Two new temporary ectoparasites (Isopoda, Cymothoida, Cymothooidea) from Korean waters with a note on geographical distributions of *Rocinela* Leach, 1818 and *Gnathia* Leach, 1814

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Two new species of temporary ectoparasitic isopods, *Rocinela excavata* **sp. nov.** and *Gnathia obtusispina* **sp. nov.**, are reported from the southern Islands of the Korean Peninsula. *Rocinela excavata* **sp. nov.** is distinguishable from its related species by the following characteristics: (1) laterally stepped rostrum; (2) separated eyes; (3) propodal blade having eight robust setae; and (4) merus having four or five blunt robust setae in pereopods 1–3. *Gnathia obtusispina* **sp. nov.** differs from its congeners by the combination of the following characteristics: (1) body covered with numerous tubercles and setae, (2) cephalon having tooth-like paraocular ornamentations; and (3) frontal border having two inferior frontolateral processes. These two new species are the 13th *Rocinela* species and 19th *Gnathia* species in the temperate Northern Pacific region, respectively. Discovery of these new species represents high species diversity of the genera *Rocinela* Leach, 1818 and *Gnathia* Leach, 1814 worldwide as well as in the Northern Pacific region. In addition, faunal diversity analysis on the members of both genera revealed that *Rocinela* species show high-latitude diversity whereas *Gnathia* species have low-latitude diversity.

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4 **Leach, 1818 and *Gnathia* Leach, 1814**

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ABSTRACT

Two new species of temporary ectoparasitic isopods, *Rocinela excavata* **sp. nov.** and *Gnathia obtusispina* **sp. nov.**, are reported from the southern Islands of the Korean Peninsula. *Rocinela excavata* **sp. nov.** is distinguishable from its related species by the following characteristics: (1) laterally stepped rostrum; (2) separated eyes; (3) propodal blade having eight robust setae; and (4) merus having four or five blunt robust setae in pereopods 1–3. *Gnathia obtusispina* **sp. nov.** differs from its congeners by the combination of the following characteristics: (1) body covered with numerous tubercles and setae, (2) cephalon having tooth-like paraocular ornamentations; and (3) frontal border having two inferior frontolateral processes. These two new species are the 13th *Rocinela* species and 19th *Gnathia* species in the temperate Northern Pacific region, respectively. Discovery of these new species represents high species diversity of the genera *Rocinela* Leach, 1818 and *Gnathia* Leach, 1814 worldwide as well as in the Northern Pacific region. In addition, faunal diversity analysis on the members of both genera revealed that *Rocinela* species show high-latitude diversity whereas *Gnathia* species have low-latitude diversity.

INTRODUCTION

Within isopod taxa, the superfamily Cymothooidea Leach, 1814 including families Aegidae White, 1850 and Gnathiidae Leach, 1814 is predominantly parasites of fish or other crustaceans (*William & Boyko, 2012*; *Smit et al., 2019*). Among the Cymothooideans, both Aegidae and Gnathiidae are known to be temporary ectoparasites that can attach to fishes (*Bruce, 2009*; *Svavarsson & Bruce, 2012*; *William & Boyko, 2012*; *Cardoso et al., 2017*; *Smit et al., 2019*). However, aegids are also regarded as free-living micro-predators because they often detach from their hosts and spend most of their time free-living on the seafloor (*Bruce, 2009*; *William & Boyko, 2012*; *Smit et al., 2019*). They morphologically differ from other Cymothooideans in terms of the maxillule having robust setae distally, maxillipedal palp articles 3 and 4 having conspicuous recurved robust setae distally, prehensile pereopods 1–3, and ambulatory pereopods

52 4–7 (*Bruce, 2009*). Similarly, adults of gnathiid isopods are also free-living (non-feeding) on

53 cryptic habitats of sponges, dead corals, barnacle nests, and polychaete's tube (*Kopuz et al.,*

54 *2011*) whereas their juveniles show a hematophagous life cycle (*Svavarsson & Bruce, 2012*;

55 *Williams & Boyko, 2012*; *Smit et al., 2019*). Although gnathiids show highly polymorphic forms

56 depending on their developmental stages and their adults exhibit considerable sexual

57 dimorphism, they are distinguishable from other cymothooideans largely based on the adult

58 male's characteristics of having remarkably enlarged mandibles and only five pairs of pereopods

59 (*Svavarsson & Bruce, 2012*; *Ota, 2014*; *Boxshall & Hayes, 2019*; *Smit et al., 2019*).

60 So far, seven *Rocinela* species have been recorded from the Far East where the survey region

61 of the present study is located: *Rocinela belliceps* (Stimpson, 1864) from the Sea of Okhotsk,

62 Russia; *Rocinela maculata* Schioedte & Meinert, 1879 from the East Sea, Russia and South

63 Korea; *Rocinela japonica* Richardson 1898 from the Hakodate Bay, Japan; *Rocinela affinis*

64 Richardson, 1904 from the Shizuoka, Japan; *Rocinela angustata* Richardson, 1904 from the

65 Manazuru, Japan; *Rocinela niponia* Richardson, 1909 from the Sado Island, Japan; and *Rocinela*

66 *lukini* Vasina, 1993 from the Sea of Okhotsk, Russia (*Schioedte & Meinert, 1879*; *Richardson,*

67 *1898*, *1904*, *1909*; *Vasina, 1993*; *National Institute of Biological Resources, 2012*). Eleven

68 *Gnathia* species have been reported in the Far East: *Gnathia tuberculata* Richardson, 1909 from

69 Nanao, Japan; *Gnathia derzhavini* Gurjanova, 1933 from Askold Island, Russia; *Gnathia*

70 *rectifrons* Gurjanova, 1933 from the East Sea, Russia; *Gnathia schmidti* Gurjanova, 1933 from

71 the Bay of Vladimir, Russia; *Gnathia bungoensis* Nunomura, 1982 from the Saeki Bay, Japan;

72 *Gnathia nasuta* Nunomura, 1992 from Kumamoto and Okinawa Islands, Japan; *Gnathia*

73 *sanrikuensis* Nunomura, 1998 from the Otsuchi Bay, Japan; *Gnathia capillata* Nunomura &

74 Honma, 2004 from Sado Island, Japan; *Gnathia mutsuensis* Nunomura, 2004 from Asamushi,

75 Japan; *Gnathia gurjanovae* Golovan, 2006 from Peter the Great Bay, Russia; and *Gnathia*

76 *koreana* Song &Min, 2018 from Geomundo Island, Korea (*Boyko et al., 2008*; *Song & Min,*

77 *2018*; *Shodipo et al., 2021*).

78 In this study, we report two temporary ectoparasitic isopods from Korean waters with their

79 detailed descriptions and illustrations. Geographical distributions of these two genera are also

80 discussed.

81

82 **MATERIAL AND METHODS**

83   All materials were collected at the bottom of sublittoral zones using a Smith-McIntyre grab and

84   SCUBA diving. *Rocinela* specimens were sampled from sandy-mud flats by using the Smith-

85   McIntyre grab. *Gnathia* specimens were collected from the bryozoans and seaweeds on bedrock.

86   SCUBA diving was used to survey the bedrock of sublittoral zones. These collected materials

87   were immediately fixed in 95% ethyl alcohol and then transferred to the laboratory. Isopods were

88   sorted from the transferred materials and then observed and dissected under a dissecting

89   microscope (Olympus SZH-ILLD, Japan). Measurements and drawings of specimens were

90   conducted with the aid of a drawing tube on a compound microscope (Olympus, BX50, Japan) or

91   the dissecting microscope. Pencil drawings were digitally scanned, inked, and arranged using a

92   tablet and Adobe Illustrator CS6 as mentioned in *Colemen (2003, 2009)*. All examined type

93   series and additional material were moved into each small glass vial filled with 95% ethanol and

94   deposited at the National Institute of Biological Resource (NIBR), South Korea.

95   The electronic version of this article in Portable Document Format (PDF) will represent a

96   published work according to the International Commission on Zoological Nomenclature (ICZN),

97   and hence the new names contained in the electronic version are effectively published under that

98   Code from the electronic edition alone. This published work and the nomenclatural acts it

99   contains have been registered in ZooBank, the online registration system for the ICZN. The

100   ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed

101   through any standard web browser by appending the LSID to the prefix http://zoobank.org/. The

102   LSID for this publication is: [urn:lsid:zoobank.org:pub:7A53937A-F2EB-49C7-B8DA-

103   F0AA36241310]. The online version of this work is archived and available from the following

104   digital repositories: PeerJ, PubMed Central and CLOCKSS.

