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1 **New sea spider species (Pycnogonida: Austrodecidae) from a submarine cave in Japan**

2

3 Running head: New submarine-cave sea spider

4

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6

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20 **Abstract**

21 We describe a new sea spider species, *Pantopipetta hosodai* sp. nov., based on one juvenile  
22 female collected from a submarine cave (“Akumanoyakata” Cave) at Shimojijima Island,  
23 Miyako Island Group, Ryukyu Islands, southwestern Japan. It was collected from the second  
24 slope zone of the cave, 80–100 m from the entrance, no light, low salinity, and with rocky  
25 substrate. This is the first record globally of a *Pantopipetta* species from a submarine cave  
26 and anchialine environment. *Pantopipetta hosodai* sp. nov. resembles *Pantopipetta auxiliata*,  
27 *Pantopipetta lenis*, and *Pantopipetta oculata* in having auxiliary claws but differs from them  
28 in having a palp with three short distal articles, lateral processes without dorsodistal  
29 tubercles, coxae 1 and 3 of legs 1–3 each with one long dorsal tubercle, and one dorsodistal  
30 tubercle bearing a seta on each femur. Features of the palp appear to delineate two species  
31 groups in *Pantopipetta*, i.e., (1) those having four small distal articles, and a small, basal palp  
32 article between the lateral cephalon process and longest palp article (8-articulate palp) and (2)  
33 those having three small distal articles, and lacking the small basal article (6-articulate palp),  
34 but further detail examination of described species is needed. We discuss the diagnostic  
35 characters separating *Pantopipetta* and *Austrodecus* and the generic affiliation of *Austrodecus*  
36 *aconae*. Few pycnogonids from marine or anchialine caves have been identified to species,  
37 and it is generally unknown whether cave-dwelling pycnogonids tend to be troglobites.

38

39 **Key words:** Akuma-no-Yakata; Chelicerata; palp; *Pantopipetta*; Pantopoda; Stiripasterida;  
40 anchialine

## 41 Introduction

42 Pycnogonida, or sea spiders, are almost exclusively free-living marine invertebrates. With  
43 more than 1300 named species (Appeltans et al., 2012; Bamber et al., 2023), pycnogonids  
44 occur in all oceans and range in depth from 0–7370 m (Arnaud & Bamber, 1987). Although  
45 most studies deal with individuals collected from open marine environments, a few have  
46 reported sea spiders from caves (e.g., Akoumianaki & Hughes, 2004; Bamber, 2008; Onorato  
47 & Belmonte, 2017; Alvarez & Ojeda, 2018; Gerovasileiou & Bianchi, 2021). Cave-dwelling  
48 sea spiders are generally not identified but just listed as Pycnogonida; exceptions are  
49 *Pycnogonum coninsulum* Bamber, 2008 from a submarine cave in Hong Kong and  
50 *Anoplodactylus batangensis* (Helfer, 1938) from an anchialine cave in Mexico (Bamber,  
51 2008; Alvarez & Ojeda, 2018). Having not yet been collected from open marine  
52 environments, *Py. coninsulum* appears to be an endemic cave species (Bamber *et al.*, 2008).  
53 *Anoplodactylus batangensis* is a cosmopolitan species also found outside the cave, suggesting  
54 that the individual in the cave may have been transported through passageways in the  
55 anchialine system (Alvarez & Ojeda, 2018).

56 There are many submarine caves around the Ryukyu Islands, southwestern Japan,  
57 but knowledge of their invertebrate faunas is limited. Recent surveys of the invertebrate fauna  
58 of “Akumanoyakata” submarine cave at Shimojijima Island have detected new or rare species  
59 among poriferans (e.g., Ise, 2019), crustaceans (e.g., Saito & Fujita, 2022), polychaetous  
60 annelids (e.g., Worsaae *et al.*, 2021), brittle stars (e.g., Okanishi & Fujita, 2019), and bivalves  
61 (e.g., Mizuyama *et al.*, 2022), but there have been no records of sea spiders to date.

