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A new species of *Hourstonius* (Amphipoda: Amphilochidae) from Todos-os-Santos Bay, Bahia State, Brazil, with an overview of the genus across the globe

Jessika Alves, Elizabeth G. Neves and Rodrigo Johnsson

Universidade Federal da Bahia (UFBA), Instituto de Biologia, Laboratório de Invertebrados Marinhos: Crustacea, Cnidaria & Fauna Associada (LABIMAR), Rua Barão de Jeremoabo, 147, Ondina, Salvador, BA, CEP 40170-290, Brasil

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Corresponding author:
Jessika Alves; Email: jessika.aop@gmail.com

Abstract

Amphilochidae comprises 92 species of small and colourful amphipods that live associated with sessile marine organisms. *Hourstonius* is one of the most diverse genera with 17 described species, most of the species are recorded from North Temperate Pacific and Tropical Atlantic and live in shallow waters. Only three species of Amphilochidae are recorded in Brazil, and from the genus *Hourstonius,* there is a single species, *H. wakabarae*. In the present work, we describe a new species of *Hourstonius* from Todos-os-Santos Bay, the second species of the genus to the country and the first record of this genus from Bahia State. A taxonomic key and an overview of the genus across the globe are also provided.

Introduction

Amphilochidae Boeck 1871 is composed of small benthic amphipods that are usually found associated with sessile marine invertebrates and comprise 14 genera (Hoover and Bousfield, 2001). The family is defined, among other characteristics by showing: (1) rostrum distinct; (2) maxilla 1 inner plate small; (3) Gnathopods not sexually dimorphic; (4) coxae 2–4 deep; (5) Uropods slender, rami lanceolate; (6) Uropod 2 small, rami unequal (Hoover and Bousfield, 2001).

In comparison with other amphipod families, Amphilochidae shows a relatively low diversity, with 92 described species (Karaman, 1980; Hirayama, 1983; Hoover and Bousfield, 2001; Leite and Siqueira, 2013; Morales-Núñez and Chigbu, 2016; Tandberg and Vader, 2018). The most diverse genus is *Gitanopsis* Sars, 1892 with 18 species, followed by *Hourstonius* Hoover and Bousfield, 2001 with 17 species (Hoover and Bousfield, 2001; Leite and Siqueira, 2013).

Many species of *Hourstonius* were previously included in *Gitanopsis*, but after the study of Hoover and Bousfield (2001), the genus *Gitanopsis* grouped species from the Arctic and Northern Atlantic Oceans living on 0–875 m in depth, whereas *Hourstonius* grouped circumtropical species inhabit only shallow waters (0–50 m) (Hoover and Bousfield, 2001; Leite and Siqueira, 2013). *Hourstonius* species show elongated telson, distally rounded; coxae 2–4 ventrally smooth, lateral cephalic lobe often broad, whereas *Gitanopsis* shows telson distally acute and minutely tridentated; coxae 2–4 ventrally serrated; lateral cephalic lobe often acute (Hoover and Bousfield, 2001).

From Brazilian waters, only three amphilochid species are recorded: *Amphilocus schubarti* Schellenberg, 1938 recorded from Pernambuco State (8°S), *Apolochus neapolitanus* (Della Valle, 1893) recorded from Rio de Janeiro (43°S) and São Paulo State (46°) and *Hourstonius wakabarae* Leite and Siqueira, 2013 from São Paulo State (46°). In the present work, we describe a new species of *Hourstonius* from Todos-os Santos Bay, Bahia State (12° S), Brazil, being the first record of the genus from Bahia State and the second species of the genus with its type locality in Brazilian waters. We also discuss the *Hourstonius* world diversity and provide a taxonomic key for the genus across the globe.

Material and methods

The biological material was collected in Todos-os-Santos Bay, Bahia State, Brazil. Scuba diving was conducted in December 2019 at the Yacht Club da Bahia (1.0–2.0 m depth), Salvador City, to collect sessile fauna (e.g. corals and sponges) that potentially presented amphilochids amphipods. The substrate consisted of debris, sediments, ascidians, sponges, and corals. Sessile fauna was enclosed in plastic bags, to avoid evasion of associated fauna, and then removed from the substratum with a hammer and chisel.

In the laboratory, samples were sorted and washed with 70% ethanol. Amphilochids were found in *Desmapsamma* Burton, 1934 washes, and retained in 500 µm sieves. Mouthparts and appendages were mounted and dissected on glass slides with glycerol gel. The holotype habitus was illustrated under a stereomicroscope with camera lucida (Zeiss Discovery V.8), while the dissected appendages were photographed under a microscope with a digital camera (Zeiss

AXIO Scope.A1 AX10/ Axiocam 305), microphotographs were treated with the software ZEN ZEISS 1.6 PRO. Line drawings were prepared using the software CorelDRAW 2019, following the method proposed by Coleman (2006).

Type material is deposited in the Crustacean Collection of the Museu de Historia Natural da Universidade Federal da Bahia (MHNBA - UFBA). For diagnostic characters, we used the setal classification of Garm and Watling (2013), whereas the nomenclature for the palms of gnathopods is based on Poore and Lowry (1997). The following abbreviations are used in the figures: Hb, habitus; A1–2, antennae 1–2; Mx1–2, maxillae 1–2; Md, mandible; Mp, maxilliped; Gn1–2, gnathopods 1–2; P3–7, pereopods 3–7; Ep1–3, epimeral plates 1–3; U1–2, uropods 1–2; Ur1–3, urosomites 1–3; T, telson; r, right; l, left.