105

106   **RESULTS**

107   **Taxonomy**

108   Order Isopoda Latreille, 1817

109   Suborder Cymthoida Wägele, 1989

110   Superfamily Cymothooidea Leach, 1814

111   Family Aegidae White, 1850

112   Genus *Rocinela* Leach, 1818

113   Type species. *Rocinela danmoniensis* Leach, 1818 by monotypy.

114   Diagnosis. Body typically flat, slightly vaulted dorsally; rostrum blunt, cover all or part of

115   antennular peduncles; eyes large, sometimes fused each other, occupying over 50% width of the

116   cephalon; pleonite 1 not abruptly narrower than pereonite 7; antennule shorter than antenna, with

117   distinct peduncles; mandibular incisor narrow, not divided and denticulate; maxillipedal palp

118   consisting of 3 articles; maxillipedal endite present; pereopod 1–3 with robust setae on propodus;

119   pleopodal endopods 3–4 without plumose setae marginally; uropodal protopod mesially produce;

120   uropodal rami lamellar; pleoptelson distally rounded (*Brusca & France, 1992*; *Bruce, 2009*).

121   Remarks. Synonymy and diagnosis have been well recognized by *Brusca & France (1992)*

122   and *Bruce (2009)* and we followed them in this study. Among the members of this family, the

123   genus *Rocinela* Leach, 1818 is distinguishable from other genera by having pleonite 1 not

124   abruptly narrowing than pereonite 7 and a 3-articled maxillipedal palp (*Bruce, 2009*). Although

125   *Rocinela* species show a quite uniform appearances to each other, the shape of the frontal margin

126   of the cephalon and the pereopodal armature are most helpful in identifying species (*Brusca &*

127   *France, 1992*; *Bruce, 2009*). *Rocinela signata* Schioedte and Meinert, 1879 is one of the rare

128   isopods that is known to attack humans (*Garzon-Ferreia, 1990*).

129

130   *Rocinela excavata* sp. nov.

131   urn:lsid:zoobank.org:act:9A4CC86D-6930-4FC6-9FC9-DBF105A2B285

132   Figures 1–3

133

134   Type material.—Holotype, designated here**:** South Korea: ♂, 19.3 mm, Chujado Island

135   (33°58′50″N, 126°20′23″E), Chuja-myeon, Jeju-si, Jeju-do, 15 January 2019, 30–40 m, gravelly

136   mud flats, S.H. Kim leg., Smith-McIntyre grab, NIBRIV0000900845. Paratype: 1♂, the same

137   location as holotype, NIBRIV0000895341.

138   Description of holotype male. Body (Fig. 1A, B), 2.1 times longer than width, oval,

139   dorsoventrally depressed; dorsal surface smooth. Cephalon (Fig. 1C, D) triangular; posterior

140   margin slightly tri-sinuated, but not distinct; rostrum truncated anteriorly, stepped laterally; eyes

141   large, separate. Pereonite 1 slightly longer than other pereonites; pereonite 3 widest; pereonite 7

142   narrower than preceding pereonites, tapering posteriorly. Coxal plates visible on dorsal side,

143   acute posteriorly; coxal furrows present in coxal plates 4–7. Pleonite 1 hidden by pereonite 7,

144   slightly visible on both lateral sides; pleonites 2–4 with subacute apex, but pleonite 5 with blunt

145 apex. Pleotelson (Fig. 1E) semicircle or shield-shaped, tapering posteriorly, with numerous

146 plumose setae and robust setae distally; lateral margins concave proximally; dorsal surface with

147 1 pair of depressions proximally and 1 medial carina.

148 Antennule (Fig. 1F) reaching anterior margin of pereonite 1; peduncular article 1 wider than

149 article 2, with 2 penicillate setae distally; article 2 subequal to article 1 in length, with 3

150 penicillate setae and 1 simple seta laterally; article 3 elongated oblong, longest, 1.7 times longer

151 than article 2, with 1 penicillate seta and 2 short simple setae distally; flagellar article 1

152 rectangular, 0.3 times as long as peduncular article 3, without setae; articles 2–5 square, with 2

153 aesthetascs distally; article 6 minute, with 2 aesthetascs, 1 penicillate seta, and 3 simple setae.

154 Antenna (Fig. 1G) exceeding beyond posterior margin of pereonite 1; peduncular article 1

155 globular; article 2 short, with 3 simple setae distally; article 3 4.7 times longer than article 2, with

156 1 simple seta distally; article 4 oblong, 1.5 times longer than article 3, with 1 simple seta; article

157 5 elongated, longest, 1.3 times longer than article 4, with 3 penicillate setae and 3 simple setae

158 distally; flagellum consisting of 16 articles; each article with short simple setae distally except

159 for first article without setae.

160 Frontal lamina (Fig. 1D) short, subacute distally; labrum projecting downwardly. Mandible

161 (Fig. 1H–J), incisor acute, with 1 process covered by minute spinous papulae; molar process

162 rounded; palp article 2 longer than others, with 10 serrated setae and 2 long simple setae along

163 with lateral margin; article 3 with 17 serrate setae (bifurcated distally) laterally. Maxillule (Fig.

164 1K, L) slender, 4 robust setae distally; apex acute. Maxilla (Fig. 1M, N) stout proximally; inner

165 lobe with 1 curved robust seta distally and 2 protrusions laterally; outer lobe with 2 curved robust

166 setae. Maxilliped (Fig. 1O, P), first article oblong, 2.6 times longer than width, wider posteriorly;

167 second article 0.3 times as long as first article, with 1 curved robust seta and long simple seta

168 distally; third article 0.6 times longer than second article, with 4 curved robust setae and 1 simple

169 seta distally.

170 Pereopods 1–3 (Fig. 2A–E), basis oblong, with 1–4 penicillate setae on superior margin and

171 1 simple seta at inferodistal angle; ischium almost 0.5 times as long as basis, expanding superior

172 distal end, with 1 or 2 robust setae superodistally; merus trapezoidal, with several robust and

173 simple setae at superodistal angle and 4 blunt robust setae along with inferior margin, but

174 pereopod 2 with 5 blunt robust setae; carpus shortest, about 0.3 times as long as merus, with 1

175 robust seta on inferodistal end; propodus almost 3 times longer than carpus, with blade on palm;

176 propodal blade 0.7 times as long as wide, with 8 robust setae distally and 1 long simple seta

177 proximally; robust setae with 1 simple setule distally; dactylus curved, as long as propodus,

178 without setae. Pereopods 4–7 (Fig. 2F–I), articles sequentially shortened; basis with 3–6

179 penicillate setae superiorly and 2 robust setae inferodistally, longest; ischium to carpus with

180 tubercles and robust setae along with inferior margins, and robust setae at superior distal angles;

181 propodus with several tubercles and robust setae along with inferior margin, and 1 penicillate

182 seta and several simple setae at superior distal angle; dactylus slightly curved, without setae.

183   Pleopods (Fig. 3A–E) sequentially larger posteriorly; pleopods 2–4 with globular patterns

184 along with lateral margins of exopods. Pleopod 1 (Fig. 3A), protopod with 6 coupling hooks and

185 3 plumose setae on medial margin, and 3 simple setae on lateral margin; rami with plumose

186 setae; exopods slightly longer than endopod. Pleopod 2 (Fig. 3B), protopod rectangular, with 5

187 coupling hooks and 8 plumose setae medially, 1 robust seta and 4 simple setae laterally; endopod

188 smaller than exopod; appendix masculina inserted proximally, expanding distal end of endopod,

189 reaching three-fourths length of endopod. Pleopods 3 and 4 (Fig. 3C, D), protopod with coupling

190 hooks and plumose setae on medial margin and plumose setae on lateral margin; endopod much

191 smaller than exopod, without plumose setae; exopod with plumose setae marginally and patch

192 laterally; partial suture present on lateral margin. Pleopod 5 (Fig. 3E) subequal to pleopods 3 and

193 4, but endopod enlarged beyond protopod and without coupling hooks and plumose setae on

194 medial margin.

195   Uropod (Figs. 1A, B, 3F), reaching distal end of pleotelson; protopod expanding distally on

196 medial margin, 1 robust seta and 8 simple setae on lateral margin; rami elongated oval, with

197 numerous plumose and robust setae; endopod longer than exopod; apexes rounded.