62 This paper reports one sea spider collected from the completely dark, anchialine  
63 zone at 10–20 m depth in the Akumanoyakata Cave. With a slender, pipette-shaped proboscis  
64 having distal annulation, it belongs to the family Austrodecidae Stock, 1954. Although the  
65 specimen is likely a juvenile female and it is unknown how many articles there are in the  
66 adult oviger (one character distinguishing between the austrodecid genera: *Austrodecus*  
67 Hodgson, 1907 with six or fewer articles (absent in males of several species) and  
68 *Pantopipetta* Stock, 1963 with 10 articles and a terminal claw), we identified the specimen as  
69 *Pantopipetta* based on the very slender trunk without dorsomedian tubercles and the palp  
70 with three short distal articles (cf. Child, 1994; for detail, see the Discussion section).  
71 *Pantopipetta* pycnogonids are relatively rare (Hedgpeth & McCain, 1971) and generally  
72 found at considerable depths (Child, 1994), with the shallowest record at 66 m (cf. Hosoda &  
73 Kakui, 2020). This is the first record of *Pantopipetta* from a submarine cave or anchialine

74 environment, and the shallowest depth record at 10–20 m. The specimen can be distinguished  
75 from all congeners (16 species; Hosoda & Kakui, 2020), and we describe it here as a new  
76 species. Additionally, we discuss the taxonomic significance of the number of palp articles in  
77 *Pantopipetta* species and cave pycnogonids in general.

78

## 79 **Materials and Methods**

80 A pycnogonid was collected by SCUBA diving on 8 March 2021 in “Akumanoyakata” Cave,  
81 located on a reef slope at Shimojijima Island, Miyako Island Group, Ryukyu Island,  
82 southwestern Japan (26°51.896’N 128°14.732’E), with the entrance at about 35 m depth; see  
83 Osawa & Fujita (2019) for detailed information on the cave. From the second slope zone  
84 (Osawa & Fujita, 2019; 80–100 m from the entrance, 10–20 m depth, no light, less than 28%  
85 salinity, rocky substrate), mud deposited around cnidarians and poriferans on the cave wall  
86 was collected with a commercially made aquatic suction sampler (yabby pump). The  
87 individual was sorted from the mud sample and preserved in 99% ethanol. The methods used  
88 for dissection, preparation of slides, light microscopy, and drawing were as described by  
89 Kakui & Angsupanich (2012). Morphological terminology follows Child (1979), except that  
90 the term "article" is used instead of "segment" for all appendages (Hosoda & Kakui, 2020).  
91 Measurements were made axially (dorsally for the trunk and abdomen; laterally for the palp,  
92 proboscis, ocular tubercle, and legs) and are presented in millimeters. Measurements for  
93 congeners were obtained from original descriptions or measured from original illustrations.  
94 Trunk length was measured from the palp insertion to the base of the abdomen, and trunk  
95 width as the width of the segment at the narrowest portion of the trunk. The specimen studied  
96 was deposited in the Invertebrate Collection of the Hokkaido University Museum (ICHUM),  
97 Sapporo. To obtain information on male genital openings in *Pantopipetta*, we observed the  
98 type series of *Pantopipetta lenis* Hosoda & Kakui, 2020 (ICHUM6038, 6039).

99

## 100 **Results**

### 101 *Systematics*

102 Family Austrodecidae Stock, 1954

103 Genus *Pantopipetta* Stock, 1963

104 *Pantopipetta hosodai* sp. nov.

105 [New Japanese name: Dokutsu-suikuchi-umigumo]

106 (Figures 1, 2, 3A–D)

107

108 *Diagnosis (juvenile female)*

109 Trunk segments 2 and 4 short (length/width ratios 1.3 and 2.6); ocular tubercle with swollen  
110 tip; lateral processes without dorsodistal tubercle; palp with three short distal articles; coxa 1  
111 of legs 1–3 with long dorsal tubercle (longer than coxa-1 width); coxa 3 of legs 1–3 with long  
112 dorsal tubercle (as long as coxa-3 width); all femora with short dorsodistal tubercle (length  
113 0.5 times femur width) bearing seta; auxiliary claws about 0.5 claw length.

114

115 *Etymology*

116 The specific name is a noun in the genitive case, honoring Yushi Hosoda, who has  
117 contributed to the taxonomy of Japanese pycnogonids.