Systematic section

Suborder Amphilochidea Lowry and Myers, 2017
Infraorder Amphilochida Lowry and Myers, 2017
Parvorder Amphilochidira Lowry and Myers, 2017
Superfamily Amphilochoidea Lowry and Myers, 2017
Family Amphilochidae Boeck, 1871
Hourstonius Hoover and Bousfield, 2001
Hourstonius karamani sp. nov.
(Figs 1–3)

Examined material

Holotype

1 male 3.5 mm, Yacht Club da Bahia, Salvador City, Todos-os-Santos Bay, Bahia State, 12°59′58.4″S 38°31′50.7″W, associated with *Desmapsamma* sp., depth 2 m, 10 December 2019. UFBA 4541

Paratype

1 male 3.0 mm. Yacht Club da Bahia, Salvador City, Todos-os-Santos Bay, Bahia State, 12°59′58.4″S 38°31′50.7″W, associated with *Desmapsamma* sp, depth 2 m, 10 December 2019. UFBA 4542

Etymology

The species name is in honour of Dr Gordan Karaman for his notable contributions to the taxonomy of Amphilochidae, as well as to many other amphipods taxa of the world.

Diagnosis

Antenna 1 and 2 subequal in length. Antenna 1 peduncle stout, accessory flagellum minute. Lateral cephalic lobes broad and truncated. Eyes ovoid and large. Mandibular molar well developed, mandibular palp article 3 setose, longer than article 2. Gnathopod 1 subchelate, carpus not projected towards propodus. Gnathopod 2 larger than gnathopod 2, subchelate, carpal lobe almost reaching palmar angle. Epimeral plate 3 not projected. Telson long, entire, subconical with a distally rounded margin.

Description

White animals with little dorsal light-brown spots. *Head.* Rostrum acute and projected, cephalic lobes truncated, not projected. Eyes subovate. Antenna 1 subequal in length to antenna 2, article 1 10% longer than rostrum, slightly shorter than article 2, article 3 reaching 50% of article 2; accessory flagellum minute; flagellum reaching 70% of peduncle length, setose, with 10 articles. Antenna 2, article 4 subrectangular, slightly longer than article 3; article 5 small with 2 setae, one of them hirsute and the other plumose; flagellum shorter than 50% of peduncle, setose, with 6 articles (Figure 1).

Mouthparts. Mandible molar well-developed and triturative; incisor serrate, with 10 accessory spines; *lacinia mobilis* serrated, laterally excavated; palp short, 3-articulated, article 1 subquadrate, reaching 50% of article 2, article 2 subrectangular, without setae, 20% wider than article 3, article 3 thin, narrowing distally, leaf-shaped, beset with several setules. Maxilla 1 palp biarticulated, article 1 subsquared, reaching 25% of article 2 length, article 2 globose, distal margin with 10 robust simple setae; outer plate as long as palp article 2, distal margin with 8 robust setae; inner plate vestigial, naked and subrounded. Maxilla 2 outer plate with distal margin truncated, beset with several simple setae; inner plate laterally and distally setose. Maxilliped palp, article 1 20% longer than article 2, outer margin with 2 setae, distal corner with small simple seta. Article 2 inner margin setose, facial margin with 3 setae, the distalmost small and stout, article 3 slightly longer than article 2, inner margin setose, outer margin with 2 simple setae; inner plate distally acute, reaching 50% of palp length, distal margin with 2 setae; inner plate subrectangular, 3.5x longer than large, distal margin with 9 small and stout setae. Upper lip and lower lip missing (Figure 1).

Pereon. Gnathopod 1, coxa 1 reduced, with posterior lobe, anteroventral corner truncated, not produced, ventral margin naked; basis subcylindrical, 40% longer than coxa 1, posteroventral margin with small seta, ischium reaching ½ of merus length, posteroventral margin with small seta, merus reaching 50% of basis length, posterior margin with robust long seta, distal margin with 3 robust ones; carpus short, reaching 40% of propodus length, posteroventral lobe not projected; propodus with long facial seta, palm transverse, covered by several setules, with set of seven long setae, dactylus as long as palm, inner margin serrate, with distal acute projection (Figure 2).

Gnathopod 2 larger than gnathopod 1, coxa 2 subovate, 2.5x longer than coxa 1, ventral margin naked; basis long subcylindrical, 15% longer than coxa 2; ischium reaching 25% of basis length; merus 10% longer than ischium, posterior margin with small stout seta, distal margin with 2 robust and long ones; carpus projected towards propodus, almost reaching propodus palm, posteroventral corner with 3 robust setae; propodus well developed, reaching 90% of basis length, palm transverse, undulated, covered by several setules, with set of 13 setae, palmar corner with 2 long robust ones; dactylus 15% longer than palm, inner margin smooth, with distal acute projection and single seta (Figure 2).

Pereopd 3, coxa 3 subrectangular, long, ventrally naked; basis subcylindrical, as long as coxa 3, posterior and anterior corners with small seta on each one; ischium reaching 15% of basis length; merus subrectangular 3× longer than ischium, anterior and posterior margins with seta on each one, anteroventral corner well projected with 2 setae, posteroventral corner less projected with single seta; carpus similar in length to merus, subrectangular, anteroventral corner with 3 small setae, posteroventral corner with 2 longer ones; propodus 30% longer than carpus, anterior margin with 2 setae, posterior margin with 4 ones; dactylus long, reaching 60% of propodus length (Figure 2). Pereopod 4, coxa 4 robust, posteriorly expanded; basis, ischium, merus, carpus, and propodus similar to that of pereopod 3 (Figure 2).