198   Remarks. The material of *R. excavata* **sp. nov.** can easily be characterized as new to science

199 by the following combinations of characters: (1) the rostrum is truncated anteriorly and stepped

200 laterally; (2) eyes are separated from each other; (3) pereopods 1–3 have eight robust setae on the

201 propodal blade and four or five blunt robust setae on each merus; (4) ischium to carpus in

202 pereopods 4–7 have tubercles along the posterior margins; and (5) one pair of depressions is

203 located at the proximal region of the pleotelson.

204   Among the known 41 species of the genus *Rocinela*, only three species have separated eyes

205 and more than seven robust setae on the propodal blade in pereopods 1–3: *R. niponia*

206 Richardson, 1909, *R. garricki* Hurley, 1957, and *R. pakari* Bruce, 2009 (*Richardson, 1909*;

207 *Bruce, 2009*). Among them, *Rocinela excavata* **sp. nov.** most resembles *R. garricki* by sharing

208 characteristics of the rostrum and propodal blade of perepopods 1–3. However, the former can be

209 rapidly distinguished from the latter in terms of the distal end of the rostrum (truncated in the

210 former vs. rounded in the latter) and the shape of the robust setae on the merus in pereopods 1–3

211 (blunt in the former vs. subacute in the latter). *Rocinela excavata* **sp. nov.** differs from the *R.*

212 *niponia* and *R. pakari* in terms of the laterally stepped rostrum (vs. not stepped rostrum in the

213 latter two species) and pereopods 4–7 having tubercles along the posterior margins (vs. smooth

214 in the latter two species) (*Bruce, 2009; Kim & Yoon, 2020*).

215   Among seven species reported from the Far East, *Rocinela excavata* **sp. nov.** is most similar

216 to *R. japonica* in the structure of rostrum and setal armature of pereopods 1–3's merus, while the

217 latter exhibits a distinct difference in the number of setae on the propodal blade in pereopods 1–3

218 (eight robustsetae in the new species vs. three or four robust setae in *R. japonica*) (*Richardson,*

219 *1898, 1904, 1909; Kussakin, 1974; Vasina, 1993*). *Rocinela excavata* **sp. nov.** can be

220 distinguishable from other six species by having separated eyes (vs. fused eyes in *R. affinis*),

221 pereopod 1 bearing eight robust setae on the propodal blade (vs. less than eight in the latter six

222 other species) (*Richardson, 1904, 1909; Kussakin, 1979; Brusca & France, 1992*).

223   Distribution. South Korea (Jeju Strait).

224   Prey (host). Unknown.

225   Etymology. The specific name, *excavata*, originates from the combination of Latin prefix *ex-*

226 meaning "out of" and Latin word *cavatus* meaning "hollow out". It refers to the shape of the

227 rostrum laterally excavated; gender feminine.

228

229 Family Gnathiidae Leach, 1814

230 Genus *Gnathia* Leach, 1814

231 Type species. *Gnathia termitoides* Leach, 1814 (= *Cancer maxillaris* Montagu, 1804), by

232 monotypy.

233   Diagnosis. Cephalon with generally straight frontal margin bearing frontal processes, while

234 not deeply concaved; mandibles not elongated, with mandibular incisor and dentate blade;

235 paraocular ornamentation and/or a dorsal sulcus present; pylopod distinct, 2 or 3-articled.

236   Remarks. Gnathiids show highly polymorphic forms depending on their developmental

237 stages (*Ota, 2014; Boxshall & Hayes, 2019*). They are distinguishable from other cymothooids

238 largely based on adult male's characteristics of having remarkably enlarged mandibles and only

239 five pairs of pereopods (*Svavarsson & Bruce, 2012*; *Smit et al., 2019*). Among the gnathiids, the

240 genera *Anceus* Risso, 1826, *Praniza* Latreille, 1817, and *Zuphea* Risso, 1826 have been

241 traditionally regarded as junior synonyms of *Gnathia*, because they were based on gnathiid larval

242 stages whose specific identifications cannot be possible (*Cohen & Poore, 1994*). *Caecognathia*

243 Dollfus, 1901 and *Elahpognathia* Monod, 1926 have been elevated to generic rank by *Cohen &*

244 *Poore (1994)*. The genus *Gnathia* can be distinguished from others by its male characteristics

245 such as a transverse frontal border on the cephalon having frontal processes, a 2- or 3-articled

246 broad pylopod, and non-elongated mandibles having dentate blades (*Cohen & Poore, 1994*; *Song*

247 *& Min, 2018*; *Hadfield et al., 2019*).

248

249 *Gnathia obtusispina* sp. nov.

250 urn:lsid:zoobank.org:act:3219C531-9A69-4805-B16D-5B14AF1B9B61

251 Figures 4–6

252

253 Type material.—Holotype, designated here**:** South Korea: ♂, 3.2 mm, Hongdo-ri (34°43′22.8″N,

254 125°11′59.5″E), Heuksan-myeon, Sinan-gun, Jeollanam-do, 20 June 2018, 10 m depth, rinsing

255 bryozoans and macroalgae on bedrock of sublittoral zones, S.H Kim, leg., SCUBA diving,

256 NIBRIV0000900846. Paratypes: 2♂♂, same location as holotype, NIBRIV0000862802.

257   Description of holotype male. Body (Fig. 4A) 2.3 times longer than greatest width, with

258 numerous long setae dorsally. Cephalon (Fig. 4B, C) oval to oblong, 0.4 times as long as wide,

259 covered with numerous tubercles, with 1 pair of tooth-like paraocular ornamentations forming

260 ridges (arrows in Fig. 4B, C); dorsal sulcus narrow, U-shaped, positioned at median area

261 anteriorly; frontal border medially concave, with 1 pair of inferior frontolateral processes; frontal

262 concavity shallow and narrow; supraocular lobes prominent, projecting upwards, with dentate

263 apex; eyes located on lateral margins. Pereonites 1–4 covered with tubercles, whereas 5–7

264 without tubercles; pereonite 1 not fused to cephalon dorsally, immersed in posterior margin of

265 cephalon; pereonites 2–4 subequal in length and width; pereonite 5 widest; pereonite 6 with

266 concave posterior margin. Pleonites, epimera of pleonites 3–5 prominent. Pleotelson (Figs 4A,

267 6F) triangular, with convex lateral margins; apex rounded, with 3 simple setae; proximal dorsal

268 side with 2 pairs of simple setae and 1 pair of plumose setae.

269   Antennule (Fig. 4F), peduncular article 1 ovoid to oblong, with 2 penicillate setae laterally;

270   article 2 square, 0.7 times longer than article 1, with 4 penicillate setae and 3 simple setae

271   distally; article 3 elongate and rectangular, 1.5 times longer than article 2, with 5 simple setae

272   distally; flagellar article 1 shortest, 0.1 times as long as peduncular article 3, with 3 penicillate

273   setae laterally; article 2 elongated oblong, 4.9 times longer than article 1, with 1 simple seta and

274   1 aesthetasc distally; article 3 oblong, 0.3 times as long as article 2, with 1 aesthetasc distally;

275   article 4 subequal to article 3 in length, with 3 simple setae and 1 aesthetasc distally. Antenna

276   (Fig. 4G) peduncular article 1 globular; article 2 square, 0.8 times as long as article 1; article 3

277   oblong, 1.9 times longer than article 2, with 2 penicillate setae and 7 simple setae distally; article

278   4 elongated rectangular, 1.3 times longer than article 3, with 3 penicillate setae and 6 simple

279   setae distally; flagellum composed of 5 articles; each article square to oblong, similar each other

280   in length, with simple setae distally.

281   Mandibles (Fig. 4A–E) triangular, not elongate, half-length of cephalon, elevated distally,

282   with dorsal and internal lobes; dentate blade irregular; basal neck indistinct. Maxilliped (Fig.

283   4H), endite reaching proximal region of palp article 2; palp articles globular, similar to each

284   other in shape, article 1 with 3 plumose setae laterally; article 2 largest, with 7 plumose setae

285   laterally; article 3 with 5 plumose setae laterally; article 4 with 7 plumose setae laterally and 2

286   short simple setae distally. Pylopod (Fig. 4I), article 1 longest, nearly occupying 70% of total

287   length of pylopod, with numerous plumose setae on lateral margin, and 1 penicillate seta, 1

288   plumose seta, and 12 simple setae on medioventral side; article 2 ovoid, 0.2 times as long as

289   article 1, with 2 short simple setae distally; article 1 elliptical, 0.3 times as long as article 2, with

290   1 simple seta on distal end.