118

119 *Type material*

120 Holotype. Juvenile female, ICHUM8407; three slides and one vial; second-slope zone in  
121 Akumanoyakata Cave (26°51.896'N 128°14.732'E), 10–20 m depth, Shimojijima Island,  
122 Miyako Island Group, Ryukyu Islands, Japan, northwestern Pacific Ocean, mud; collected on  
123 8 March 2021 by Yoshihisa Fujita.

124

125 *Description of holotype (juvenile female)*

126 Trunk (Figures 1A, B, 2A–C) fully segmented, without dorsomedian tubercles; segments 2  
127 and 4 short; segment 3 deformed, flattened by accidentally pinching with forceps (Figure 2A,  
128 gray-shaded area with asterisk). Lateral processes long, separated by about their basal  
129 diameter (trunk segments 1–3) or about twice their basal diameter (segments 3 and 4),  
130 without dorsodistal tubercle. Ocular tubercle (Figure 2B, C) tall, erect, with swollen tip  
131 bearing four tiny eyes; tiny distal process present. Proboscis pipette-like, annulated. Abdomen  
132 longer than trunk segment 4, with pair of subposterior setae (one broken).

133 Palp (Figures 1C, 2D, E) 6-articulate. Article 1 longest, with two spines. Article 3  
134 with one middle and two strong distal setae; two strong curved spines, one subdistal and one  
135 distal. Articles 4–6 (= 3 short distal articles) with three, three, and four distal setae.

136 Oviger (Figures 1D, 2F) with 1 article, naked.

137 Legs 1–3 (Figures 2G–I, 3A–C) slender. Coxa 1 with long dorsal tubercle (longer  
138 than coxa-1 width). Coxa 2 with tiny dorsal projection and tiny ventro-subdistal genital  
139 opening; subdistal seta on legs 1 and 2. Coxa 3 with long dorsal tubercle (longer than coxa-3

140 width) and ventrodiscal seta. Femur with two distal setae and short dorsodistal tubercle  
 141 (length half femur width) bearing seta. Tibia 1 with two (legs 1 and 2) or one (leg 3)  
 142 dorsodistal and one ventro-subdistal setae, and dorsodistal robust seta. Tibia 2 with six (leg 1)  
 143 or four (legs 2 and 3) ventral, two (legs 1 and 3) or one (leg 2) anterior, two (legs 1 and 3) or  
 144 one (leg 2) posterior setae and mid-dorsal robust seta. Tarsus with two (legs 1 and 2) or one  
 145 (leg 3) ventral, two (legs 1 and 2) or one (leg 3) anterior, and two (leg 1) or one (legs 2 and 3)  
 146 posterior setae. Propodus with one dorsodistal and six (legs 1 and 2) or three (leg 3) ventral  
 147 setae, and two auxiliary claws; with one anterior and one posterior setae on leg 1; auxiliary  
 148 claws similar in size, about half claw length. Cement gland opening not observed.

149 Leg 4 (Figures 2J, 3D) slender, much shorter than legs 1–3. Coxa 1 with short dorsal  
 150 tubercle (shorter than half coxa-1 width). Coxa 2 similar to those in legs 1–3; tiny ventro-  
 151 subdistal genital opening present. Coxa 3 with short dorsal tubercle (shorter than half coxa-3  
 152 width) and ventrodiscal seta. Femur with distal seta and short dorsodistal tubercle (length half  
 153 femur width) bearing seta. Tibia 1 similar to those in legs 1 and 2. Tibia 2 with three ventral,  
 154 one anterior and one posterior setae, and mid-dorsal robust seta. Tarsus with one ventral and  
 155 one anterior setae. Propodus with one dorsodistal and two ventral setae, and two auxiliary  
 156 claws; auxiliary claws similar in size, about half claw length. Cement gland opening not  
 157 observed.

