral teeth, it is slender and curved upwards (Chace, 1985). At *H. monnioti*, and also at the material from south Atlantic examined herein (Fig. 3a), the rostrum is short, not overreaching sacphocerite, with a wide base tapering to the tip and with 7 dorsal teeth (Crosnier, 1987).

The material herein examined agrees in all features with the original description of *H. monnioti* but all pereopods and telson extremity were lost and could not be checked. The main differences between the material from the south Atlantic and that from the Indian Ocean are a not well marked branchiostegal suture (Fig. 3a), observed only herein, and the rostrum ventral margin without teeth at south Atlantic material (Fig. 3a). In this way, the diagnosis of this species was modified to include these variations.

Since its first record at occidental Indian Ocean, when two specimens (a male and a female) were sampled (Crosnier, 1987), *H. monnioti* have never been recorded anymore. So the present record of five females, the second for this species, is very important, expanding its known distribution to the south Atlantic Ocean.

Chace (1986) stated that the long posteromesial tooth on third abdominal somite of *H. microphthalma* could constrain its swimming habit, but analysis of the foregut contents indicate that it is not confined to the neighborhood of the bottom (Wasmer, 1972). The posteromesial tooth on third abdominal somite of *H. monnioti* probably also constrains the total extension of abdomen but there are no data on foregut contents of this species.

Genus *Hymenodora* Sars, 1877

Hymenodora glacialis (Buchholz, 1874)

Hymenodora mollicutis Bate, 1888: 848, pl. 137, fig. 2.

Hymenodora glacialis Sivertsen & Holthuis, 1956: 15, figs. 11, 12; Crosnier & Forest, 1973: 84, fig. 25b; Wasmer, 1986: 48, figs. 10a, 11.

Material examined: superstation 7, 29°27´39"S, 01°08´25"E, WRS, 3721 m, local station 201, Mar Eco 1030, 02 specimens without pleopods (6.6, 13.1 mm), MNRJ 22564.

Diagnosis: rostrum short, not overreaching eyes, dorsal and lateral margins swollen, dorsal margin with 6 teeth, ventral margin strongly convex and unarmed; carapace with anteriorly convex groove connecting suprabranchial groove to a groove extending dorsoposteriorly from near mid length of hepatic groove. Epipod of second maxilliped without podobranch. Anterior margin of second segment of antennular peduncle forming broadly and evenly rounded lobe over outer basal part of scaphocerite (modified from Wasmer, 1986).

Distribution: Arctic Ocean. North and south Atlantic Ocean; Western: Argentina; Central: Tristan da Cunha; Eastern: Canary Islands, Sierra Leone, Walvis Ridge (first record) (Fig. 2). Indian Ocean: 9°06'N,