291   Pereopod 2 (Fig. 5A) with tubercles on ischium to propodus inferiorly; basis with 3

292   penicillate setae superiorly, numerous simple setae superiorly and inferiorly; ischium 0.8 times

293   as long as basis, with 1 serrate seta and 6 simple setae inferiorly, and 1 penicillate seta and 4

294   simple setae superiorly; merus 0.3 times as long as ischium, with 1 serrate seta and 3 simple

295   setae   inferiorly, and 3 simple setae superiorly; carpus similar to merus in length, with 1 simple

296   seta and 2 serrate setae inferiorly; propodus oblong, 1.8 times longer than carpus, with 2 robust

297   simple setae, 1 simple seta and several short simple setae on inferior margin, and 1 penicillate

298   seta and 1 short simple seta at superodistal angle; dactylus rectangular, with 4 simple setae and 1

299   unguis distally. Pereopods 3–6 (Fig. 5B–E) almost similar to pereopod 2; basis with tubercles

300   superiorly except for pereopod 5.

301   Pleopods (Fig. 6A–E) similar to each other; protopod ovoid to oblong, with 1 simple seta

302   laterally, 2 coupling hooks medially; rami elongated ovoid, without plumose setae distally,

303   except for pleopods 3 and 5; pleopod 2 with penicillate seta distally and 1 penicillate seta

304   subdistally on exopod; pleopod 3 with 3 plumose setae on enopod and 2 plumose setae on

305   exopod distally; pleopod 5 with 1 plumose seta on endopod and 3 plumose setae distally;

306   appendix masculina not observed in pleopod 2.

307   Uropod (Fig. 6F), protopod rectangular, with 1 simple dorsal seta; rami with 7–10 simple

308   setae along margin; endopod slightly longer than exopod, with 6–8 penicillate setae and 0–2

309   simple setae dorsally.

310   Remarks. In the 133 *gnathia* species, 13 species have paraocular ornamentations forming a

311   ridge (*Monod, 1926*; *Menzies, 1962*; *Schultz, 1966*; *Holdich & Harrison, 1980*; *Müller, 1993*;

312   *Cohen & Poore, 1994*; *Pires, 1996*; *Tanaka, 2004*; *Kensley et al., 2009*; *Ota, 2013*; *Song & Min,*

313   *2018*; *Shodipo et al., 2021*). Among them, *G. obtusispina* **sp. nov.** most resembles two species,

314   *G. lignophila* Müller, 1993 and *G. andrei* Pires, 1996, by having body integument covered by

315   numerous tubercles (*Müller, 1993*; *Pires, 1996*). However, the new species can be easily

316   distinguishable from these two species in that the frontal border of the cephalon is medially

317   concave (vs. convex in the latter two species) and the pleotelson has rounded distal end (vs. acute

318   distal end in the latter two species).

319   In the East Asia where is the new species were collected, there are nine species characterized

320   by the presence of tubercles on the cephalon and pereonites among 25 *Gnathia* species reported:

321   *G. tuberculata* Richardson, 1909 from the Nanao, Japan; *G. derzhavini* Gurjanova, 1933 from

322   the Askold Island, Russia; *G. schmidti* Gurjanova, 1933 from the Bay of Vladimir, Russia; *G.*

323   *teruyukiae* Ota, 2011 from the Ishigaki Island, Japan; *G. rufescens* Ota, 2015 from the Okinawa

324   Island Japan; *G. albipalpebrata* Ota, 2014 from the Okinawa-jima Island, Japan; *G. parvirostata*

325   Ota, 2014 from the Ishigaki Island, Japan; *G. nubila* Ota & Hirose, 2009 from the Okinawa

326   Island, Japan; and *G. dejimagi* Ota, 2014 from the Okinawa-jima Island, Japan (*Boyko et al.,*

327   *2008*; *Song & Min, 2018*; *Shodipo et al., 2021*). Although *G. obtusispina* **sp. nov.** also represents

328   this character state, this new species is easily distinguishable from the latter species by the

329   combination of the following character states: (1) the body is covered with long setae; (2) the

330   cephalon has a pair of remarkable tooth-like blunt paraocular ornamentations; (3) the frontal

331   border of the cephalon is medially concave; (4) two inferior frontolateral processes are present

332   ventrally; (5) the supraocular lobe is prominent and projecting upwards; (6) the dentate blade of

333   the mandible is present and irregular; (7) pereonite 1 is not fused with cephalon dorsally and

334   conspicuous; and (8) the apex of the pleotelson is rounded (*Richardson, 1909*; *Gurjanova, 1933*;

335   *Ota, 2011, 2015*; *Ota & Hirose, 2009*).

336   Among the above-mentioned species, *G. obtusispina* **sp. nov.** is most similar to *G.*

337   *tuberculata* by having inferior frontolateral processes and prominent supraocular lobes on

338   cephalon, and mandible as long as half-length of the cephalon. However, the former differs from

339   the latter in terms of the medially concave frontal border of the cephalon (vs. produced in the

340   latter), presence of a tooth-like paraocular ornamentations (vs. absent in the latter), number of

341   inferior frontolateral processes (two in the former vs. four in the latter), and rounded apex of the

342   pleotelson (vs. acute in the latter) (*Richardson, 1909*).

343   Distribution. South Korea (the Yellow Sea)

344   Host. Unknown.

345   Etymology. The specific name, *obtusispina*, originates from the combination of Latin words

346   *obtusus*, meaning "blunt" and *spina*, meaning "thorn". This name refers to tooth-like paraocular

347   ornamentation; gender feminine.

348

349   **DISCUSSION**

350   *Rocinela* is distributed worldwide. It particularly shows high-latitude diversity (*Bruce, 2009*).

351   Indeed, based on marine ecoregions of the world by *Spalding et al. (2007)*, 29 of 41 known

352   *Rocinela* species have been reported from a temperate region (Table 1). Among the temperate

353   species, 21 known species are recorded from the Pacific, with 12 species from the temperate

354   Northern Pacific region, including seven species from the Far East. This means that the majority

355   of *Rocinela* species have been described from the temperate Northern Pacific, so the region

356   could be considered as diversity hotspot for the genus *Rocinela*. However, given that *Bruce*

357   *(2009)* has mentioned that a significant number of undescribed species from the tropical western

358   Pacific region is held at the Muséum national d'Histoire naturelle in Paris, the lack of attention

359   on the *Rocinela* species was likely to negatively affect our knowledge of the *Rocinela* species

360   diversity in trophic region. So, undescribed species can be discovered through further study in

361   this region. While among 29 species are known from the temperate region, only two species, *R.*
362   *angustata* and *R. belliceps*, show a broad distribution ranging from the Northwest to Northeast
363   Pacific despite most *Rocinela* species having endemic distribution ranges (*Richardson, 1904,*
364   *1905, 1909*; *Kussakin, 1979*; *Brusca & France, 1992*). Considering that host-association times is
365   correlated with the distribution range and that *Rocinela* species can attach to the host temporally,
366   these endemic distribution ranges of *Rocinela* species might be due to their feeding strategy with
367   temporary ectoparasites attaching to fishes in their particular life history (*Bruce, 2009*; *Smit et*
368   *al., 2019*). Although hosts of *R. angustata* and *R. belliceps* remain unknown, broad distribution
369   ranges of these two species could be related to their host's distribution patterns (*Smit et al.,*
370   *2019*).
371   Fifty-six and 76 species of 133 known *Gnathia* species have been reported from a temperate
372   region and tropical region, respectively (Table 2; *Song & Min, 2018*; *Shodipo et al., 2021*). Only
373   two species, *G. fragilis* Schultz, 1977 and *G. tuberculosa* (Beddard, 1886), are from the Southern
374   Ocean, Antarctic (*Monod, 1926*; *Schultz, 1977*). According to the marine ecoregions of the
375   world, the Central Indo-Pacific (with 47 species) is thought to be the most diverse hotspot of
376   *Gnathia* (*Shodipo et al., 2021*). After the Central Indo-Pacific, the second-most rich species of 18
377   species have been reported from the temperate Northern Pacific that includes the study area of
378   the present study. Consequently, the temperate Northern Pacific is considered to be the second
379   most diverse hotspot following the Central Indo-Pacific. Within the temperate Northern Pacific,
380   the Far East, from which 11 *Gnathia* species are recorded, could be regarded as a representative
381   hotspot. While looking for substrate types from which *Gnathia* species are collected, most
382   temperate species have been collected from soft substrates such as mud, silt, and sandy flats in
383   contrast to tropical *Gnathia* species reported from coral-reef habitats (*Cohen & Poore, 1994*;
384   *Svavarsson & Bruce, 2012*). This result is a mismatch to the general knowledge that gnathiid
385   species prefer coral reef-associated habits (*Cohen & Poore, 1994*; *Santos & Sikkel, 2019*; *Smit et*
386   *al., 2019*; *Svavarsson & Bruce, 2012, 2019*). Furthermore, the feature of the substratum strongly
387   affects the distribution of gnathiids, and each species has a different habitat depending on its life
388   stages (*Smit et al., 2019*). Taken all together, the life history of *Gnathia* species is likely to differ
389   depending on whether they live in a temperate or a tropic region (*Santos & Sikkel, 2019*).
390   However, further study about the substratum preference between temperate and tropic *Gnathia*
391   species is needed because most ecological studies of these species have been conducted from