158 *Measurements.* Trunk length 0.46; width across second lateral processes 0.30;  
 159 proboscis length 0.66; ocular tubercle length 0.33; abdomen length 0.22; length/width of  
 160 trunk segments 2 and 4, 0.11/0.08, 0.12/0.05; length of palp articles 1–6, 0.30, 0.05, 0.20,  
 161 0.02, 0.04, 0.01 (0.62 in total); length of leg-1 articles (from coxa 1; including claw), 0.07,  
 162 0.18, 0.08, 0.30, 0.32, 0.33, 0.04, 0.16, 0.08 (1.55 in total); length of leg-2 articles (ditto),  
 163 0.08, 0.15, 0.07, 0.28, 0.27, 0.31, 0.03, 0.16, 0.08 (1.41 in total); length of leg-3 articles  
 164 (ditto), 0.06, 0.14, 0.07, 0.26, 0.24, 0.28, 0.03, 0.17, 0.08 (1.33 in total); length of leg-4  
 165 articles (ditto), 0.05, 0.11, 0.05, 0.21, 0.18, 0.24, 0.03, 0.15, 0.07 (1.09 in total).

166

167

168 *Pantopipetta lenis* Hosoda & Kakui, 2020

169 (Figure 3E)

170

171 *Material examined*

172 Holotype, male, ICHUM6038. Paratype, male, ICHUM6039.

173

174 *Supplementary information on male genital openings*175 Coxa 2 of legs 1–3 without genital opening. Coxa 2 of leg 4 with ventro-subdistal genital  
176 opening (Figure 3E).

177

178

179 **Discussion**180 *Staging and sexing*

181 Our specimen has the leg 4 much shorter than the leg 3, with a length of about 0.82 times of  
182 that of the leg 3. Although Austrodecidae lacks information on ontogenetic development after  
183 the postlarval stage that bears unarticulated legs 4, the above condition was reported in non-  
184 adult individuals in several other families (e.g., Okuda, 1940; Brenneis et al., 2011; Miyazaki  
185 & Hoshino, 2019). The oviger of our specimen comprises one naked article. Uniarticulate  
186 ovigers have been reported in three austrodecid species, namely, *Austrodecus (Microdecus)*  
187 *fryi* Child, 1994, *Austrodecus palauense* Child, 1983, and *Austrodecus varum* Child, 1994,  
188 but the latter two were species described based on juveniles (Child, 1983, 1994). The oviger  
189 of *A. (M.) fryi* bears setae, not naked. Naked uniarticulate ovigers were reported in non-adults  
190 of other families (e.g., Okuda, 1940; Brenneis et al., 2011; Miyazaki & Hoshino, 2019).

191 We observed genital openings on the coxa 2 of legs 1–4 of our specimen, but they  
192 appeared to be smaller than those reported in confamilial adults (Loman, 1908; Miyazaki,  
193 2004), suggesting that they may not be fully formed. In Austrodecidae, genital openings were  
194 found on legs 1–4 in females (e.g., Loman, 1908; Turpaeva, 1955; Miyazaki, 2004) and only  
195 on leg 4 in *Austrodecus* males (Miyazaki, 2004). Male genital openings had not been  
196 described in *Pantopipetta* until now. Here we showed that males of *Pantopipetta lenis* bear  
197 genital openings only on the coxa 2 of leg 4 as do *Austrodecus* males. Cement gland openings  
198 were not observed in our specimen.

199 Given the above, we concluded that our specimen is a juvenile female having  
200 immature leg 4 and oviger.

201

202 *Generic affiliation*

203 We identified our specimen as a member of *Pantopipetta* mainly based on that its palp has  
204 three short distal articles. All known *Pantopipetta* species have three or four short distal  
205 articles on the palp whereas all *Austrodecus* species have one or two, except *Austrodecus*

206 *aconae* (Hedgpeth & McCain, 1971) having three short distal articles.

207 *Austrodecus aconae* was originally described as a member of *Pantopipetta*.

208 Hedgpeth & McCain (1971) speculated their specimens that have four- or five-articulate  
209 oviger (but see below) may be immature and described them as a member of *Pantopipetta*.