Pereopod 5 20% shorter than pereopod 6, coxa 5 lobated; basis globose, posterior margin smooth and naked, anterior margin with 3 distal small setae; ischium subsquared, anteroventral corner with setula; merus reaching 70% of basis length, posteroventral corner produced with 3 setae, posterior margin with distal one; anterior margin with 2 anterior setae, anteroventral corner with 2 longer ones; carpus slightly shorter than merus, posteroventral, and anteroventral corners with 1 and 2 setae respectively, anterior margin with 2 setae; propodus 30% longer than carpus, anterior margin with 4 setae, posterior margin with 2 ones; dactylus long reaching 60% of propodus length (Figure 3).

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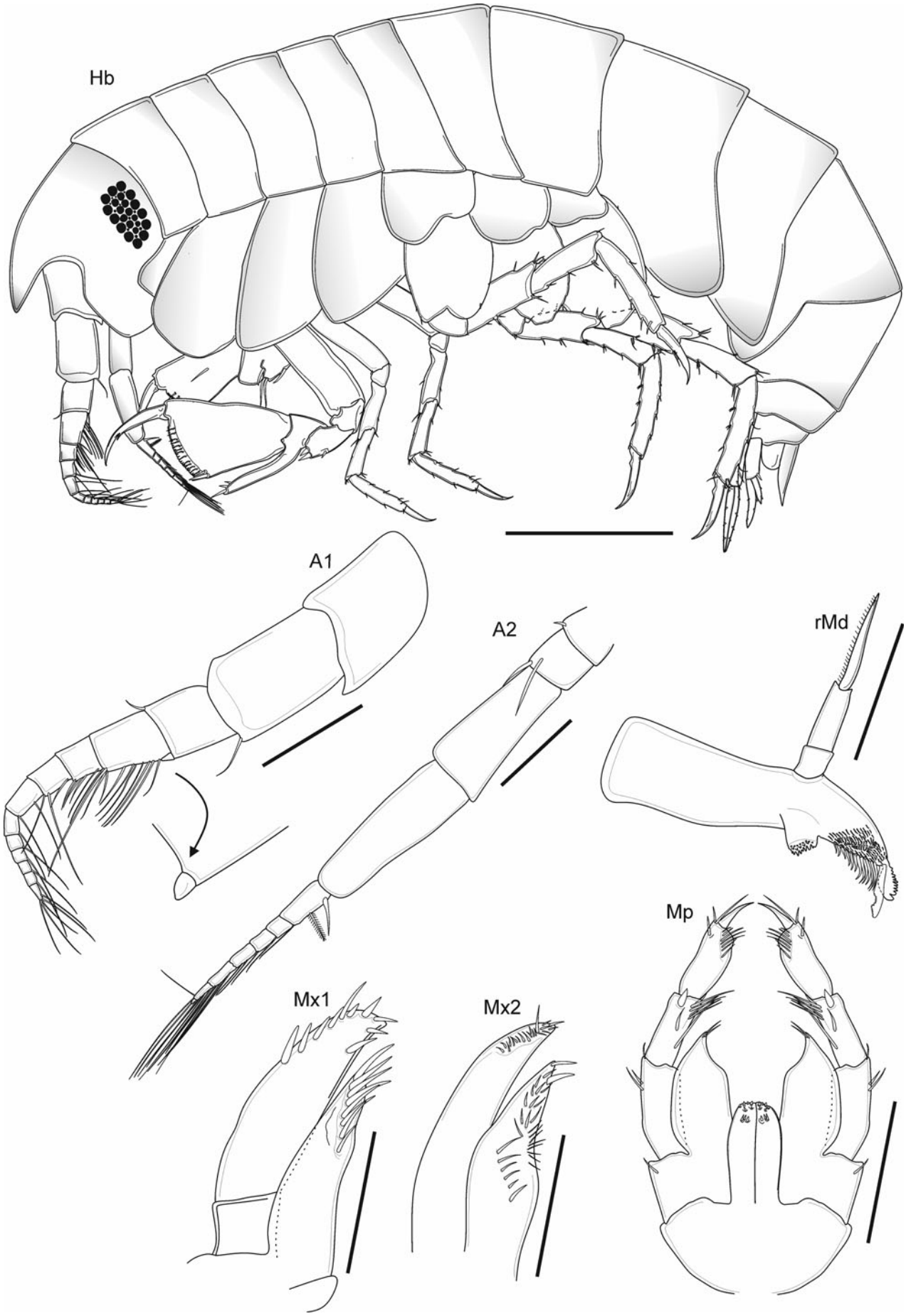

Figure 1. *Hourstonius karamani* sp. nov., Yatch Club da Bahia, Salvador City, Todos-os-Santos Bay, Bahia State, 12°59′58.4″S 38°31′50.7″W, holotype male. Scale bars: 1 mm (Hb), A1 and A2 (0.4 mm), Mx1, Mx2, rMd, Mp (0.3 mm).

