

# Taxonomy and distribution of shrimps genus *Heterocarpus* A. Milne-Edwards, 1881 collected on the Brazilian slope by the Program REVIZEE – central score

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## Abstract

The Family Pandalidae is represented in Brazilian waters mainly by deep-sea organisms, among them five species of the genus *Heterocarpus* A. Milne-Edwards, 1881. Samples examined herein were collected during the REVIZEE/Central Score – Fishery program, in 1999, 2000 and 2001, using bottom traps, mid-water and bottom trawls, between the latitudes of 11°S and 22°S. The specimens were identified, measured (length of the carapace), and the identified species were redescribed. An identification key for the Brazilian *Heterocarpus* is given. Three species of the genus were identified: *H. ensifer* A. Milne-Edwards, 1881, with 235 specimens sampled in Bahia, and from southern Espírito Santo to Rio de Janeiro; *H. inopinatus* Tavares, 1999, a Brazilian endemic species, with 871 specimens collected through all the sampled region, and *H. laevigatus* Bate, 1888, with 83 specimens sampled between southern Bahia and northern Espírito Santo. *Heterocarpus laevigatus* is one of the largest species of the genus, and had its occurrence expanded to the south. This species was caught only by bottom traps, that can indicate benthic habits, and its presence seems to be related to wide continental shelves. *Heterocarpus inopinatus* and *H. ensifer* were collected mostly by trawling in mid-water, which indicates that they have more pelagic habits than previously thought.

Key words: Deep-sea; *Heterocarpus*; Caridea; Taxonomy; Distribution.

## Introduction

The infraorder Caridea includes today, more than 3.062 species (Fransen and De Grave, 2009), which are distributed in 17 superfamilies and 38 families. The family Pandalidae is a moderately diverse group within Caridea, with 189 species distributed in 23 genera (De Grave *et al.*, 2009). These organisms are mostly epibenthic, with a laterally compressed body, strong abdomen and the antennal scale well developed (Bauer, 2004). Its greatest diversity is in boreal shallow waters, while in tropical regions it is represented mainly by organisms of the cold deep sea waters (Bauer, 2004).

In Brazilian waters there are 13 species of Pandalidae, distributed in 4 genera: *Pandalus* Leach, 1814; *Heterocarpus* A. Milne-Edwards, 1881; *Plesionika* Bate, 1888, and *Stylopandalus* Coutière, 1905 (Ramos-Porto and Coelho, 1998; Cabral

*et al.*, 2000; Cardoso and Serejo, 2007; Cardoso, 2009).

The genus *Heterocarpus* includes about 30 species (Crosnier, 1988; 1999; Tavares, 1999; Li, 2006; Yang *et al.*, 2010), that can be found in all tropical and some temperate deep seas, in depths varying from 73 to 2.834 m (Chace, 1985). The adults are benthic, being caught in greatest abundance by bottom traps and bottom trawls, while juveniles and larvae are often caught in the water column (Crosnier and Forest, 1973). In Brazilian waters five species have been recorded: *Heterocarpus dorsalis* Bate, 1888; *H. ensifer* A. Milne-Edwards, 1881; *H. inopinatus* Tavares, 1999; *H. laevigatus* Bate, 1888 and *H. oryx* A. Milne-Edwards, 1881 (Ramos-Porto and Coelho, 1998; Tavares, 1999; Viana *et al.*, 2007).

The objective of the present study is to provide information about the distribution of the

shrimps of the genus *Heterocarpus* of the central slope of Brazil, as well as the description of the sampled material, for future comparisons with other localities and to facilitate the identification of this genus in Brazilian waters.

### Material and Methods

The material examined herein is deposited in the Crustacea Collection, Museu Nacional/UFRJ, and was collected by the oceanographic program REVIZEE/Central Score – Fishery.

During this program, two sampling campaigns were done with trawl nets. The first in 1999, between May 27 and July 07, with 72 mid-water trawls. The second in 2000, between June 06 and July 08, with 58 bottom trawls. Both campaigns were done by the R/V “Thalassa”, in the central coast of Brazil (from 11°S – Rio Real estuary, state of Bahia, to 22°S – São Tomé Cape, state of Rio de Janeiro) in depths between 200 and 2076 m.

During the program REVIZEE/Central Score-Fishery, samples with two types of bottom baited traps (circular, with 80 cm diameter and 30 cm opening and rectangular 1.6 × 0.8 m, and 30 cm opening) were also carried out. Two sets of five traps, in each one of the 48 stations, were attached to a rope anchored to the bottom and connected to a float with a signalization flag (Netto and Gaelzer, 2005).

All the measurements provided are of carapace length (taken from the orbit to the posterior end of the carapace).

### Systematics

#### *Heterocarpus ensifer* A. Milne-Edwards, 1881 (fig. 1)

*Heterocarpus ensifer* A. Milne-Edwards, 1881: 8; 1883: pl. 27; Pequegnat, 1970: 84; Crosnier and Forest, 1973: 189, fig. 61a; Chace, 1985: 25, fig. 14 (as *H. ensifer parvispina* De Man, 1917), fig. 16; Crosnier, 1988: 67, p. 2, figs. a-f.

*Pandalus carinatus* Smith, 1882: 63, pl. 10.

*Atlantocaris gigas* Ortmann, 1893: 80, pl. 5, fig. 2.

*Procletes atlanticus* Lenz and Strunck, 1914: 334, pl. 22, figs. 9-14.

Not *Heterocarpus ensifer*-Bate, 1888: 638, pl. 112, fig. 4. (= *Heterocarpus hayashii* Crosnier, 1988); Crosnier, 1986: 362. (= *Heterocarpus parvispina* De Man, 1917).