210 Hedgpeth & McCain (1971: p. 218) stated that “In all species of *Austrodecus* so far described  
211 the terminal joint [= terminal short distal article] of the palp is set at an angle on the  
212 penultimate joint [= penultimate short distal article]; this feature is not found in the species of  
213 *Pantopipetta*,” which appears to be the major reason why they put their species in  
214 *Pantopipetta*. It should be noted that, in the palp of *Pantopipetta*, the second short distal  
215 article is set at an angle on the first short distal article but not so between the terminal and  
216 penultimate short distal articles (e.g., Figure 2D, E; Hedgpeth & McCain, 1971, fig. 6f; Child,  
217 1994, fig. 15E).

218 Stock (1991: p. 270) wrote “*A.* [= *Austrodecus*] *aconae* (Hedgpeth & McCain, 1971),  
219 originally described as a species of *Pantopipetta*” and transferred the species into  
220 *Austrodecus* without providing any reason. Child (1994) followed this view and put the  
221 species in *Austrodecus*. The author observed its holotype and paratypes (two females and five  
222 males) and found that females bear four-articulate ovigers but males lack any trace of  
223 ovigers; a five-articulate oviger was not observed (note: Hedgpeth & McCain (1971)  
224 observed four females). Male austrodecids lacking ovigers have been reported only in two  
225 *Austrodecus* species, *A. (Tubidecus) excelsum* Stock, 1991 and *A. (T.) latum* Stock, 1991, but  
226 they have palps with two short distal articles (Stock, 1991).

227 The generic affiliation of *Austrodecus aconae* can vary depending on whether  
228 researchers emphasize the number of short distal articles on the palp or that of the oviger. In  
229 this study, although we refrain from returning *A. aconae* into *Pantopipetta*, we deemed the  
230 number of short distal articles on the palp to be one of the diagnostic characters to distinguish  
231 *Austrodecus* (one or two) and *Pantopipetta* (three or four) and identified our specimen as a  
232 member of *Pantopipetta*.

233

#### 234 *Morphological comparisons*

235 Because we concluded that our specimen was a juvenile female with immature oviger and leg  
236 4, we did not use the character states for these two appendages to distinguish our species  
237 from congeners. In having auxiliary claws, *Pantopipetta hosodai* sp. nov. resembles  
238 *Pantopipetta auxiliata* Stock, 1968 from off the eastern coast of South Africa (68–69 m

239 depth), *P. lenis* from Japan (140.7–151.5 m depth), and *Pantopipetta oculata* Stock, 1968  
 240 from the Andaman Islands (66 m depth). It differs from the latter three species (character  
 241 state in parentheses) in having the palp with three short distal articles (four) and in lacking a  
 242 short palp article articulated with the cephalon (article present) (see the following section). In  
 243 addition, *P. hosodai* sp. nov. differs from *P. auxiliata* in having lateral processes without  
 244 dorsodistal tubercles (with one tall, knobby spur in *P. auxiliata*), coxa 1 of legs 1–3 with one  
 245 dorsal tubercle (two in *P. auxiliata*), and the auxiliary claw on the legs about 1/2 claw length  
 246 (about 1/3 in *P. auxiliata*); from *P. lenis* in having coxa 1 of legs 1–3 with one long dorsal  
 247 tubercle (no tubercles in *P. lenis*), a long dorsal tubercle on coxa 3 of legs 1–3, as long as  
 248 coxa-3 width (short, half coxa-3 width in *P. lenis*), and the femur of the legs with one short  
 249 dorsodistal tubercle bearing a seta (no tubercle in *P. lenis*); and from *P. oculata* in having  
 250 coxa 1 of legs 1–3 with one dorsal tubercle (four in *P. oculata*), the dorsodistal tubercle on  
 251 the femur of the legs short, half femur width (long, longer than femur width in *P. oculata*),  
 252 and the auxiliary claw on the legs about 1/2 claw length (about 1/3 in *P. oculata*).

253 *Pantopipetta hosodai* sp. nov. differs from *A. aconae* in having lateral processes  
 254 without dorsodistal tubercles (with one short tubercle in *A. aconae*), coxa 1 of legs 1–3 with  
 255 one dorsal tubercle (two in *A. aconae*), and auxiliary claws (no auxiliary claws in *A. aconae*).  
 256 It also differs from three *Austrodecus* species having uniarticulate ovigers (*A. (M.) fryi*, *A.*  
 257 *palauense*, and *A. varum*) by the number of short distal articles on the palp.