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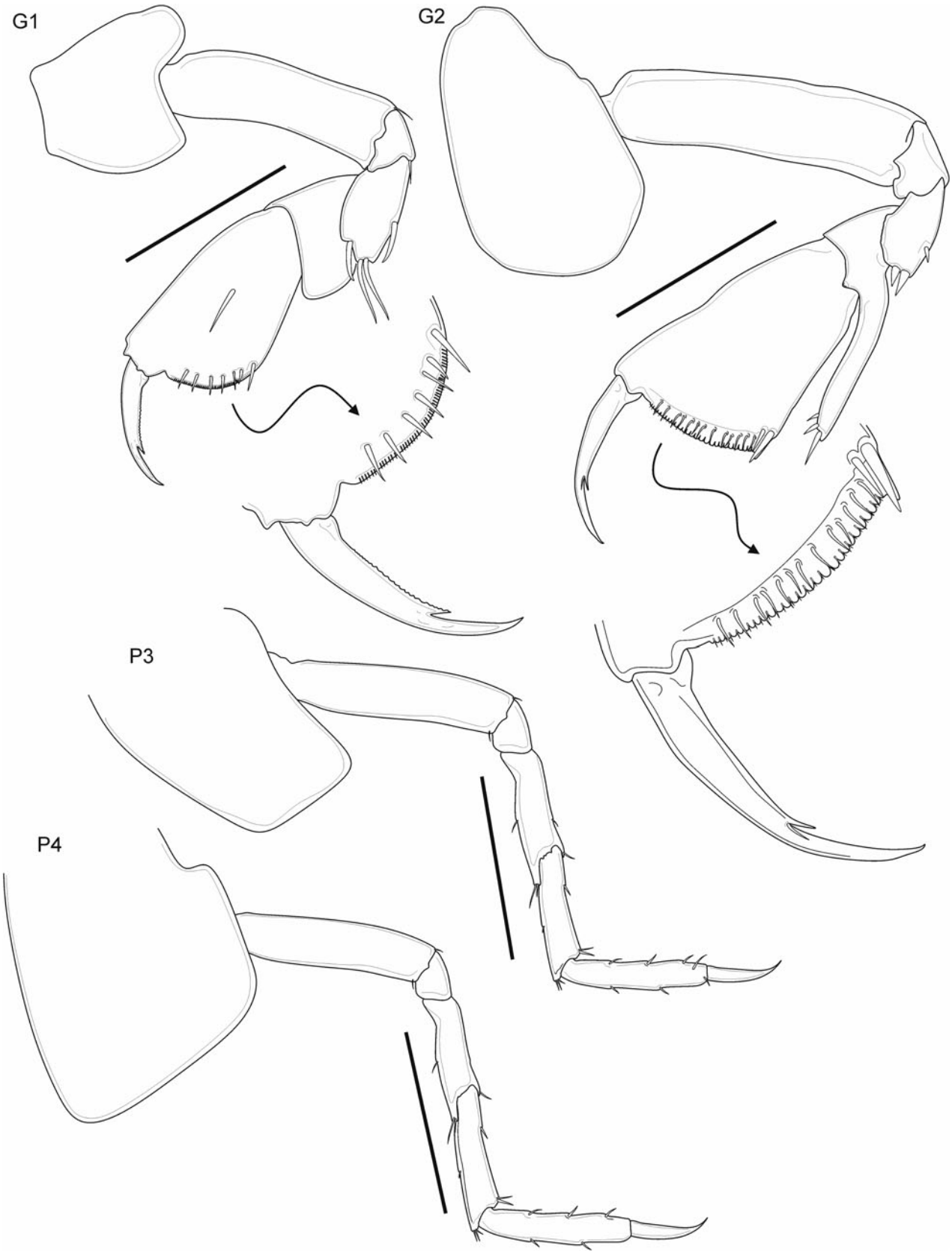

Figure 2. *Hourstonius karamani* sp. nov., Yatch Club da Bahia, Salvador City, Todos-os-Santos Bay, Bahia State, 12°59′58.4″S 38°31′50.7″W, holotype male. Scale bars: 0.4 mm.

Pereopod 6, coxa 6 lobated, basis globose, 25% longer than pereopod 5 basis, posterior margin slightly undulated, without seta, anterior margin with 5 setae, anteroventral corner with robust one; ischium small, subquadrate, anteroventral corner with 2 small setae; merus as long as carpus, anterior margin with 3 setae, anteroventral corner setose, posterior margin with 3 setae, posteroventral corner less produced than pereopod 5 merus, with 3 robust setae; carpus subrectangular, anterior margin with 3 setae, anteroventral corner with 2 longer ones, posterior margin with 2 medial small setae, posteroventral corner with 2