*Material examined:* REVIZEE, D-0464, 21°48.49'S/40°01.54'W, 592-618 m, 7 males (16.1-24 mm), 3 females (14.8-17.9 mm), 5 ovigerous females (17.1-26 mm), MNRJ 13946; D-0464, 21°48.49'S/40°01.54'W, 592-618 m, 5 males (17.1-25 mm), 4 females (9.5-11 mm), 5 ovigerous females (21.5-29.5 mm), MNRJ 13947; D-0463, 21°48.35'S/40°02.27'W, 571-623 m, 90 males (13.5-26.1 mm), 25 females (15-21.5 mm), 71 ovigerous females (16.5-26 mm), MNRJ 14083; E-0543, 21°23.94'S/40°11.29'W, 666 m, 3 males (21-24 mm), 3 ovigerous females (19.5-21.5 mm), MNRJ 14649; E-0534, 19°42.16'S/39°21.6'W, 613 m, 1 male (20.5 mm), 3 females (11.5-21.5 mm), MNRJ 14650; E-0541, 21°13.64'S/40°14.03'W, 557 m, 3 males (20-22 mm), 3 ovigerous females (19-21.8 mm), MNRJ 14651; E-0508, 15°21.84'S/38°40.82'W, 421 m, 1 female (22 mm), MNRJ 14652; E-0546, 21°43.57'S/40°03.14'W, 565 m, 1 male (20.1 mm), 3 ovigerous females (20-24 mm), MNRJ 14653; Covo #17910, 20°40.625'S/39°40.07'W, 625-655 m, 2 males (18.1-19.5 mm), 1 female (23 mm), MNRJ 16954.

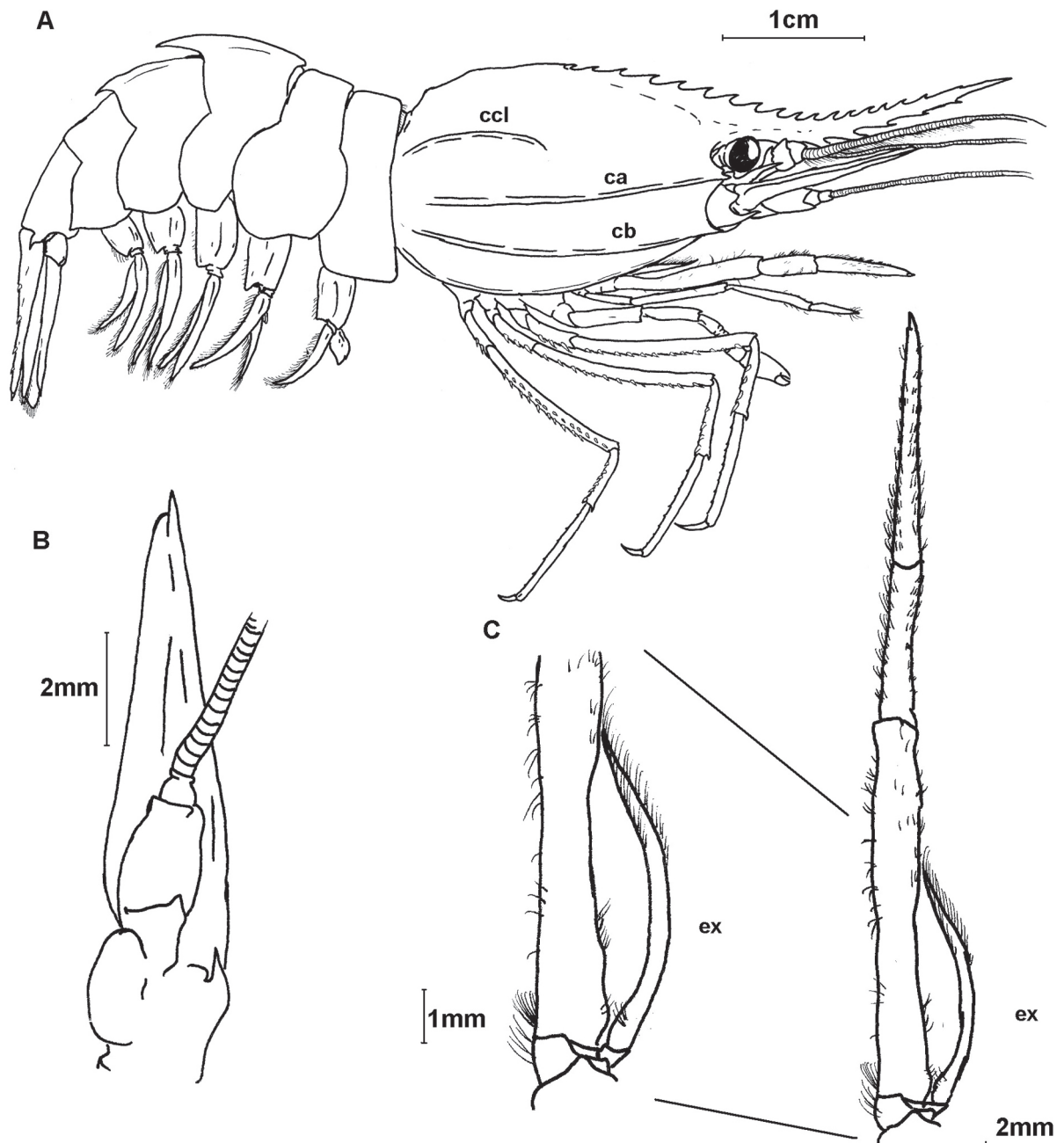
*Redescription:* Rostrum 0.9-1.6 times as long as carapace, 14 dorsal teeth and 6-10 ventral teeth; antennal and pterygostomial spines similar in size; carapace dorsally carinate, with 5 teeth on the anterior half, 3 lateral carinae well developed, cardiolateral carina short and convex, antennal and branchiostegal carinae long, reaching the posterior part of carapace (fig. 1A). Spine of the scaphocerite overreaching the apex of scale (fig. 1B). Maxilliped 3 with well developed exopod (fig. 1C). Pereopod 1 with microscopic chelae; pereopod 2 unequal, the right side usually short and strong, carpus with 7 articles, and the other side usually longer and thinner, carpus with 18 articles; pereopod 3 with 3 ventral spines on ischium, 12 on merus, and 4 on carpus, carpus slightly longer than a half of propodus; pereopod 4 with 3 ventral spines on ischium, 13 on merus and 4 on carpus, carpus a little longer than a half of propodus; pereopod 5 with 2 ventral spines on ischium, 24 on merus, and 7 on carpus, carpus a little longer than a half of propodus. First and second abdominal somites without carinae or spines; third abdominal somite with strong

dorsal carina and posteromedian spine that overreaches a half of the fourth somite; fourth somite with strong dorsal carina and posteromedian spine a half of the length of the anterior spine, pleura with a small tooth; fifth somite without carinae or spines, pleura forms a tooth; sixth abdominal somite slightly longer than the half of the telson. Telson with four pairs of dorsal spines; acute apex, with 3 pairs of spines.