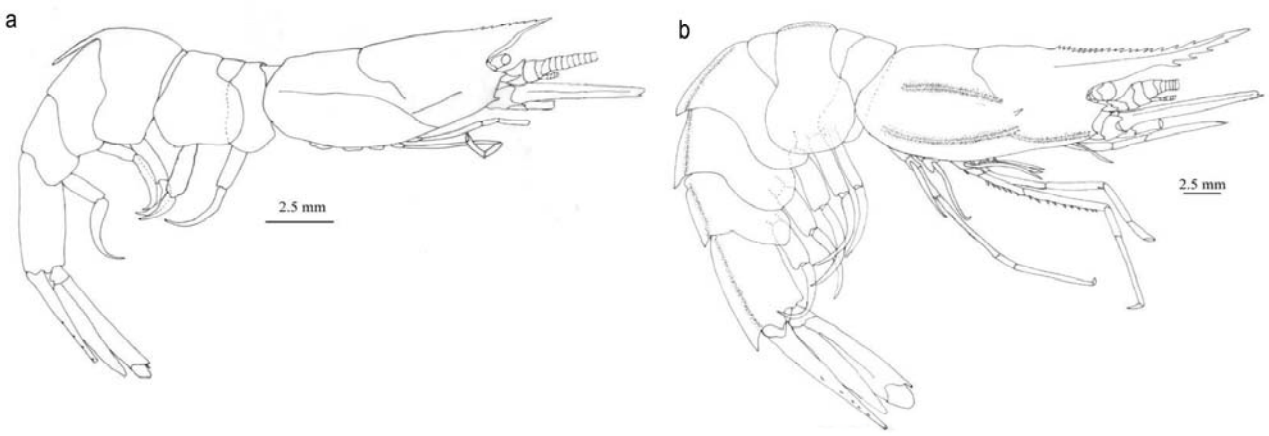

Figure 3. *Heterogenys monnioti* Crosnier, 1987, female (7.4 mm), MNRJ 22563. a) lateral view; *Kemphyra corallina* (A. Milne-Edwards, 1883), male (14.5 mm), MNRJ 22565; b) lateral view.

53°41'E. North Pacific: Bering Sea, gulf of Panama. Southern Ocean: Antarctic Region at Antarctic Polar Front and slightly crossing it. Rarely taken above 2000 m, maximum depth reported of 3900 m.

Remarks: according Sivertsen & Holthuis (1956) specimens *of Hymenodora glacialis* and *H. gracilis* Smith, 1886 have very similar morphology and have been considered by several authors to be one species until around 1939 when Dr. Stanley Kemp studied the genus and came to the conclusion that the two species are really distinct. His results, however, were published only in 1956 by Sivertsen & Holthuis and accordingly them Dr. Kemp stated that the best character to distinguish both species is a groove that connects the suprabranchial groove to a groove that extends dorsoposteriorly from near mid length of hepatic groove, that is present in *H. glacialis* and absent in *H. gracilis*. Yet, according to Sivertsen & Holthuis (1956) the character mentioned by Smith (1886) in the original description of *H. gracilis*, namely the presence of a podobranch on the second maxilliped in this species and its absence in *H. glacialis*, is also reliable to distinguish these species. There are also some differences in the rostrum shape that are used to distinguish these species, but they are not so clear. The presence of the specific groove on carapace and the absence of podobranch in the second maxilliped has been used by several authors to identify *H. glacialis* (Crosnier & Forest, 1973; Wasmer, 1986).

The material examined herein was identified as *H. glacialis* due to the presence of the groove that connects suprabranchial groove to a groove that extends dorsoposteriorly from near mid length of hepatic groove, and the absence of podobranch in the second maxilliped. Other features mentioned by Wasmer (1986) (as the rostrum and second segment of antennular peduncle shape) also agree with that observed at the material examined.

Due to this past confusion between *H. gracilis* and *H. glacialis* many of the older references to *H. glacialis*, mainly before Sivertsen & Holthuis, (1956); cannot be trusted (Sivertsen & Holthuis, 1956; Wasmer, 1986). According Sivertsen & Holthuis (1956) its distribution includes the Arctic region down to the Atlantic as far south as 30°N and the gulf of Panama. Crosnier & Forest (1973) examined the types of *H. mollicutis* Bate, 1888 (a synonym junior of *H. glacialis*) at British Museum, and the material of *H. glacialis* (from Valdivia Expedition - published by Balls, 1925) and *H. mollicutis* (from Challenger Expedition - published by Bate, 1888) at the Zoological Museum of Berlin and assigned this species to the Atlantic (Canary Islands, Sierra Leone, Argentina and Tristan da Cunha) and Indian oceans. Wasmer (1986) confirmed the data above and also added records for the North Pacific from the gulf of Bering to the gulf of Panama and at the Southern Ocean.

Genus *Kemphyra* Chace, 1986

Kemphyra corallina (A. Milne-Edwards, 1883) (Fig. 3b)

Notostomus corallinus A. Milne-Edwards, 1883: pl. 32.