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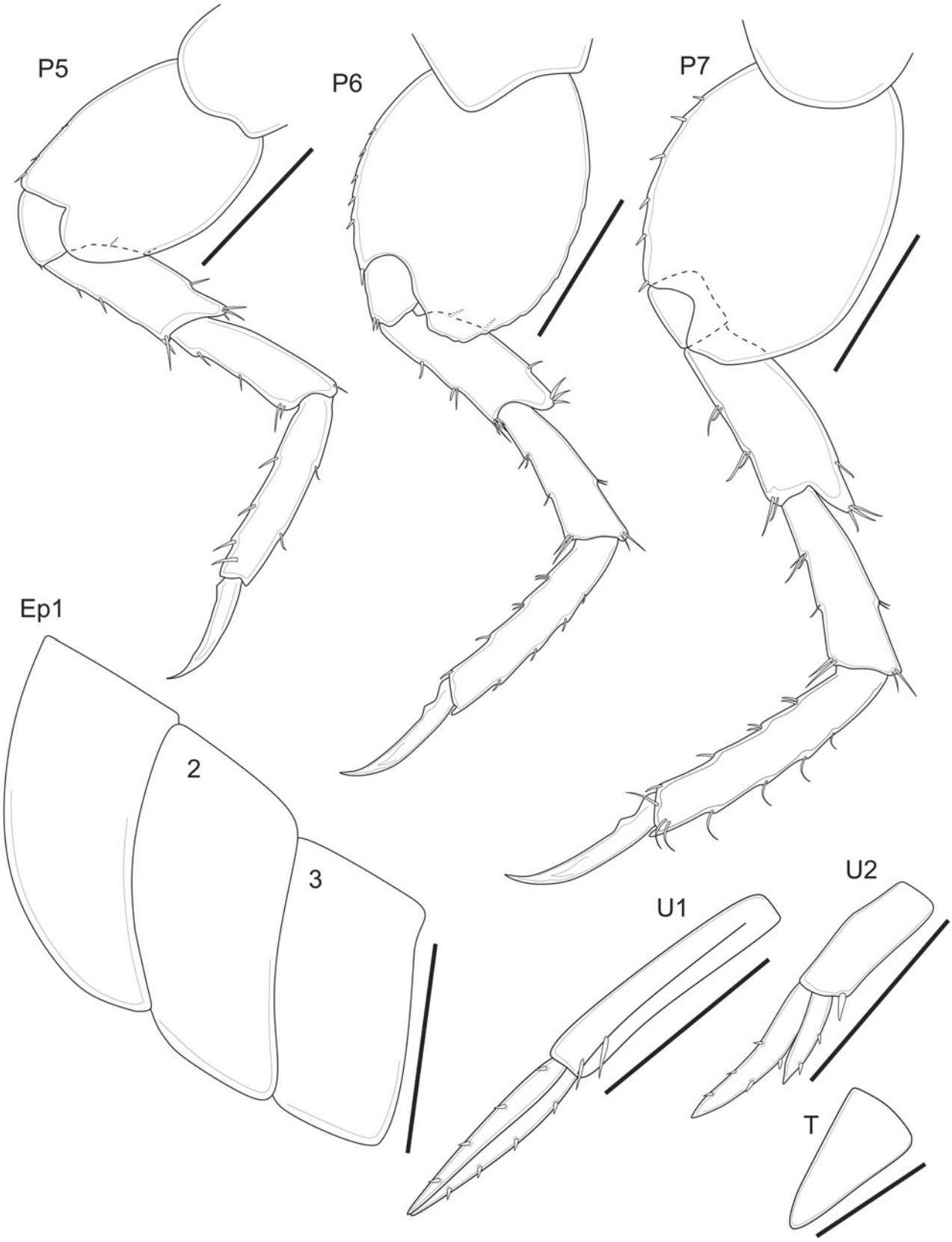

Figure 3. *Hourstonius karamani* sp. nov., Yatch Club da Bahia, Salvador City, Todos-os-Santos Bay, Bahia State, 12°59′58.4″S 38°31′50.7″W, holotype male. Scale bars: 0.4 mm (P5-7, Ep1-3), 0.3 mm (U1-3, T).

longer ones; propodus 35% longer than carpus, anterior margin with 5 setae, anteroventral corner with single seta, posterior margin with 4 ones, posteroventral corner projected; dactylus reaching 60% of propodus length (Figure 3).

Pereopod 7 20% longer than pereopod 6; coxa 7 subrounded; basis globose, 10% longer than pereopod 6 basis, posterior margin smooth and rounded, anterior margin with 6 setae; ischium subsquare; merus reaching 80% of basis length; posteroventral corner well projected with 3 setae, anterior margin with 2 sets of 2 setae, anteroventral corner with 2 setae; carpus similar in length to merus, anterior margin with set of 3 setae and a posterior seta, anteroventral corner with 2 long ones, posterior margin with a

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medial set of 2 setae, posteroventral corner with 2 ones; propodus 40% longer than carpus, setation similar to pereopod 6 propodus, except by the distal margin with 3 long setae; dactylus long, reaching 65% of propodus length (Figure 3).

Pleossome. Epimeral plates without setae; epimeral plate 1 posterior corner rounded and slightly projected; epimeral plate 2, posterior corner rounded, not projected; epimeral plate 3 posterior corner subsquare, not projected (Figure 3).

Urossome. Uropod 1 peduncle subrectangular 5× longer than wide, with 2 distal setae, 10% longer than rami; rami narrowing distally, inner ramus similar in length and shape to outer ramus, each one with 4 small and stout setae. Uropod 2 35% shorter than uropod 1, peduncle 25% shorter than outer ramus, 2.2x longer than wide, with distal stout seta; rami unequal in length, outer ramus with 5 small stout setae; inner ramus shorter, with 2 small stout setae. Uropod 3 missing. Telson conical, long, about 1.4x longer than wide (Figure 3).

Remarks

Hourstonius karamani **sp. nov.** is closely related to *H. wakabarae* from Brazil by the cephalic lobe not projected, the similar shape of gnathopod 2, with carpal lobe long and projected angle, and by the shape of pereopods 3–7 (Leite and Siqueira, 2013). Nevertheless, *H. karamani* **sp. nov.** is different from *H. wakabarae* by the ovoid eyes (curved in *H. wakabarae*); Antenna 1 accessory flagellum minute not reaching the end of article 3 (long and reaching the end of article 3 in *H. wakabarae*); Mandible palp article 1 subsquared and article 3 beset with setules (article 1 subrectangular and article 3 naked in *H. wakabarae*); Gnathopod 1 carpus without projected lobe (carpus with a long projected lobe in *H. wakabarae*); Epimeral plate 3 not projected and subquadrate (acute and projected in *H. wakabarae*) (Leite and Siqueira, 2013).

The absence of a projected gnathopod 1 carpal lobe resembles the congener from Tropical Atlantic Realm *H. tortugae*, but the new species is different by showing: eyes large and ovoid (small and rounded in *H. tortugae*); maxilla 2 outer lobe distal margin with several setae (with just 7 distal setae in *H. tortugae*); mandible palp article 3 beset with setules (naked in *H. tortugae*); coxa 1 distally rounded with a posterior lobe (coxa 1 tapering distally without posterior lobe in *H. tortugae*); epimeral pate 3 not projected (projected and upturned in *H. tortugae*) (Shoemaker, 1933; LeCroy, 2002).