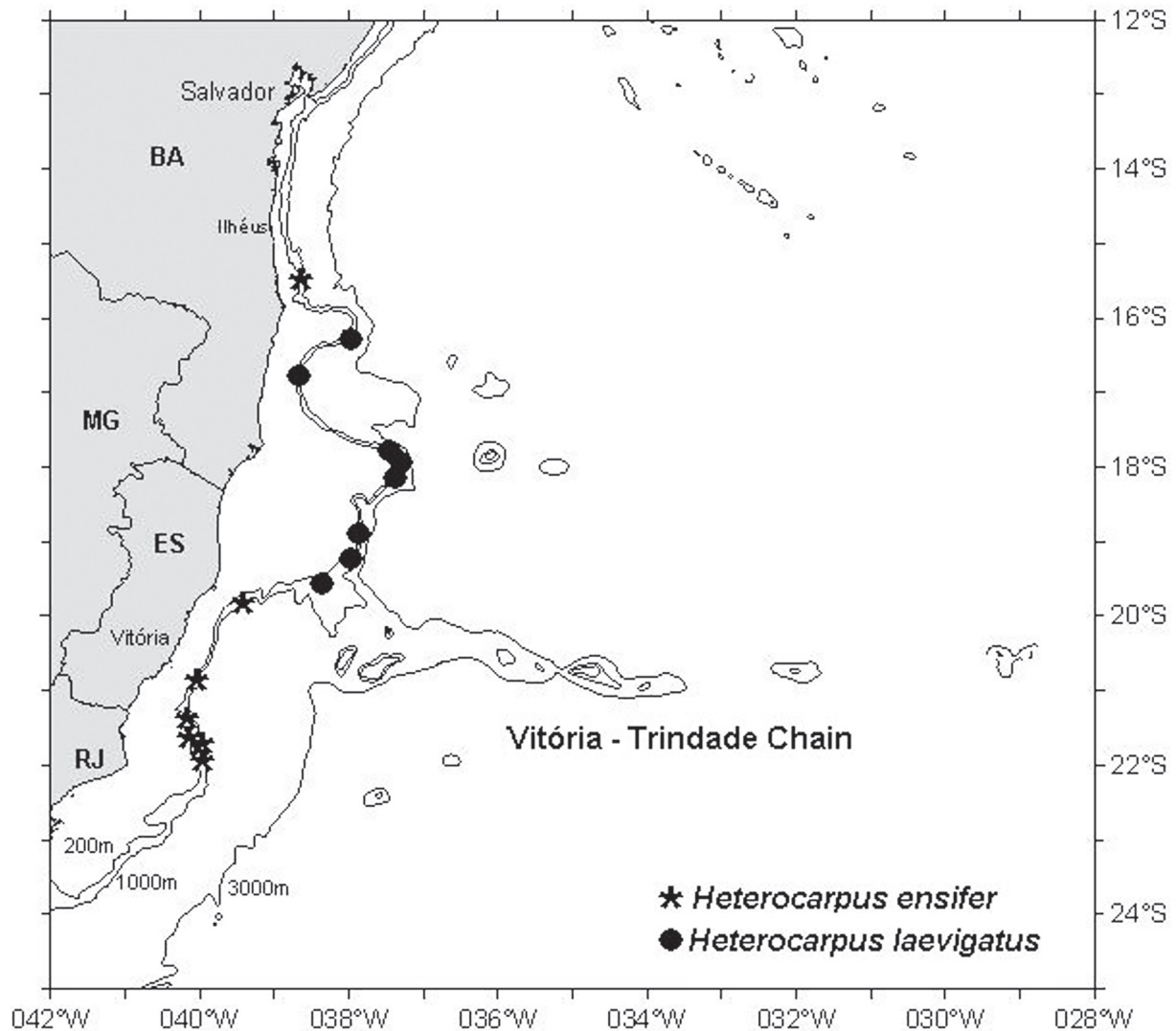
*Type-locality:* Western Atlantic, near Barbados.

*Distribution:* Southwestern Indian Ocean, Pacific (Hawaii and Kiribati). Western Atlantic: from North Carolina to Brazil (Rio de Janeiro). Eastern Atlantic: from Iberian Peninsula to Congo, including Azores, Madeira, and Canary Islands, Cape Verde and Mediterranean sea (references must be provided).

*Habitat:* On muddy and sandy bottoms, between 88 and 885 m depth (Crosnier, 1988; García-Rodríguez *et al.*, 2002; Tuset *et al.*, 2009).

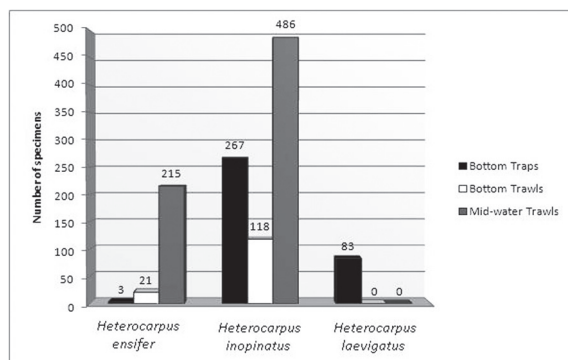


**Figure 1:** *Heterocarpus ensifer* A. Milne-Edwards, 1881; MNRJ 14651; male (CL = 22 mm). A) Lateral view (ca = antennal carina, cb = branchiostegal carina, ccl = cardiolateral carina); B) left antenna, ventral view; C) left third maxilliped, ventral view (ex = exopod).



**Figure 2:** Distribution of *Heterocarpus ensifer* A. Milne-Edwards, 1881 and *H. laevigatus* Bate, 1888 collected by the REVIZEE/Score Central program. Brazilian states: (BA) Bahia, (MG) Minas Gerais, (ES) Espírito Santo, (RJ) Rio de Janeiro.

*Remarks:* Few differences between the examined material and previous descriptions (Crosnier, 1988) were observed: the material examined herein



**Figure 3:** Number of specimens of *Heterocarpus ensifer* A. Milne-Edwards, 1881; *H. laevigatus* Bate, 1888 and *H. inopinatus* Tavares, 1999 caught by the different sampling methods used at REVIZEE/Score Central program.

is not so large, the largest individual was an ovigerous female with 29.5 mm, while Tuset *et al.* (2009) recorded individuals with 39 mm. The posteromedian spine of the fourth abdominal somite, even being a little short (on average a half of the spine on third somite), is still large enough to be inside the variation described by Crosnier (1988): length between  $2/5$  and  $2/3$  of the third spine. This spine is considered the main diagnostic feature to distinguish *H. ensifer* from the two close related species: *H. parvispina* De Man, 1917 and *H. amacula* Crosnier, 1988, on which this proportion is always shorter than  $1/4$ .