258

#### 259 *Palp base and number of palp articles*

260 Hosoda & Kakui (2020) found that the palp base (the short article-like structure proximal to  
 261 the longest palp article) is actually the first palp article in *P. lenis*. In *P. hosodai* sp. nov.,  
 262 however, the palp base is not articulated with the cephalon, but instead is a lateral process of  
 263 the cephalon (Figure 1C); the long article (the first palp article in *P. hosodai* sp. nov.) that  
 264 appears homologous to the second palp article in *P. lenis* articulates with the lateral process.  
 265 The condition in *P. hosodai* sp. nov. is equivalent to Child's (1994: p. 82) description, "no  
 266 suture or segmentation lines at all around their [= palp bases'] root".

267 The connection between the lateral process of the cephalon and the palp has not  
 268 generally been described in detail, but a short palp article distal to the process has been  
 269 illustrated in the original descriptions or re-descriptions for eight species: *P. auxiliata* (Stock,  
 270 1968, fig. 8b); "*Pantopipetta brevicauda* Stock, 1963" in Turpaeva (1990, fig. 6-3; Child  
 271 [1982] synonymized this species with *Pantopipetta longituberculata* Turpaeva, 1955);

272 *Pantopipetta brevipilata* Turpaeva, 1990 (Turpaeva, 1990, fig. 8-2); *Pantopipetta capensis*  
 273 (Barnard, 1946) in Stock (1963, fig. 8a); *Pantopipetta gracilis* Turpaeva, 1993 (Turpaeva,  
 274 1993, fig. 4-1); *P. oculata* (Stock, 1968, fig. 7b); *Pantopipetta weberi* (Loman, 1904) in  
 275 Loman (1908, fig. 14-194 and 14-197); and *P. lenis* (Hosoda & Kakui, 2020, fig. 3B, C). All  
 276 of these have a palp bearing four short distal articles. A short basal article has so far not been  
 277 illustrated in the descriptions of *Pantopipetta* species that have a palp with three short distal  
 278 articles (*Pantopipetta armata* Arnaud & Child, 1988; *Pantopipetta armoricana* Stock, 1978;  
 279 *Pantopipetta bilobata* Arnaud & Child, 1988; *Pantopipetta clavata* Stock, 1994; and *P.*  
 280 *hosodai* sp. nov.). This suggests that *Pantopipetta* species comprises two species groups: (i)  
 281 species with an eight-articulate palp having a short article distal to the lateral process of the  
 282 cephalon and four short distal articles and (ii) species with a six-articulate palp lacking a  
 283 short article distal to the process and having three short distal articles. To confirm this  
 284 hypothesis, the connection between the lateral process of the cephalon and the palp needs to  
 285 be reexamined in known species.

286

### 287 *Cave-dwelling pycnogonids*

288 At least 15 pycnogonid species have been recorded from marine or anchialine caves in the  
 289 Mediterranean (e.g., Gerovasileiou & Bianchi, 2021), Caribbean (Alvarez & Ojeda, 2018), or  
 290 northwestern Pacific (Bamber, 2008; this study). Among these species, only three were  
 291 identified to the species level, each collected from a different environment. *Pycnogonum*  
 292 *coninsulum* inhabited a submarine cave at 33‰ salinity, with no information on light  
 293 provided (Bamber, 2008; Morton et al., 2008). *Anoplodactylus batangensis* came from among  
 294 vegetation in the illuminated anchialine pool of a cenote (1.63 salinity; Alvarez & Ojeda,  
 295 2018). *Pantopipetta hosodai* sp. nov. came from a completely dark, anchialine environment  
 296 inside a submarine cave (less than 28‰ salinity; cf. Osawa & Fujita, 2019).

297 It is unknown whether pycnogonids inhabiting caves are troglobites (obligate cave-  
 298 dwelling species). Two species, *Py. coninsulum* and *P. hosodai* sp. nov., were reported based  
 299 on a single individual each from two different caves, and it is not known whether they also  
 300 occur outside the caves. Faunal surveys have been conducted intermittently in  
 301 Akumanoyakata Cave across a span of 10 years but our *P. hosodai* sp. nov. specimen is the  
 302 first pycnogonid found. This suggests a very low abundance of pycnogonids in caves, or at  
 303 least in Akumanoyakata Cave. More comprehensive sampling in both inside and outside  
 304 caves is needed to ascertain the degree of their dependence on caves.