Hourstonius karamani **sp. nov.** is also different from its congeners in Tropical Atlantic *H. laguna* by showing antenna 1 peduncle stout and gnathopod 2 carpal lobe long (peduncle thin and carpal lobe short in *H. laguna*); *H. templadoi* by the gnathopod 1 carpal lobe not projected and telson distal margin subrounded (carpal lobe long and projected and telson distal margin acute in *H. templadoi*); *H. petulans* by the gnathopod 1 dactylus inner margin not serrated with a distal spine (dactylus serrated in *H. petulans*), and *H. magdai* by eyes regularly ovoid and epimeral plate 3 not projected (eyes irregularly rounded and epimeral plate 3 projected in a rounded lobe in *H. magdai*) (Reid, 1951; McKinney, 1978; Karaman, 1980; Ortiz and Lalana, 1996; LeCroy, 2002).

Lecroy (2002) described a morphotype called '*Hourstonius* sp. B' from Florida, Tropical Atlantic. Nevertheless, these described specimens are different from all *Hourstonius* species of Atlantic by the gnathopod 1 and 2 similar in size, gnathopod 2 propodus margins subparallel, carpal lobe not projected, and propodus palm transverse. This pattern resembles *H. pusilloides* from California (Shoemaker, 1942; Karaman, 1980; Hoover and Bousfield, 2001).

Hoover and Bousfield (2001) suggested the existence of an unnamed group of *Gitanopsis* including the species *G. marionis* (Stebbing, 1888), *G. tai* Myers, 1985, and *G. squamosa* (Thompson, 1880). The authors do not describe the characteristics that support the unnamed group but argue that it is closer to *Hourstonius* than *Gitanopsis*. *Gitanopsis marionis*, one of the species of this group, was synonymized with *Amphilochus marionis* (Azman, 2009). Species of this unnamed group show a subtriangular telson with an entire tip, antenna 1 without accessory flagellum, and a broad rostrum (Myers, 1985).

The new species shows a similar telson of *G. tai* but is different by having a minute accessory flagellum, wider lateral cephalic lobe, and antennae similar in length. Species of *Gitanopsis* complex should be analysed by a cladistics study to clarify the existence of another genus including the species *G. tai* and *G. squamosa*, the available data are not sufficient to define it as a valid genus. Nevertheless, *H. karamani* sp. nov. fits *Hourstonius* by the morphological characteristics, and additionally is found in the same biogeographic region originally proposed for the genus (Hoover and Bousfield, 2001).

Gitanopsilis Rauschert, 1994 is a monospecific genus related to *Gitanopsis* whose type species, *G. amissio,* shows maxilla 2 inner lobe as wide as outer one, gnathopods 1 and 2 with acute palm and telson subtriangular with a concave tip. The new species is different from *G. amissio* in the shape of gnathopods, telson, and maxilla 2 lobes shape.

Discussion

The genus *Hourstonius* was established by Hoover and Bousfield (2001), comprising species from Temperate and Warm Temperate Oceans and Tropical Atlantic species. According to the authors, Amphilochidae was classified as a basal group, a *Gitanopsis* and *Hourstonius* are closely related genera, forming a group whose centre of origin is thought to be the Arctic and posteriorly dispersed to warmer waters (Hoover and Bousfield, 2001).

Hourstonius comprises small species living in association with a great diversity of organisms. Of the 18 described species, 25% were recorded living in algae, 30% were captured in sand or muddy bottom, and 10% were found in seagrass beds (Figure 4). Species were also found living associated with sponge, coral, associated with *Aplysia* eggs, plankton community, and floating objects (Barnard, 1979; Hirayama, 1983; LeCroy, 2002; Madrigal, 2007).

The genus is typical from shallow waters and most of the species are found in less than 10 m depth (Figure 4). Some descriptions available by the consulted bibliography do not provide a precise measure of collection depth, but according to the methods of collection described, we can conclude that species without depth data were probably found in shallow waters.

Considering the *Hourstonius* biogeographic distribution, most of the species were recorded from Temperate Northern Pacific, located in Korea, Japan, and the USA (California) (Shoemaker, 1933; Barnard, 1962; Hirayama, 1983; Hirayama and Takeuchi, 1993; Kim *et al*., 2010). The second most diverse realm is Tropical Atlantic with six species (Figure 5). The species *H. pusilla* from False Bay, South Africa, was recorded from India, Mozambique, and Tristan da Cunha (Barnard, 1916; Karaman, 1980). Nevertheless, for this review, we consider only the type locality of species because most of these records are out-of-date. Considering the taxonomic changes that the family and the genus have undergone over time, these records can probably represent new species.

The most recent *Hourstonius* species was described one decade ago, being the Brazilian species *H. wakabarae*. During the middle of the '90s (1978–1995), nine species of the genus were described. After that, the discovery of the new *Hourstonius* abruptly paused (McKinney, 1978; Barnard, 1979; Hirayama, 1983; Hirayama and Takeuchi, 1993; Ortiz and Lalana, 1996).