*Heterocarpus ensifer* was sampled on the central region of Bahia ( $15^{\circ}18.873'S$ ) and from the south half of Espírito Santo ( $19^{\circ}42'S$ ) to the north of Rio de Janeiro ( $21^{\circ}48.491'S$ ) (fig. 2), between 421 and 666 m depth. There was a great differ-

ence in the number of specimens captured by each method: of the 239 sampled specimens, only 3 individuals were captured by bottom traps, 21 by bottom trawls and the great majority (215) by mid-water trawls (fig. 3).

***Heterocarpus inopinatus* Tavares, 1999**  
(fig. 4)

*Heterocarpus inopinatus* Tavares, 1999: 673, fig. 1; Cardoso and Serejo, 2007: 47, fig. 3; Serejo *et al.*, 2007: 147, fig. 5a.

*Material examined:* REVIZEE, D-0505, 19°43.8'S/38°38.15'W, 926-927 m, 3 males (31.5-33 mm), 1 female (38 mm), 1 ovigerous female (34.5 mm), MNRJ 13948; D-0506, 19°42.71'S/38°36.5'W, 935 m, 3 males (12.5-20 mm), 3 females (13.1-20.5 mm), MNRJ 14081; D-0503, 19°39.9'S/38°38.4'W, 808 m, 29 males (20.9-36 mm), 22 females (12.5-40 mm), 30 ovigerous females (30.5-43 mm), MNRJ 14084; D-0504, 19°42.7'S/38°16.47'W, 910 m, 48 males (12-35 mm), 42 females (13.1-43.1 mm), 32 ovigerous females (29-41.5 mm), MNRJ 14085; D-0504, 19°42.7'S/38°16.47'W, 910 m, 45 males (12.5-34 mm), 39 females (9-42.5 mm), 27 ovigerous females (30.5-43.2 mm), MNRJ 14094; D-0502, 19°37.5'S/38°41.9'W, 706 m, 4 ovigerous females (29.1-39.5 mm), MNRJ 14111; D-0506, 19°42.71'S/38°36.5'W, 935 m, 86 males (12-35 mm), 35 females (13.5-41 mm), 33 ovigerous females (29.5-40 mm), MNRJ 14112; E-0537, 20°26.85'S/39°41.63'W, 1545 m, 1 male (21 mm), 2 females (14-23.5 mm), MNRJ 14673; E-0526, 20°06.56'S/38°40.5'W, 1637 m, 2 males (20.1-20.5 mm), 1 female (18.5 mm), MNRJ 14674; E-0529, 19°48.48'S/39°02.35'W, 1337 m, 1 male (22.1 mm), MNRJ 14675; E-0504, 14°28.97'S/38°54'W, 278 m, 1 ovigerous female (39 mm), MNRJ 14676; E-0549, 21°25.74'S/39°43.94'W, 1718 m, 1 male (18 mm), MNRJ 14678; E-0527, 19°50.73'S/39°10.82'W, 1402 m, 2 males (15.5-19 mm), 2 females (15.9-19 mm), MNRJ 14679; E-0512, 13°17.6'S/38°17.6'W, 1717 m, 1 male (18 mm), 1 female (18 mm), MNRJ 14680; E-0499, 13°23.82'S/38°37.54'W, 761 m, 4 females (26.5-38 mm), 8 ovigerous female (29-41 mm), MNRJ 14682; E-0503, 14°37.8'S/38°52'W, 740 m, 7 females (29-40.2 mm), 8 ovigerous

females (29-41 mm), MNRJ 14683; E-0517, 13°22.17'S/38°35.4'W, 750 m, 5 females (25-37.9 mm), 4 ovigerous females (33.5-40 mm), MNRJ 14684; E-0528, 19°45.26'S/39°03'W, 1237 m, 1 male (15.9 mm), MNRJ 14685; E-0535, 19°58.94'S/39°38.65'W, 1002 m, 10 males (26.1-34 mm), 8 females (13-44.1 mm), 2 ovigerous females (38-38.5 mm), MNRJ 14686; E-0524, 19°43.66'S/38°39.84'W, 925 m, 2 males (27.5-34.1 mm), 1 ovigerous female (43 mm), MNRJ 14687; E-0522, 13°30.5'S/38°38.97'W, 1144 m, 8 males (26-34.2 mm), 3 females (29.5-37 mm), 1 ovigerous female (41.5 mm), MNRJ 14688; E-0523, 19°42.6'S/38°32.03'W, 922 m, 10 males (13-32.5 mm), 9 females (13.5-36 mm), 8 ovigerous females (29.5-40.2 mm), MNRJ 14689; E-0506, 14°36.6'S/38°49.5'W, 1067 m, 2 males (24 mm), 1 female (24.5 mm), MNRJ 14691; E-0497, 13°13.84'S/38°19.525'W, 1374 m, 1 male, MNRJ 14692; Covo #8126, 17°45.07'S/37°23.26'W, 646-549 m, 1 male (35 mm), 8 females (32.1-44 mm), 66 ovigerous females (30.1-44.5 mm), MNRJ 16926; Covo #8110, 16°47.23'S/38°39.73'W, 639-596 m, 2 females (35-40.5 mm), 26 ovigerous females (34.1-42 mm), MNRJ 16927; Covos #8017, #8022, #8096, 14°48.1'S/38°51.15'W, 809 m, 10 females (28-39.1 mm), 10 ovigerous females (30.5-38.8 mm), MNRJ 16929; Covo #8033, 15°47.7'S/38°35.4'W, 631-385 m, 1 male (33 mm), 3 females (34-37.5 mm), 10 ovigerous females (33.1-39.9 mm), MNRJ 16931; Covo #8118, 18°15.85'S/37°15.8'W, 571-726 m, 12 ovigerous females (31-43 mm), MNRJ 16932; Covo #8121, 17°07.03'S/38°37.01'W, 650-713 m, 8 ovigerous females (32.9-40 mm), MNRJ 16933; Covo #8149, 16°47.15'S/38°39.7'W, 652-680 m, 1 female (38 mm), 7 ovigerous females (33.9-40 mm), MNRJ 16937; Covo #8140, 16°08.22'S/37°53.54'W, 770-776 m, 10 females (30-38.5 mm), 6 ovigerous females (31.9-37.5 mm), MNRJ 16939; Covos #17859, #17864, #17868, 13°28.2'S/38°40.96'W, 711-694 m, 8 females (36.5-41.5 mm), 37 ovigerous females (33.1-41.1 mm), MNRJ 16942; Covo #17996, 20°57.7'S/40°07.24'W, 662-625 m, 1 female (43.6 mm), 1 ovigerous female (39.5 mm), MNRJ 16943; Covo #17884, 13°48.5'S/38°63.7'W, 663-486 m, 3 females (37-40 mm), 7 ovigerous females (39-45 mm), MNRJ 16947; Covo #8057, 14°08.8'S/38°48.9'W, 711-786 m, 3 ovigerous females (34.2-40 mm), MNRJ 16948;