392   coral reef-associated habitats (*Grutter et al., 2000, 2018*; *Santos & Sikkel, 2019*; *Smit et al.,*

393   *2019*; *Shodipo et al., 2021*). Additionally, although most *Gnathia* species are known as endemic,

394   two species, *Gnathia calmani* Monod, 1926 and *Gnathia nasuta* Nunomura, 1992, have wide

395   distributions ranging from the tropic to the temperate region (*Monod, 1926*; *Holdish & Harrison,*

396   *1980*; *Nunomura, 1992*; *Ota, 2013*). Another two species, *Gnathia grandilaris* Coetzee, Smit,

397   Grutter & Davies, 2008 and *Gnathia trimaculata* Coetzee, Smit, Grutter & Davies, 2009, have

398   been reported only from the Central Indo-Pacific, and also show a wide geographical distribution

399   ranging from Australia to Japan (*Coetzee et al., 2008, 2009*; *Ota & Hirose, 2009*). According to

400   *Shodipo et al. (2021)*, the long-distance dispersal of some *Gnathia* species was facilitated by

401   their host that had a wide movement radius in a short period of time (e.g. sharks). Considering

402   wide movement radii of hosts such as sharks and ray in *G. grandilaris* and *G. trimaculata*, the

403   two species showing wide distribution ranges, *G. calmani* and *G. nasuta*, also could be parasites

404   of hosts having wide movement radii (*Coetzee et al., 2008, 2009*; *Shodipo et al., 2021*).

405

406   **CONCLUSION**

407   The present study of Korean ectoparasitic isopods revealed high species diversity of *Rocinela*

408   and *Gnathia* species in the temperate Northern Pacific region by the discovery of two new

409   species, *Rocinela excavata* **sp. nov.** and *Gnathia obtusispina* **sp. nov.** The two new species are

410   the species records for the 13th *Rocinela* species and the 19th *Gnathia* species in this region,

411   respectively. Our investigation on the geographical distributions of known *Rocinela* and *Gnathia*

412   species indicated that the temperate Northern Pacific has the most *Rocinela* species and the

413   second most *Gnathia* species in the regional species richness of each genus. It also showed that

414   even if both genera indicate great diversity in the western Pacific, *Rocinela* species reveal high-

415   latitude diversity while *Gnathia* species represent low-latitude diversity, particularly in the

416   Central Indo-Pacific region.

417

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Author Contributions

- Sung Hoon Kim conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, and approved the final draft.
- Jong Guk Kim designed the experiments, analyzed the data, reviewed drafts of the paper, and approved the final draft.
- Seong Myeong Yoon conceived and designed the experiments, reviewed drafts of the paper, and approved the final draft.

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603   **Figure legends**

604   **Figure 1. *Rocinela excavata* sp. nov., holotype, male.** (A) Habitus, dorsal view; (B) Habitus,

605   lateral view; (C) Cephalon, dorsal view; (D) Distal end of cephalon, ventral view; (E) Distal end

606   of pleotelson; (F) Antennule; (G) Antenna; (H) Mandible; (I) Serrate seta of mandibular palp; (J)

607   mandibular incisor; (K) Maxillule; (L) Distal end of maxillule; (M) Maxilla; (N) Distal end of

608   maxilla; (O) Maxilliped; (P) Distal end of maxilliped. Scale bars: A, B = 5 mm, C–E = 2 mm, F,

609   G = 1 mm; H, K, M, O = 0.5 mm, N = 0.2 mm, L, P = 0.1 mm, I, J = 0.05 mm.

610   **Figure 2. *Rocinela excavata* sp. nov., holotype, male.** (A) Pereopod 1; (B) Propodal blade of

611   pereopod 1; (C) Pereopod 2; (D) Robust seta of propodal bladed in pereopod 2; (E) Pereopod 3;

612   (F) Pereopod 4; (G) Pereopod 5; (H) Pereopod 6; (I) Pereopod 7. Scale bars: A, C, E, F–I = 1

613   mm, B = 0.1 mm; D = 0.05 mm.

614   **Figure 3. *Rocinela excavata* sp. nov., holotype, male.** (A) Pleopod 1; (B) Pleopod 2; (C)

615   Pleopod 3; (D) Pleopod 4; (E) Pleopod 5; (F) Uropod. Scale bar: A–F = 1 mm.

616   **Figure 4. *Gnathia obtusispina* sp. nov., holotype, male.** (A) Habitus, dorsal view; (B)

617   Cephalon, dorsal view; (C) Cephalon, ventral view; (D) Cephalon, lateral view; (E) Mandible,

618   lateral view; (F) Antennule; (G) Antenna; (H) Maxilliped; (I) Pylopod. Arrows indicate a tooth-

619   like blunt spine. Scale bars: A = 1 mm, B–D = 0.5 mm, E–I = 0.2 mm.

620   **Figure 5. *Gnathia obtusispina* sp. nov., holotype, male.** (A) Pereopod 2; (B) Pereopod 3; (C)

621   Pereopod 4, (D) Pereopod 5; (E) Pereopod 6. Scale bar: A–E = 0.2 mm.

622   **Figure 6. *Gnathia obtusispina* sp. nov., holotype, male.** (A) Pleopod 1; (B) Pleopod 2; (C)

623   Pleopod 3; (D) Pleopod 4; (E) Pleopod 5; (F) Pleotelson and uropod. Scale bar: A–F = 0.5 mm.

624

625 **Table legends**

626 **Table 1.** Summary of *Rocinela* species from the temperate region.

627 **Table 2.** Summary of *Gnathia* species from the temperate region.

Summary of *Rocinela* species from the temperate region.

1   **Table 1.**

Species	Location	Biogeographic realms	References
R. affinis **Richardson, 1904**	Japan (Numazu)	TNP	Richardson (1904)
R. americana **Schioedte & Meinert, 1879**	USA (Maine)	TNA	Schioedte & Meinert (1879); Kussakin 1979
R. angustata **Richardson, 1904**	USA (Bering Sea to Washington); Japan (Manazuru Zaki)	TNP	Richardson (1904); Brusca & France (1992)
R. austeralis **Schioedte & Meinert, 1879**	Chile (Straits of Magellan)	TSA	Schioedte & Meinert (1879)
R. belliceps **(Stimpson, 1864)**	USA (Alaska to California); Mexico (Clarion Island); Russia (Sea of Okhotsk)	TNP; TEP	Brusca & France (1992); Kussakin (1979)
R. bonita **Bruce, 2009**	New Zealand (Bounty Trough)	TA	Bruce (2009)
R. cornuta **Richardson, 1898**	USA (off Shumagin Bank)	TNP	Richardson (1898)
R. danmoniensis **Leach, 1818**	Europe (Bay of Biscay to Iceland)	TNA	Bruce (2009)
R. dumerilii **(Lucas, 1849)**	Mediterranean Sea	TNA	Bruce (2009)
R. excavata **sp. nov.**	South Korea (Chujado Island)	TNP	Present study
R. garricki **Hurley, 1857**	New Zealand (Cook strait)	TA	Hurley (1957)
R. granulosa **Barnard, 1914**	South Africa (Natal)	TSAf	Barnard (1914b)
R. Japonica **Richardson, 1898**	Japan (Hakodate Bay)	TNP	Richardson (1898)

R. juvenalis Menzies & George, 1972	Peru (off Peru)	TSAm	Bruce (2009)
R. kapala Bruce, 1988	Australia (New South Wales)	TA	Bruce (1988)
R. laticauda Hansen, 1897	Mexico (off Acapulco); USA (California)	TEP; TNP	Brusca & France (1992)
R. leptopus Bruce, 2009	New Zealand (Pagasus Bay)	TA	Bruce (2009)
R. lukini Vasina, 1993	Sea of Okhotsk	TNP	Vasina (1993)
R. maculata Schioedte & Meinert, 1879	Russia (Vladivostok)	TNP	Schioedte & Meinert (1879)
R. niponia Richardson, 1909	Japan (Sado Island)	TNP	Richardson (1909)
R. ophthalmica Milne Edwards, 1840	Italy (Sicily)	TNA	Bruce (2009)
R. pakari Bruce, 2009	New Zealand (Chatham Rise)	TA	Bruce (2009)
R. patriciae Brasil Lima, 1986	Brazil (off Rio Grande do Sul)	TSAm	Bruce (2009)
R. propodialis Richardson, 1905	USA (Washington)	TNP	Richardson (1905)
R. resima Bruce, 2009	New Zealand (Christabel Sea Mount)	TA	Bruce (2009)
R. satagia Bruce, 2009	New Zealand (Chatham Rise)	TA	Bruce (2009)
R. sila Hale, 1925	Australia (Adelaide)	TA	Hale (1925)
R. tridens Hatch, 1947	USA (Washington)	TNP	Hatch (1947)
R. tropica Brasil Lima, 1986	Brazil (Espírito Santo)	TSAm	Bruce (2009)

***R. tuberculosa* Richardson, 1898**	Mexico (Baja California)	TNP	Richardson (1898)

Note.