Hourstonius diversity is still underestimated, considering the occurrence of 3 different species from Florida, in comparison

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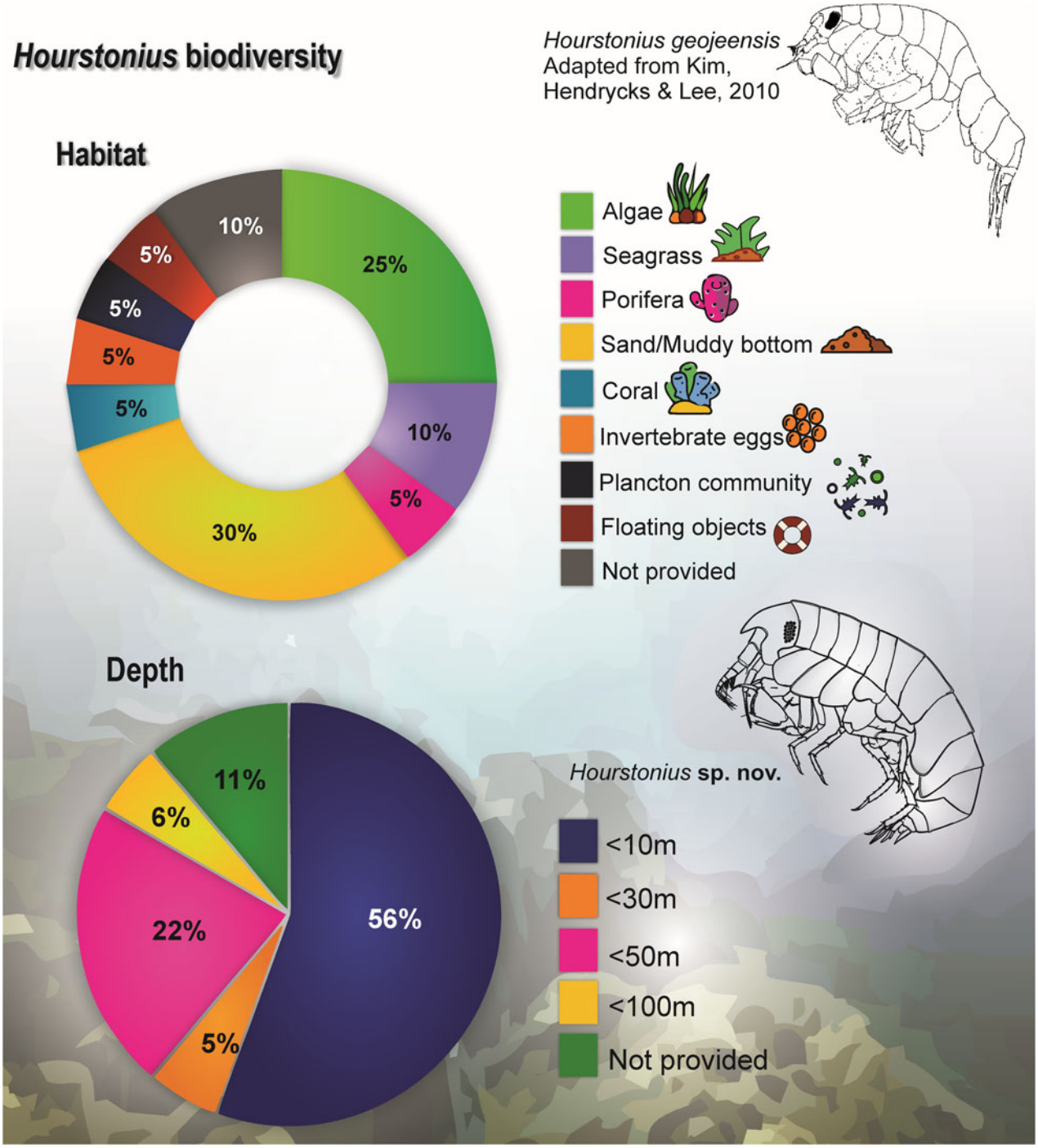

Figure 4. Infographic of habitat and depth of *Hourstonius* species across the globe.

with just 2 species in South America and Africa, both continents with a larger geographic extension (Figure 5). The symbiont habit of *Hourstonius* requires accurate collection and sorting methods. In addition, specimens of this genus used to be smaller in comparison with other amphipods, this may contribute to the underestimated known biodiversity. As noted in other amphipod genera, the knowledge of *Hourstonius* biodiversity is dependent on the taxonomist's efforts in different geographic areas.

Taxonomic key of Hourstonius *of the world*

1. Maxilla 2 inner lobe with 3 setae . . . . . *Hourstonius magdai* (Reid, 1951)
   Maxilla 2 inner lobe with more than 3 setae 2

2. Antenna 1 accessory flagellum present 3
   Antenna 1 accessory flagellum absent 11

3. Gnathopod 1 dactylus inner margin serrated 4
   Gnathopod 1 dactylus inner margin not serrated (smooth or with the distal acute process) 6