305

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315

**316 Author contributions**

317 KK conceived and designed the study, and made morphological observations; YF collected the  
318 pycnogonid; KK and YF wrote the manuscript, and read and approved the final draft.

319

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323

**324 Conflict of interest**

325 The authors declare no conflict of interests.

326

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428

429 **Figure legends**

430

431 **Fig. 1.** *Pantopipetta hosodai* sp. nov., holotype, ICHUM8407, juvenile, ethanol-fixed  
 432 specimen. A, habitus, dorsal view; B, habitus, left view; C, cephalon, right view; D, right  
 433 oviger. Abbreviations: lpc, lateral process of cephalon; ov, oviger; p1, palp article 1.

434

435 **Fig. 2.** *Pantopipetta hosodai* sp. nov., holotype, ICHUM8407, juvenile. A, habitus, dorsal  
 436 view (gray-shaded area marked with asterisk indicates damaged area flattened by accidentally

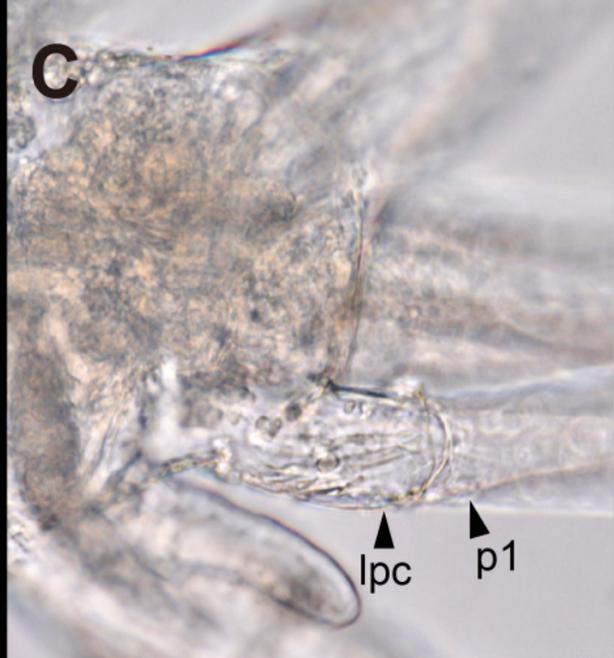
437 pinching with forceps); B, distal tip of ocular tubercle, dorsal view; C, cephalon, left view  
438 (lateral process of cephalon and leg 1 omitted); D, left palp (ornamentation on short distal  
439 articles omitted); E, distal portion of left palp; F, right oviger; G–J, left legs 1–4.

440

441 **Fig. 3.** Genital openings of *Pantopipetta*. A–D, *P. hosodai* sp. nov., holotype, juvenile female;  
442 E, *P. lenis* Hosoda & Kakui, 2020, holotype, male. A–E, left legs 1, 2, 3, 4, and 4,  
443 respectively. c2, c3, coxae 2 and 3. Arrowheads, genital opening.

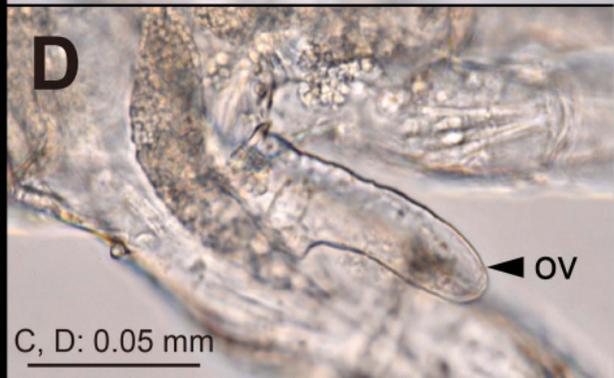
**A****B**

A, B: 0.5 mm

**C**

lpc

p1

**D**

ov

C, D: 0.05 mm