TA, Temperate Australasia; TEP, Temperate Eastern Pacific; TNA, Temperate Northern Atlantic; TNP, Temperate Northern Pacific; TSAf, Temperate Southern Africa; TSAm, Temperate Southern America.

Table 2. Summary of *Gnathia* species from the temperate region.

1 **Table 2.**

Species	Location	Biogeographic realms	References
G. africana **Barnard, 1914**	South Africa (Cape Town)	TSAf	Barnard (1914a); Monod (1926); Smit et al. (1999, 2002)
G. albescens **Hansen, 1916**	Denmark (Foroe Island)	TNA	Hansen (1916)
G. andrei **Pires, 1996**	Brazil (Ubatuba continental slope)	TSAm	Pires (1996)
G. brachyuropus **Monod, 1926**	New Zealand (Akaroa, Lyttelton)	TA	Monod (1926)
G. brucei **George, 2003**	USA (North Carolina)	TNA	George (2003)
G. bungoensis **Nunomura, 1982**	Japan (Saeki Bay)	TNP	Nunomura (1982)
G. calamitosa **Monod, 1926**	Australia (New South Wales)	TA	Monod (1926)
G. calmani **Monod, 1926**	Australia (Heron Island; Victoria)	CIP; TA	Monod (1926)
G. campontus **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. capillata **Nunomura & Honma, 2004**	Japan (Sado Island)	TNP	Nunomura & Honma (2004)
G. clementensis **Schultz, 1966**	USA (California)	TNP	Schultz (1966)
G. coronadoensis **Schultz, 1966**	USA (Coronado canyon)	TNP	Schultz (1966)
G. dentata **(G. O. Sars, 1872)**	Norway (Hardangerfijord)	TNA	Sars (1872); Monod (1926)
G. derzhavini **Gurjanova, 1933**	Russia (Askold Island)	TNP	Gurjanova (1933)
G. disjuncta **Barnard, 1920**	South Africa (Cape Town)	TSAf	Monod (1926)

G. epopstruma **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. fallax **Monod, 1926**	Spain (Bay of Biscay)	TNA	Monod (1926)
G. gurjanovae **Golovan, 2006**	Russia (Peter the Great Bay)	TNP	Golovan (2006)
G. hirsuta **Schultz, 1966**	USA (California)	TNP	Schultz (1966)
G. illepidus **(Wagner, 1869)**	Mediterranean Sea (Italy, Monaco)	TNA	Monod (1926)
G. incana **Menzies & George, 1972**	Peru (off Peru)	TSAm	Menzies & George (1972); Cohen & Poore (1994)
G. inopinata **Monod, 1925**	Mediterranean Sea (Italy, Monaco)	TNA	Monod (1926)
G. iridomyrmex **Cohen & Poore, 1994**	Australia (Victoria)	TA	Cohen & Poore (1994)
G. koreana **Song & Min, 2018**	South Korea (Geomundo Island)	TNP	Song & Min (2018)
G. lacunacapitalis **Menzies & George, 1972**	Peru (off Peru)	TSAm	Menzies & George (1972); Cohen & Poore (1994)
G. maxillaris **(Montagu, 1804)**	England (Cornwall)	TNA	Monod (1926)
G. mulieraria **Hale, 1924**	Australia (Gulf St. Vincent)	TA	Hale (1924)
G. mutsuensis **Nunomura, 2004**	Japan (Asamushi)	TNP	Nunomura (2004)
G. mystrium **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. nasuta **Nunomura, 1992**	Japan (off Tomioka; Amai;	CIP; TNP	Nunomura (1992)

	Keramal Okinawa islands)		
G. nkulu **Smit & Van As, 2000**	South Africa (Port Alfred)	TSAf	Smit & Van (2000)
G. notostigma **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. obtusispina **sp. nov.**	South Korea (Hongdo Island)	TNP	Present study
G. odontomachus **Cohen & Poore, 1994**	Australia (Victoria)	TA	Cohen & Poore (1994)
G. oxyuraea **(Lilljeborg, 1855)**	North Sea	TNA	Monod (1926)
G. panousei **Daguerre de Hureaux, 1971**	Morocco	TNA	Boyko et al. (2008)
G. pantherina **Smit & Basson, 2002**	South Africa (Jeffreys Bay)	TSAf	Smit & Basson (2002)
G. phallonajopsis **Monod, 1925**	Mediterranean Sea (France, Italy, Monaco, Sapin)	TNA	Monod (1926)
G. pilosus **Hadfield, Smit & Avenant-Oldewage, 2008**	South Africa (Sheffield Beach, Tinley Manor)	TSAf	Hadfield, Smit & Avenant-Oldewage (2008)
G. productatriedns **Menzies & Barnard, 1959**	USA (California)	TNP	Menzies & Barnard (1959)
G. prolasius **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. rectifrons **Gurjanova, 1933**	Russia (East Sea)	TNP	Gurjanova (1933)
G. ricardoi **Pires, 1996**	Brazil (Ubatuba continental	TSAm	Pires (1996)

	slope)		
G. sanrikuensis **Nunomura, 1998**	Japan (Otsuchi Bay)	TNP	Nunomura (1998)
G. schmidti **Gurjanova, 1933**	Russia (Bay of Vladimir)	TNP	Gurjanova (1933)
G. serrulatifrons **Monod, 1926**	Mediterranean Sea	TNA	Monod (1926)
G. sifae **Svavarsson, 2006**	New Zealand (Bay of Plenty)	TA	Svavarsson (2006)
G. spongicola **Barnard, 1920**	South Africa (False Bay)	TSAf	Monod (1926)
G. steveni **Menzies, 1962**	USA (California)	TNP	Menzies (1962)
G. stigmacros **Cohen & Poore, 1994**	Australia (Bass Strait)	TA	Cohen & Poore (1994)
G. teissieri **Cals, 1972**	Spain (Bay of Biscay)	TNA	
G. tridens **Menzies & Barnard, 1959**	USA (California)	TNP	Menzies & Barnard (1959)
G. trilobata **Schultz, 1966**	USA (Coronado)	TNP	Schultz (1966)
G. tuberculata **Richardson, 1909**	Japan (Nanoa)	TNP	Richardson (1909)
G. ubatuba **Pire, 1996**	Brazil (Ubatuba continental slope)	TSAm	Pire (1996)
G. venusta **Monod, 1925**	Mediterranean Sea (Monaco)	TNA	Monod (1926)
G. vorax **(Lucas, 1849)**	Mediterranean Sea (Algeria, Bay of Biscay, Cape Bojador)	TNA	Monod (1926)

Note.

CIP, Central Indo-Pacific; TA, Temperate Australasia; TEP, Temperate Eastern Pacific; TNA, Temperate Northern Atlantic; TNP, Temperate Northern Pacific; TSAf, Temperate Southern Africa; TSAm, Temperate Southern America.