Covo #8077, 14°08.5'S/38°48.8'W, 719-743 m, 2 ovigerous females (38-38.8 mm), MNRJ 16957; Covos #17711, #17715, 19°26.4'S/38°14.66'W, 770-776 m, 4 females (36.9-43 mm), 9 oviger-

ous females (20-42 mm), MNRJ 16960; E-0507, 15°08.6'S/38°40.64'W, 1026 m, 1 ovigerous female (35 mm), MNRJ 21805; Covo #12978, 18°51.7'S/37°50.95'W, 744-622 m, 4 ovigerous

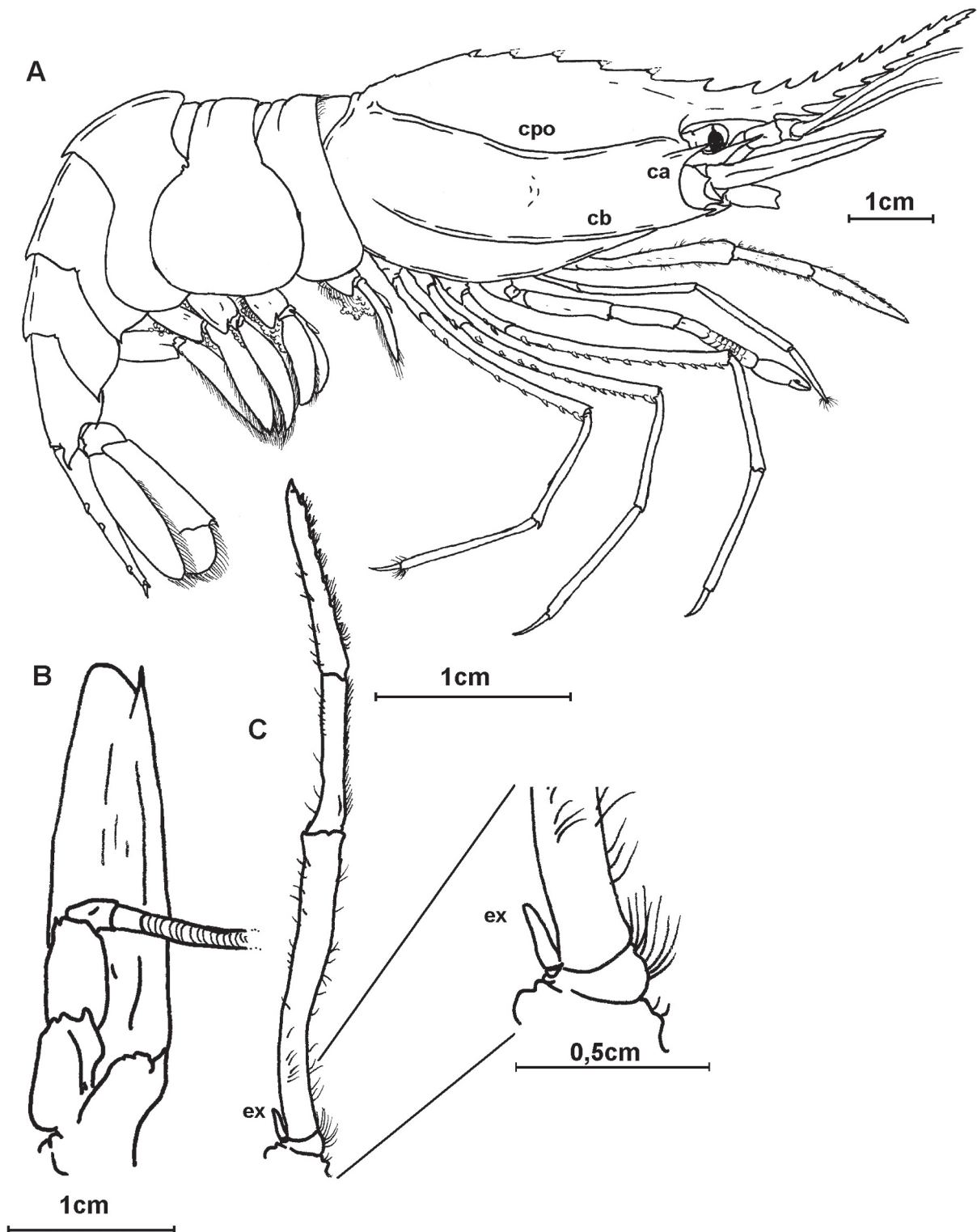


Figure 4: *Heterocarpus inopinatus* Tavares, 1999; MNRJ 16939; ovigerous female (CL = 3.1 mm). A) Lateral view (ca = antennal carina, cb = branchiostegal carina, cpo = post-orbital carina); B) the left antenna, ventral view; C) left third maxilliped, dorsal view (ex = exopod).

females (31.5-39.5 mm), MNRJ 21806; Covo #8142, 17°46.31'S/37°28.07'W, 604-395 m, 1 ovigerous female (41.5 mm), MNRJ 21807; Covo #8178, 16°08'S/37°53.6'W, 757-949 m, 1 ovigerous female (40 mm), MNRJ 21808; Covo #8272, 18°01.49'S/37°15.63'W, 723-828 m, 2 ovigerous females (36.5-37.1 mm), MNRJ 21809; Covo #8129, 18°14.42'S/37°50.94'W, 715-350 m, 5 ovigerous females (32.9-40.0 mm), MNRJ 21810.

*Redescription:* Rostrum 0.82-1.4 times as long as carapace, 9-10 dorsal teeth and 6-10 ventral; antennal and pterigostomial spines similar in size; carapace dorsally carinate, with 5 teeth, with 2 well developed lateral carinae, the postorbital and branchiostegal carinae reach the posterior part of the carapace, and the antennal carina is short and restricted to the basis of the antennal spine (fig. 4A).