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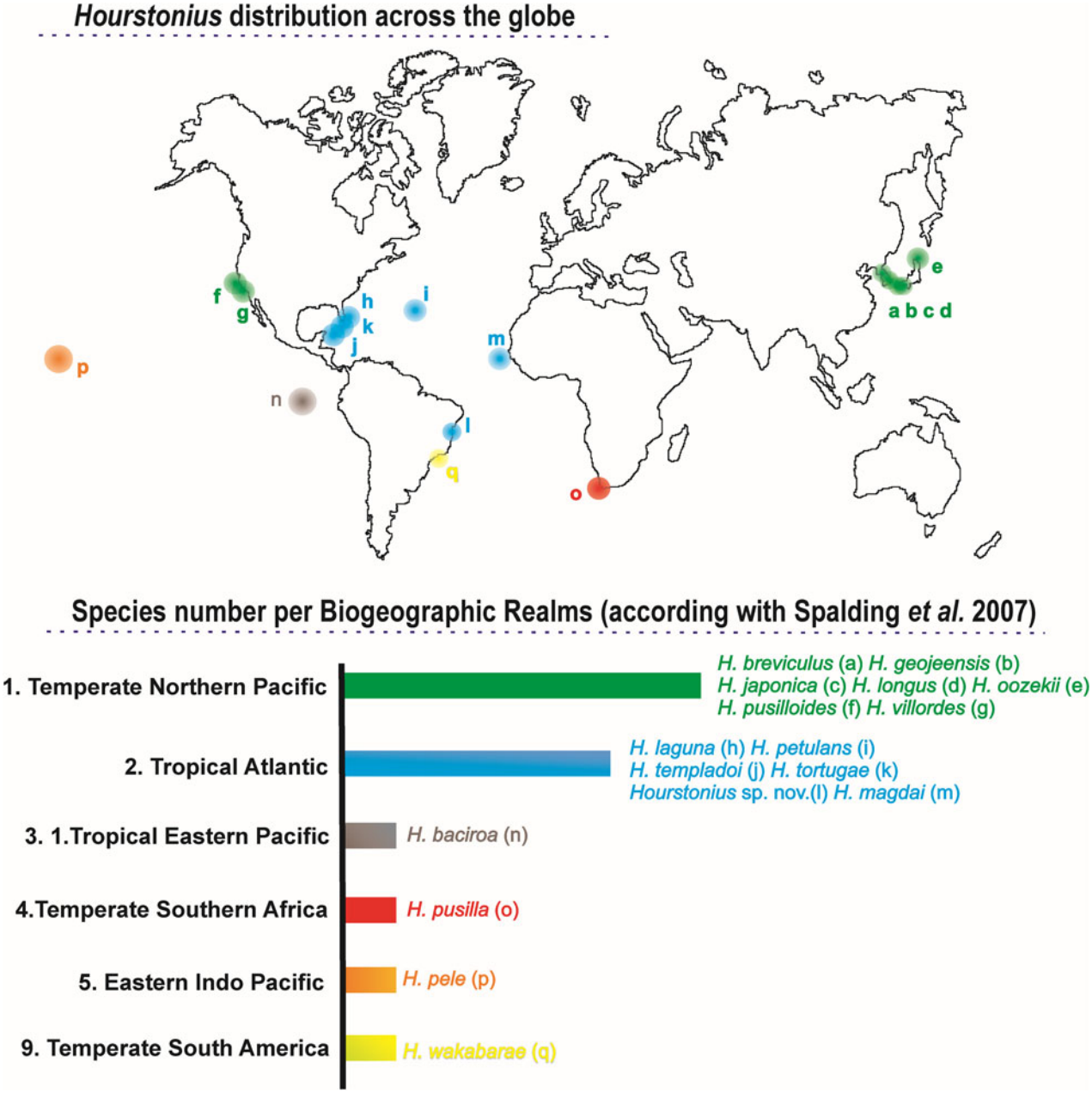

Figure 5. Infographic of *Hourstonius* distribution.

4. Gnathopod 1 dactylus inner margin proximally serrated . . . . . *Hourstonius geojeensis* Kim, Hendrycks and Lee, 2010
Gnathopod 1 dactylus inner margin distally serrated 5

5. Telson long and longer than the half of U3 peduncle . . . . . *Hourstonius vilordes* (Barnard, 1962)
Telson short and shorter than the half of the U3 peduncle . . . . . *Hourstonius pusilla* (Barnard, 1916)

6. Gnathopod 1–2 dactylus shorter than propodus palm . . . . . *Hourstonius oozekii* (Hirayama and Takeuchi, 1993)
Gnathopod 1–2 dactylus as long as or slightly longer than propodus palm 7

7. Antenna 1 accessory flagellum as long as flagellum article 1 length . . . . . *Hourstonius wakabarae* Leite and Siqueira, 2013
Antenna 1 accessory flagellum shorter than flagellum article 1 length s 8

8. Mandibular palp article 3 setose . . . . . *Hourstonius karamani* **sp. nov.**
Mandibular palp article 3 naked 9

9. Mandible palp article 3 similar in length to article 2 . . . . . *Hourstonius longus* (Hirayama, 1983)
Mandible palp article 3 dissimilar in length to article 2 10

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10. Mandible palp article 3 longer than article 2 . . . . . *Hourstonius breviculus* (Hirayama, 1983)
    Mandible palp article 3 shorter than article 2 . . . . . *Hourstonius robastodentes* (Hirayama, 1983).

11. Coxa 1 narrowing distally 12
    Coxa 1 not narrowing distally 14

12. Gnathopod 2 dactylus distally serrated . . . . . *Hourstonius pele* (Barnard, 1970)
    Gnathopod 2 dactylus distally smooth or with a single spine 13

13. Coxa 1 distally acute . . . . . *Hourstonius japonica* (Hirayama, 1983)
    Coxa 1 distally conical . . . . . *Hourstonius laguna* (McKinney, 1978)

14. Mandible palp short, reaching half of the mandible length . . . . . *Hourstonius templadoi* (Ortiz and Lalana, 1996)
    Mandible palp long, well developed reaching more than half of mandible length 15

15. Coxa 1 subrounded . . . . . *Hourstonius tortugae* (Shoemaker, 1942)
    Coxa 1 subrectangular or subquadrate 16

16. Epimeral plate 3 posteroventral corner rounded . . . . . *Hourstonius petulans* (Karaman, 1980)
    Epimeral plate 3 posteroventral corner acute 17

17. Maxiliped palp article 3 with 6 distal finger-shaped processes . . . . . *Hourstonius baciroa* (Barnard, 1979)
    Maxiliped palp article 3 with 2 small distal finger-shaped processes . . . . . *Hourstonius pusilloides* (Shoemaker, 1933)

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