Figure 1

Rocinela excavata sp. nov., holotype, female. (A) Habitus, dorsal view; (B) Habitus, lateral view; (C) Cephalon, dorsal view; (D) Distal end of cephalon, ventral view; (E) Distal end of pleotelson; (F) Antennule; (G) Antenna; (H) Mandible; (I)
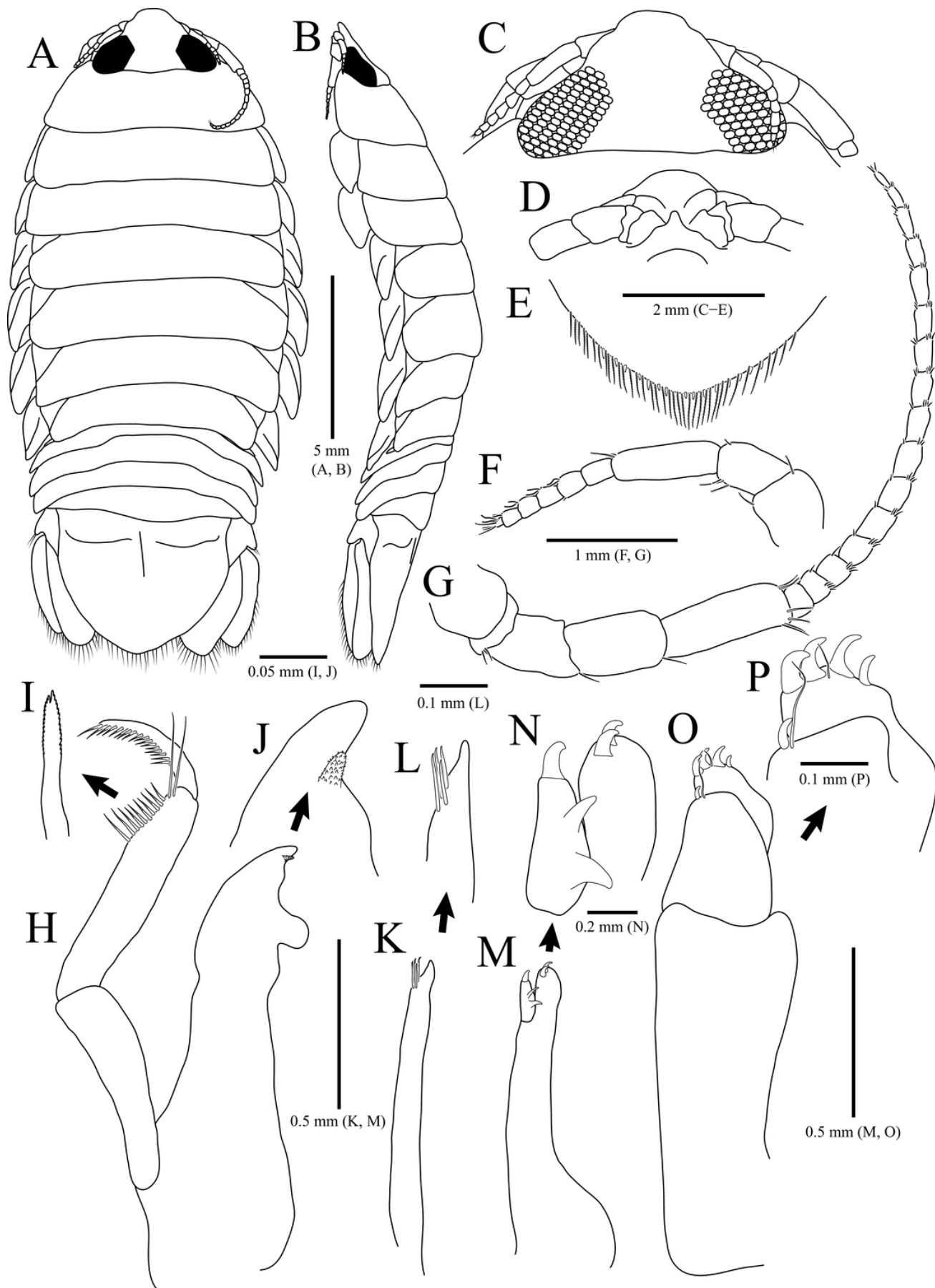
Figure 2

Rocinela excavata sp. nov., holotype, female. (A) Pereopod 1; (B) Propodal blade of pereopod 1; (C) Pereopod 2; (D) Robust seta of propodal bladed in pereopod 2; (E) Pereopod 3; (F) Pereopod 4; (G) Pereopod 5; (H) Pereopod 6; (I) Pereopod 7. S

A

B

0.1 mm (B)

C

E

1 mm (A, C, E)

D

0.05 mm (D)

F

G

H

1 mm (F–I)

I
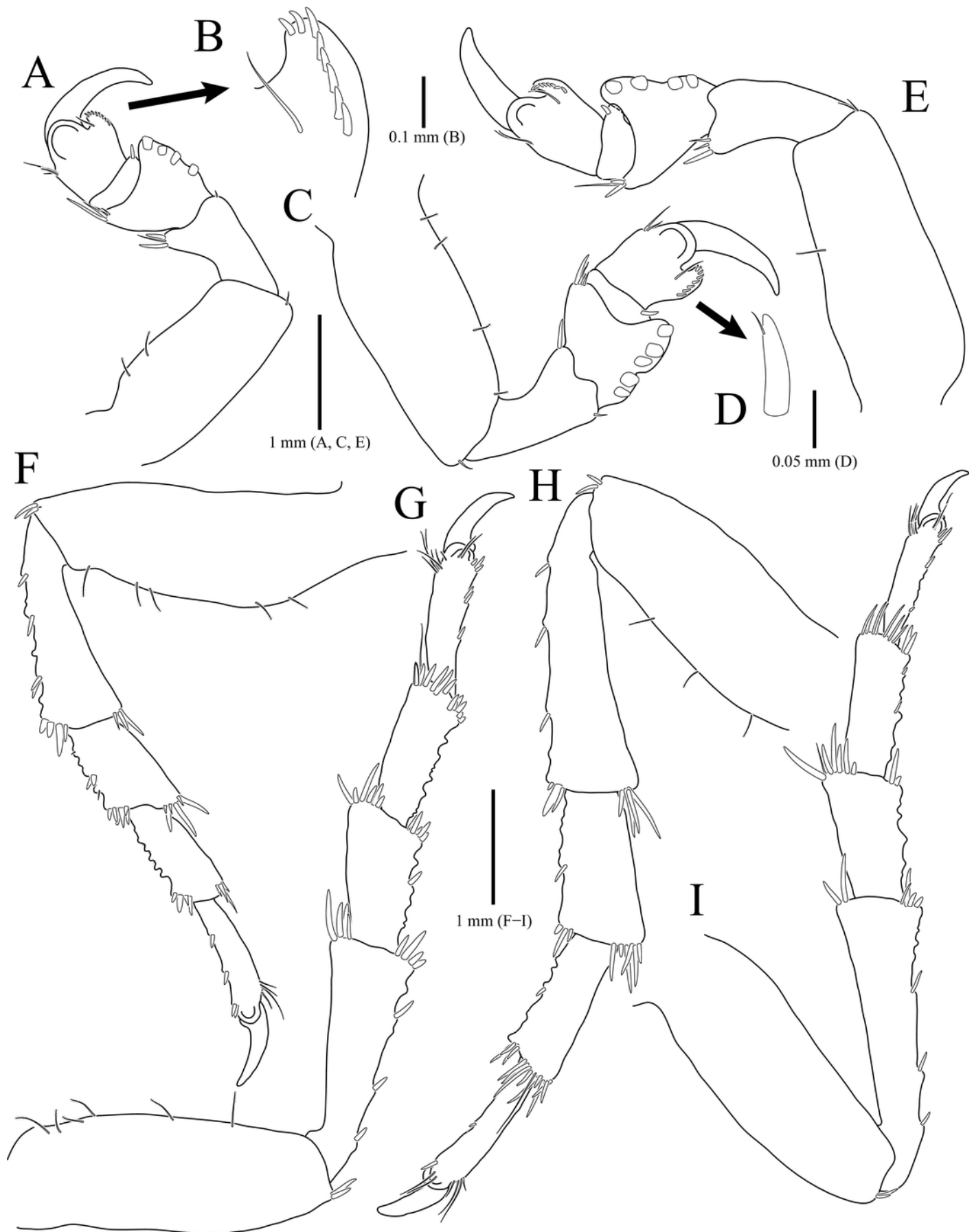
Figure 3

Rocinela excavata sp. nov., holotype, female. (A) Pleopod 1; (B) Pleopod 2; (C) Pleopod 3; (D) Pleopod 4; (E) Pleopod 5; (F) Uropod. Scale bar: A–F = 1 mm