Spine of the scaphocerite reaches or not the apex of the antennal scale, that forms a rounded angle (fig. 4B). Maxilliped 3 with a reduced, but distinct, exopod (fig. 4C); pereopod 1 with microscopic chelae; pereopod 2 unequal, one side is short and strong, carpus with 8-10 articles, other side long, thin, carpus with 23-25 articles; pereopod 3 with 2 ventral teeth on ischium and 15 on merus, carpus of the 3 last pairs similar in size to the propodus; pereopod 4 with 2-3 ventral teeth on ischium and 10-15 on merus; pereopod 5 without teeth on ischium and 7 on merus. First and second abdominal somites without carinae or spines; third, fourth and fifth abdominal somites dorsally carinate and with posteromedian spines, pleura of the fourth and fifth somites with distal spines; sixth somite a little longer than the half of telson. Telson with

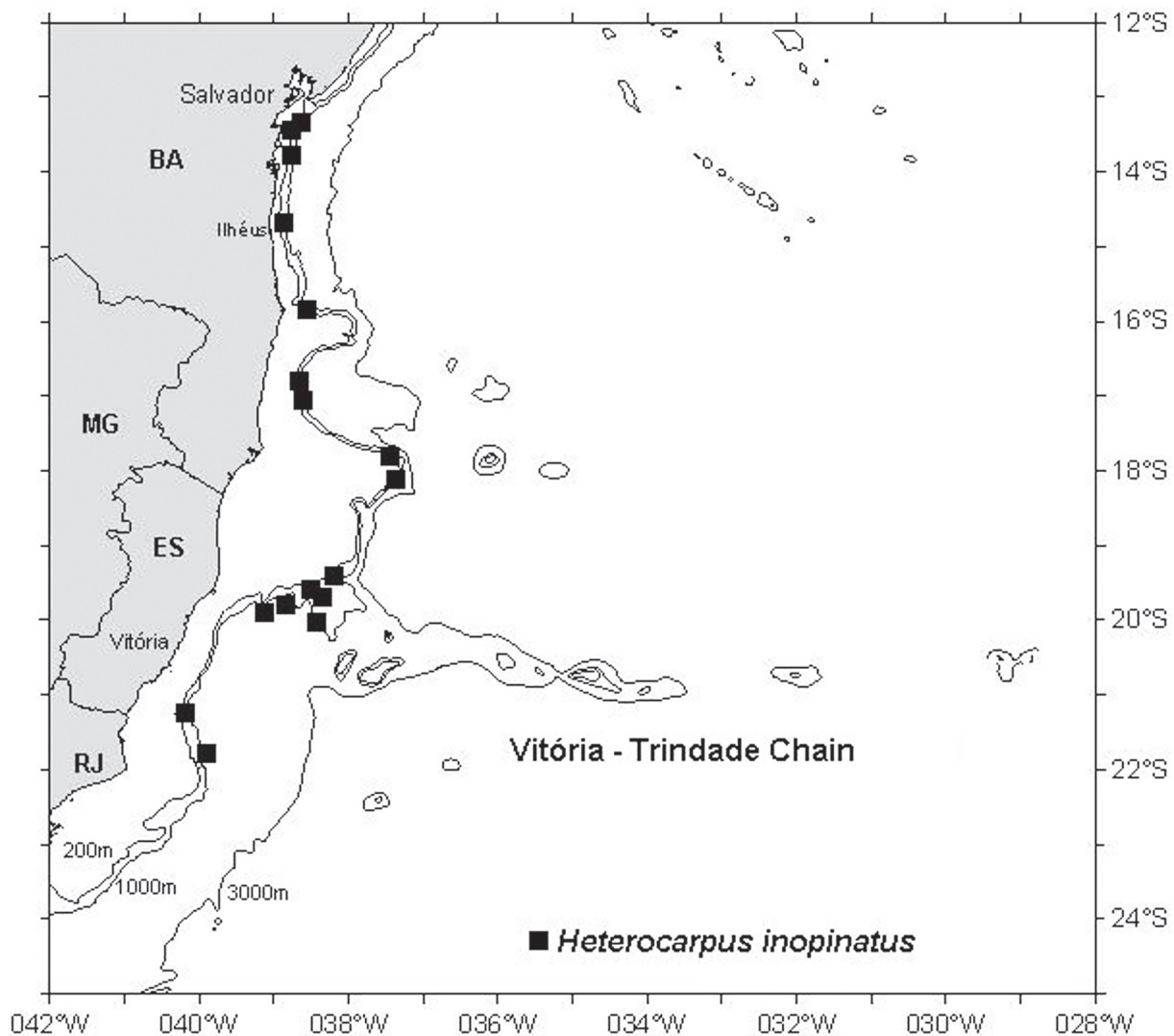


Figure 5: Distribution of *Heterocarpus inopinatus* Tavares, 1999 collected by the REVIZEE/Score Central program. Brazilian states: (BA) Bahia, (MG) Minas Gerais, (ES) Espírito Santo, (RJ) Rio de Janeiro.

four pairs of dorsal spines, acute apex, with usually 3 pairs of terminal spines.

*Type-locality:* Western Atlantic: Brazil, Espírito Santo (19°38'S/038°43'W), 960 m.

*Distribution:* Brazil: from Bahia to Rio de Janeiro. In depths between 278 and 1718 m (Tavares, 1999; Cardoso and Serejo, 2007; Serejo *et al.*, 2007).

*Remarks:* The present material does not show many differences when compared with the original species description of Tavares (1999). The only difference was in the spines of telson. This species was described as having 4 dorsal and 2 terminal pairs of spines, herein some variations were observed. Most of specimens examined present 3 pairs of terminal spines, some specimens present 4, and none specimen presents 2 pairs.

Tavares (1999) distinguishes *H. inopinatus* from *H. dorsalis* by the dorsal teeth on carapace (in *H. inopinatus* they overreach the anterior 2/3 of the carapace and in *H. dorsalis*, they reach the anterior 1/3 of carapace). According to Tavares (1999), *H. inopinatus* differs from *H. affinis* Faxon, 1893 by the absence of an incision on the dorsal carina of the third abdominal somite and, from *H. hostilis* Faxon, 1893, by the well defined dorsal carinae of the carapace. Despite the extensive comparison with some related species presented by Tavares (1999), *H. inopinatus* is not compared to *H. oryx* which seems to be a close related species. These two species are distinguished mainly by the exopod of the third maxilliped, absent in *H. oryx* and short but distinct in *H. inopinatus*. According to some descriptions of *H. oryx* (see Pequegnat, 1970; Paulmier, 1993), this is the only difference between the species.