Acanthephyra valdiviae Balss, 1914: 595; 1925: 260.

Acantephyra corallina Chace, 1936: 27; Kensley, 1968: 314, figs. 15-17.

Kemphyra corallina Chace, 1986: 46, fig. 25.

Material examined: superstation 9, 32°50'55"S, 01°49'52"E, WRS, 1107 m, local station 201, Mar Eco 1040, 3 males (15-23.1 mm), MNRJ 22565.

Diagnosis: rostrum overreaching scaphocerite, slightly curved upwards, with lateral carina overreaching orbits; 17-22 dorsal and 3-4 ventral teeth, 7-8 of them posterior to the orbits (Fig. 3b). Carapace with dorsal carina notched at two-thirds of its length; hepatic spine strong, at base of a not well marked cervical groove and of a well defined suprabranchial ridge; antennal spine small; bran-chiostegal spine stout, flared outwards, with a branchiostegal carina extending to the hepatic spine region, followed by a lateral carina that extends to carapace end and marks the lower border of the branchial region (Fig. 3b). Eyes slightly wider than eyestalk. Abdominal somites dorsally carinated, somites 3-6 with a distal tooth (Fig. 3b). Exopod of uropod as long as telson, with two spines on posterior half of outer margin; telson with 4-5 pairs of dorsolateral spines and one pair of distal spines (Fig. 3b) (modified from Kensley, 1968).

Distribution: Central Indian Ocean. Eastern Atlan-tic: north: off northern Portugal; south: off Cape of Good Hope; Walvis Ridge (first records) (Fig. 2). From 1000 to 2782 m depth.

Remarks: *Kemphyra corallina* is a rare species, restricted to the Atlantic Ocean, with less than 20 specimens deposited in zoological collections around the world. The presence of an hepatic spine on its carapace distinguishes this species from the remaining Oplophoridae.

Described originally as *Notostomus corallinus* (A. Milne-Edwards, 1883), posteriorly it was included in the enigmatic genus *Acanthephyra* by Chace (1936) and Kensley (1968). In 1985, Chace used this clear species autapomorphy (presence of hepatic spine) to define a monotypic genus (*Kemphyra*) and accommodate this species.

The only difference noticed between the material herein examined and Kensley´s (1968) description is the number of dorsolateral spines on telson (4-5 in MAR material and 4 in South African material).

DISCUSSION

The oplophorid fauna of south Mid-Atlantic Ridge is so far poorly investigated; these are the first records of these species at this area. Interestingly, some rare species were sampled, as *K. corallina* and mainly *H. moniotti* (second record of the species), showing how the MAR is a special and unknown environment. There is some discussion about the rarity of deep-sea species. As some authors mentioned, rare in respect to abyssopelagial fauna could be replaced by “seldom found till now” (Tiefenbacher, 2001). But, if we compare the frequency and abundance of some deep sea Oplophoridae we can conclude that some species are effectively rare and others are common, in terms of how many specimens were historically sampled. In this way *H. monnioti* is extremely rare, *K. corallina* is rare, and the three remaining MAR species are relatively common.

All Oplophoridae species sampled occur at southeastern Atlantic and at Indian Ocean, except *H. monnioti* that is restricted to Indian Ocean (Crosnier, 1987). Only two of them occur also at southwestern Atlantic (*A. quadrispinosa* and *H. glacialis*) (Wasmer, 1986; Cardoso & Young, 2005). So, the South MAR Oplophoridae fauna looks to be more related with that of southeastern Atlantic and Indian Ocean than to that of southwestern Atlantic. Probably, the Walvis Ridge is acting as a bridge between the MAR and the east Atlantic. A strong sample effort is needed at Rio Grande Rise region, to get a more satisfactory observation of the relations between the MAR fauna and the western Atlantic. The MAR fauna is also weakly related with that of Antarctic waters, which actually is poor in Decapoda species. Only *H. glacialis* is shared between MAR and Antarctic waters.

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