1 mm (A–F)
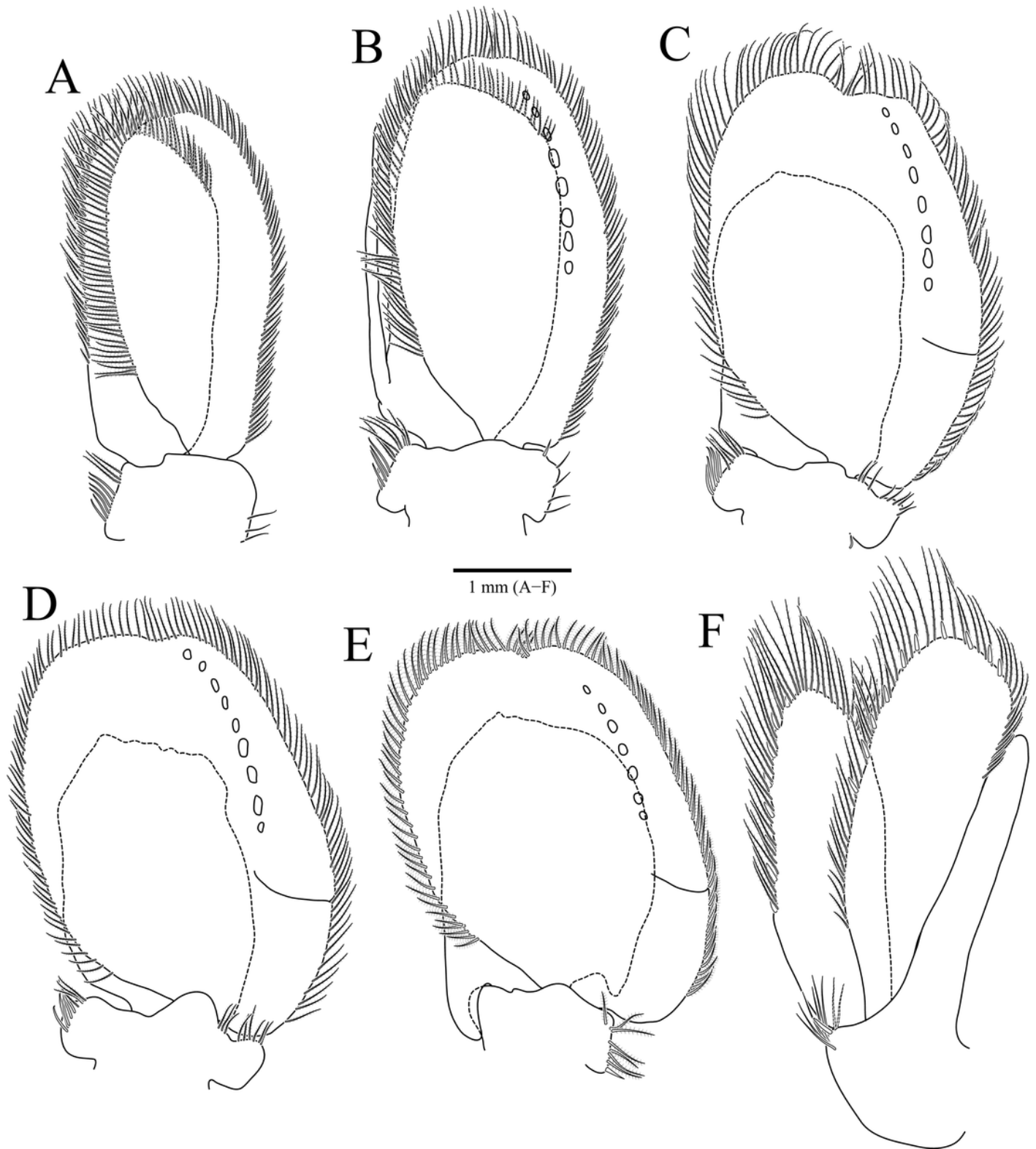
Figure 4

Gnathia obtusispina sp. nov., holotype, male. (A) Habitus, dorsal view; (B) Cephalon, dorsal view; (C) Cephalon, ventral view; (D) Cephalon, lateral view; (E) Mandible, lateral view; (F) Antennule; (G) Antenna; (H) Maxilliped; (I) Pylopod. Arrows in
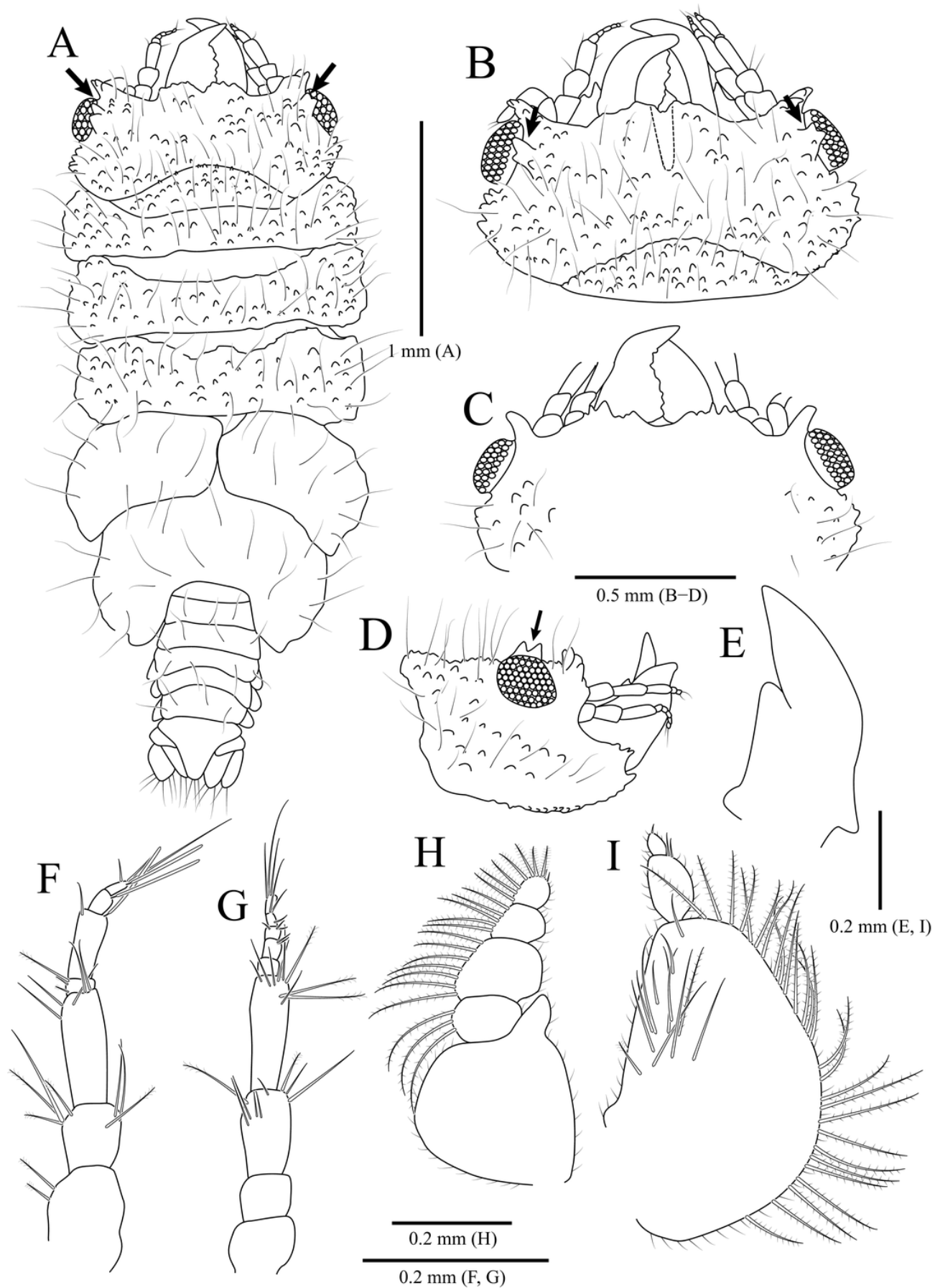
Figure 5

Gnathia obtusispina sp. nov., holotype, male. (A) Pereopod 2; (B) Pereopod 3; (C) Pereopod 4, (D) Pereopod 5; (E) Pereopod 6. Scale bar: A–E = 0.2 mm.

0.2 mm (A–E)

Figure 6

Gnathia obtusispina sp. nov., holotype, male. (A) Pleopod 1; (B) Pleopod 2; (C) Pleopod 3; (D) Pleopod 4; (E) Pleopod 5; (F) Pleotelson and uropod. Scale bar: A–F = 0.5 mm.

0.5 mm (A–F)