*H. inopinatus* was sampled between the latitudes 13°22'60.00"S (Bahia) and 21°23'60.00"S (north of Rio de Janeiro) (fig. 5), between 278 and 1718 m depth. Besides that, it was the most abundant species sampled by the Program REVIZEE/Score Central, with a total of 871 specimens sampled, mainly by mid-water trawls (486 specimens). A total of 267 specimens were sampled by bottom traps and 118 by bottom trawls (fig. 3).

***Heterocarpus laevigatus* Bate, 1888  
(fig. 6)**

*Heterocarpus laevigatus* Bate, 1888: 636, pl. 112, fig. 3; Crosnier and Forest, 1973: 195,

fig. 61c; Chace, 1985: 33, fig. 13i; Crosnier, 1988: 74; Viana *et al.*, 2007: 35, fig. 2.

*Material examined:* REVIZEE, Covo #8142, 17°46.31'S/37°28.07'W, 604-395 m, 5 males (42.8-47.1 mm), 14 ovigerous females (40-54.4 mm), MNRJ 16928; Covo #8129, 18°14.42'S/37°50.94'W, 715-350 m, 2 males (42-46.4 mm), 2 ovigerous females (41-54.5 mm), MNRJ 16935; Covo #8178, 16°08'S/37°53.6'W, 757-949 m, 14 males (32-45.9 mm), 2 females (33.5-37 mm), 5 ovigerous females (36-45 mm), MNRJ 16941; Covo #12978, 18°51.72'S/37°50.94'W, 744-828 m, 7 males (35-45.1 mm), 6 females (19-36 mm), MNRJ 16950; Covos #12969, #12974, 18°52.18'S/37°51.07'W, 622-573 m, 3 females (42-48.5 mm), MNRJ 16959; Covo #8272, 18°01.49'S/37°15.63'W, 723-828 m, 12 ovigerous females (36-54 mm), MNRJ 16962; Covos #17711, #17715, 19°26.4'S/38°14.66'W, 770-776 m, 2 males (40-42.5 mm), MNRJ 21811; Covo #8140, 16°08.22'S/37°53.54'W, 770-776 m, 1 male (39.5 mm), MNRJ 21812; Covo #8149, 16°47.15'S/38°39.7'W, 652-680 m, 2 males (30.5-37.5 mm), 1 ovigerous female (51 mm), MNRJ 21813; Covo #8126, 17°45.07'S/37°23.26'W, 646-549 m, 5 males (36-43 mm), MNRJ 21815.

*Re-description?:* Rostrum 0.88-1.17 times as long as carapace, 1 dorsal tooth, on its base, and 7-9 ventral teeth; pterigostomial spine larger than the antennal spine; carapace dorsally carinate with 5 teeth, with 2 lateral carinae well developed, the postorbital and branchiostegal carinae reach the posterior part of the carapace, and the antennal carina is short and restricted to the basis of the antennal spine (fig. 6A). Spine of the scaphocerite reaches or not the apex of the antennal scale, that forms a rounded angle (fig. 6B). Maxilliped 3 with a reduced, but distinct, exopod (fig. 6C); pereopod 2 unequal, one is short, strong, carpus with 6-7 articles, the other is long, thin, carpus with 19-20 articles, pereopod 3 with 2 ventral spines on ischium, 13 on merus and none on carpus; carpus of 3 last pairs of pereopods as long as propodus; pereopod 4 with 0-2 ventral spines on ischium, 11-13 on merus and none on carpus; pereopod 5 without spines on ischium and carpus, and 6-9 spines on merus. First and second abdominal somites without dorsal carinae or spines; third and fourth abdominal somites with low dorsal carinae,



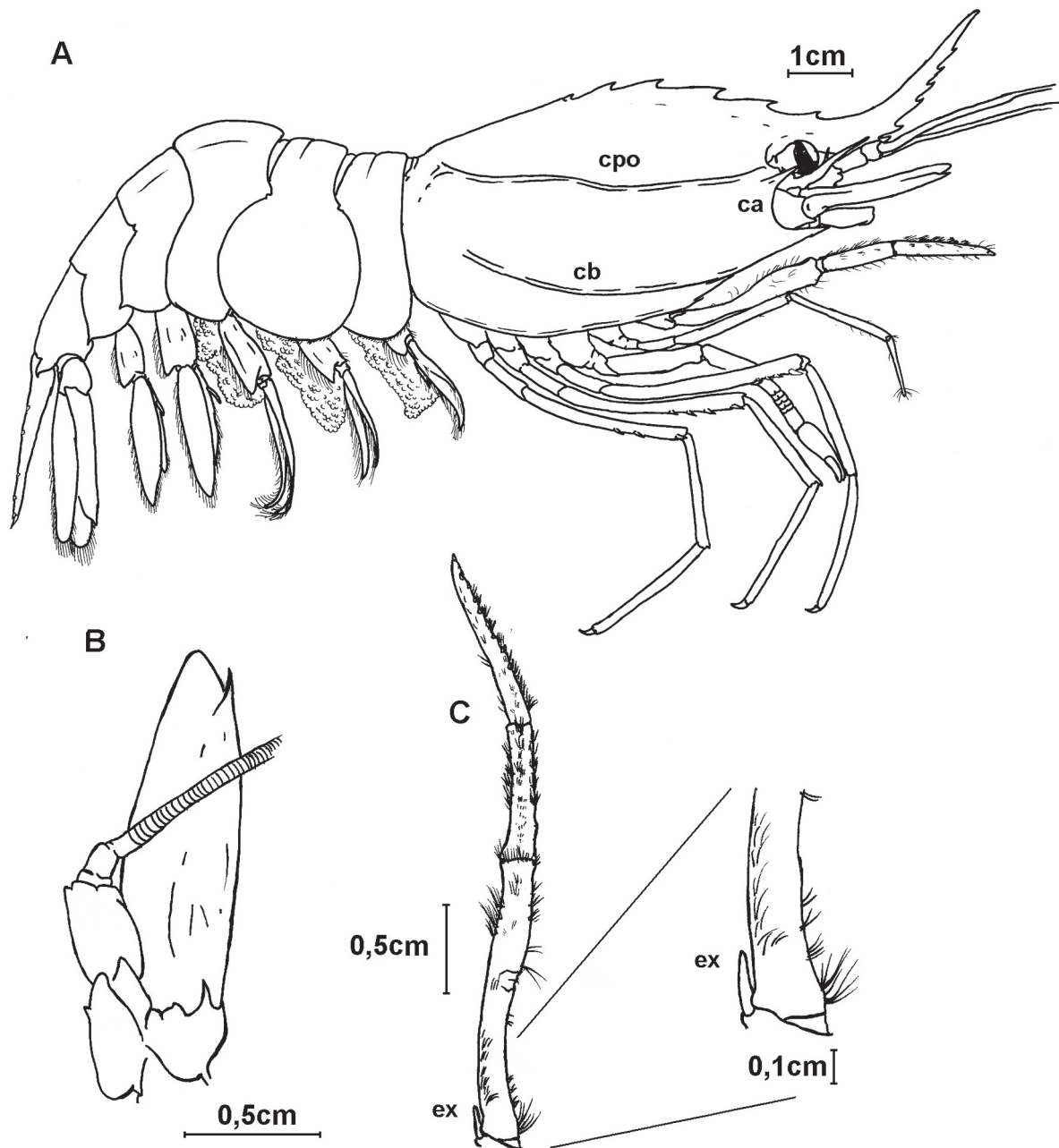
with a rounded end; pleura of the fourth somite with a distal tooth; fifth abdominal somite without dorsal carinae or spines, pleura with a distal tooth; sixth somite slightly longer than the half of telson. Telson with four pairs of dorsal spines, acute apex, with 3 pairs of terminal spine *Type-locality*: Pacific, Indonesia.

*Distribution*: Indo-Pacific: Hawaii, French Polynesia, Australia, Japan, New Caledonia; Eastern and Western tropical Atlantic (Chace, 1985;

Crosnier, 1988). Brazil: Pernambuco (Viana *et al.*, 2007), Bahia, Espírito Santo (new records in bold).

*Habitat*: On muddy bottoms, in depths varying from 366 to 966 m.

*Remarks*: The specimens examined are not different from some previous descriptions of material from the Eastern Atlantic (Crosnier and Forest, 1973), Madagascar, New Caledonia, Indonesia (Crosnier, 1988) and Pernambuco (Viana *et al.*, 2007).



**Figure 6:** *Heterocarpus laevigatus* Bate, 1888; MNRJ 16928; ovigerous female (CL = 53 mm). A) Lateral view (ca = antennal carina, cb = branchiostegal carina, cpo = post-orbital carina); B) left antenna, ventral view; C) left third maxilliped, dorsal view (ex = exopod).

*Heterocarpus laevigatus* have some well defined diagnostic features that make its identification relatively easy, such as the rostrum dorsally unarmed, the pterigostomial spine larger than the antennal spine and the absence of posteromedian teeth on abdomen (Crosnier and Forest, 1973). Even the close related species, *H. grimaldii* A. Milne-Edwards and Bouvier, 1900, can be easily distinguished by the two last features cited above.

*H. laevigatus* was sampled between 16°08.008'S (south Bahia) and 19°26.4'S (north Espírito Santo), where the continental shelf is wider (fig. 2). These are new records of this species, that was previously recorded only to Pernambuco (Viana *et al.*, 2007). *Heterocarpus laevigatus* was sampled between 395 and 949 m depth. This was the least abundant species, with a total of 83 specimens sampled by bottom traps (fig. 3).

### Identification Key for the Brazilian species of *Heterocarpus*

1. Third pair of maxillipeds with exopods ..... 2  
Third pair of maxillipeds without exopods ..... *H. oryx* A. Milne-Edwards, 1881
2. Dorsal surface of the rostrum armed throughout its entire length; abdomen with well defined dorsal carinae and posteromedian spines at least on somites 3 and 4; pterigostomial and antennal spines of similar size... 3  
Dorsal surface of the rostrum armed only on its proximal half; abdomen with poorly defined dorsal carinae, without posteromedian spines; pterigostomial spine much larger than antennal spine .....  
..... *H. laevigatus* Bate, 1888 (fig. 3)
3. The antennal spine continues in a short antennal carina, restricted to its base; the dorsolateral carina (post-orbital) reaches the posterior part of the carapace; abdominal somite 5 dorsally carinate and with a posteromedian spine ..... 4  
The antennal spine continues in a carina reaching the posterior half of the carapace; the dorsolateral carina (cardiolateral) is restricted to the branchiocardiac region of the carapace; abdominal somite 5 without dorsal spines or carinae ..... *H. ensifer* A. Milne-Edwards, 1881 (fig. 1)
4. Carapace armed dorsally only on its anterior third; rostrum, in adults, as long as, or longer than carapace ..... *H. dorsalis* Bate, 1888  
Carapace armed dorsally on its anterior two thirds; rostrum, in adults, shorter than carapace.....  
..... *H. inopinatus* Tavares, 1999 (fig. 2)

### Discussion

The genus *Heterocarpus* is usually considered benthic (Crosnier and Forest, 1973) because its species are captured mainly by bottom traps, besides that they do not show many features related with pelagic habits, as well developed exopods. However, the present study shows that these species, except *H. laevigatus*, are present in the water column, being captured mainly by mid-water trawls (fig. 3). Data on the trophic position of these animals (Vaske Júnior *et al.*, 2009; Vêras *et al.*, 2009) also showed a pelagic lifestyle. Studies about the feeding of some *Heterocarpus* species showed a significant presence of pelagic resources (King, 1993; Rainer, 1992) and some species have been found in the stomach contents of some pelagic fishes (King, 1984; Vaske Júnior *et al.*, 2009; Vêras *et al.*, 2009). Rainer (1992) proposed that these animals have benthic habits, where they feed occasionally, and do nocturnal vertical migrations

to the water column, where they would feed preferentially. This hypothesis seems to be corroborated by the results shown here.

The absence of *H. laevigatus* in mid-water trawls (fig. 3) indicates that this species really has benthic habits. The distribution of *H. laevigatus* and *H. ensifer* do not overlap, and it is known that specimens of this genus are predators and can be cannibalistic (Gooding *et al.*, 1988). Smaller or injured individuals, even of the same species, are preyed upon by larger specimens. *Heterocarpus laevigatus* is one of the largest species of the genus and can be preying on *H. ensifer* one of the smallest species of the genus.

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