Heterobranch sea slugs (Gastropoda: Heterobranchia) from the Región de Atacama, northern Chile, with the description of a new species of *Berthella* Blainville, 1825

Juan Francisco Araya, Ángel Valdés

The coasts of the Región de Atacama, in northern Chile, have been sparsely studied in regard to its invertebrate fauna, with just a few works reviewing the distribution of their local mollusks. This work reviews the littoral communities of heterobranch sea slugs currently occurring around the port of Caldera (27º S), in the Región de Atacama, northern Chile. Nine species of sea slugs were found in this study: *Baptodoris peruviana* (d'Orbigny, 1837), *Diaulula punctuolata* (d'Orbigny, 1837), *Doris fontainei* (d'Orbigny, 1837), *Ercolania evelinae* (Marcus, 1959), *Onchidella marginata* (Couthouy in Gould, 1852), *Peltodoris marmorata* (Bergh, 1898), *Phidiana lottini* (Lesson, 1831), *Tyrinna nobilis* Bergh, 1898 and the new species *Berthella schroedli* sp. nov., described herein. All of the species found in the area are endemic to South America, having distributions in the southeastern Pacific and south Atlantic Oceans, from Ancash, Perú to Peninsula Valdés, Argentina; two species are endemic to the Chilean coasts (*Berthella schroedli* and *Peltodoris marmorata*), and three species, *Diaulula punctuolata*, *Ercolania evelinae* and *Phidiana lottini*, constitute new distribution records in the area. Further surveys, particularly in subtidal and deeper waters, are essential to improve the knowledge on this neglected fauna.

Heterobranch sea slugs (Gastropoda: Heterobranchia) from

the Región de Atacama, northern Chile, with the description

of a new species of Berthella Blainville, 1825

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30 **Heterobranch sea slugs (Gastropoda: Heterobranchia) from the Región de Atacama,**

31 **northern Chile, with the description of a new species of *Berthella* Blainville, 1825**

32

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40

41 **ABSTRACT**

42 The coasts of the Región de Atacama, in northern Chile, have been sparsely studied in regard to

43 its invertebrate fauna, with just a few works reviewing the distribution of their local molluscs.

44 This work reviews the littoral communities of heterobranch sea slugs currently occurring around

45 the port of Caldera (27º S), in the Región de Atacama, northern Chile. Nine species of sea slugs

46 were found in this study: *Baptodoris peruviana* (d'Orbigny, 1837), *Diaulula punctuolata*

47 (d'Orbigny, 1837), *Doris fontainei* (d'Orbigny, 1837), *Ercolania evelinae* (Marcus, 1959),

48 *Onchidella marginata* (Couthouy in Gould, 1852), *Peltodoris marmorata* (Bergh, 1898),

49 *Phidiana lottini* (Lesson, 1831), *Tyrinna nobilis* Bergh, 1898 and the new species *Berthella*

50 *schroedli* sp. nov., described herein. All of the species found in the area are endemic to South

51 America, having distributions in the southeastern Pacific and south Atlantic Oceans, from

52 Ancash, Perú to Peninsula Valdés, Argentina; two species are endemic to the Chilean coasts

53 (*Berthella schroedli* and *Peltodoris marmorata*), and three species, *Diaulula punctuolata*,

54 *Ercolania evelinae* and *Phidiana lottini*, constitute new distribution records in the area. Further

55 surveys, particularly in subtidal and deeper waters, are essential to improve the knowledge on

56 this neglected fauna.

57

58 **INTRODUCTION**

59   The mollusks of the Región de Atacama, in northern Chile, have been sparsely studied;

60 most of the species commonly present in the area were described in the nineteenth century

61   (Broderip & Sowerby, 1832; Sowerby, 1832, 1833; d'Orbigny, 1835-1847; Gould, 1852; Hupé

62   in Gay, 1854, among others), with a few works reviewing species during the past century (Dall,

63   1909; Gigoux, 1932, 1934; Rehder, 1945) and, more recently, with several works describing

64   new species (Osorio, 2012; Araya, 2013; Miquel & Araya, 2013; Araya, 2015a, 2015b; Collado,

65   2015) or giving new records for them (Araya & Araya, 2015). Regarding Heterobranch sea slugs

66   in particular, only the studies by Marcus (1959), Schrödl (1996a, 1996b, 1997, 2003) and most

67   recently Labrín, Guzmán & Sielfeld (2015) have included species from the northern Chile.

68   However, a few recent papers dealing with the Peruvian fauna, including some species

69   commonly found in Chilean waters (e.g., Millen *et al*. 1994; Nakamura 2006, Martynov &

70   Schrödl 2011; Uribe *et al*. 2013; Schrödl & Hooker, 2014 and others), have also contributed to

71   the knowledge of this group in the southeastern Pacific.

72   The present study provides records of sea slugs found in shallow waters around Caldera

73   (27º S), Region of Atacama, northern Chile. The coast of this area consists of rocky formations

74   with sparse sandy beaches and a comparatively narrow intertidal zone. Rocky platforms, boulder

75   fields and intertidal pools are common; however some sheltered areas have open sandy beaches,

76   usually exposed to strong surf. The sea slug fauna recorded in the area in this study consisted of

77   nine species, including *Baptodoris peruviana* (d'Orbigny, 1837), *Diaulula punctuolata*

78   (d'Orbigny, 1837), *Doris fontainei* (d'Orbigny, 1837), *Ercolania evelinae* (Marcus, 1959),

79   *Onchidella marginata* (Couthouy in Gould, 1852), *Peltodoris marmorata* (Bergh, 1898),

80   *Phidiana lottini* (Lesson, 1831), *Tyrinna nobilis* Bergh, 1898 and *Berthella schroedli* sp. nov., a

81   new pleurobranchomorph species described herein. All of these species are endemic to southern

82   South America; with three of them presenting new distributional records in Chile. The aim of

83   this preliminary study is to contribute additional information to the knowledge of the molluscan

84   fauna in Chile, particularly from the largely neglected northern coasts.

85

86   **MATERIALS AND METHODS**

87   The material examined was collected in the summers of 2010, 2011 and 2012 in diverse

88   locations near the port of Caldera (27º S), Region of Atacama, northern Chile. All the collecting

89   was made manually in the intertidal areas, mostly on rocky outcrops and tidal pools. The

90   specimens were deposited in the collections of the Museo de Paleontología de Caldera

91   (MPCCL), Caldera; Museo de Zoología de la Universidad de Concepción (MZUC), Concepción,

92 Chile, and in the collection of the Natural History Museum of Los Angeles County Museum

93 (LACM), Los Angeles, California, USA. Field study permits were not required for this study and

94 none of the species studied herein are currently under legal protection. All the collected

95 specimens were preserved in 95 % ethanol. Photographs of living animals were taken with a

96 Canon A530 digital camera and a 10x geologic loupe. All sizes given are living measurements,

97 radular features were examined by scanning electron microscopy (SEM). Color plates were

98 composed with basic image programs and colors of the images were not modified.

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

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

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

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

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

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

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

106 LSID for this publication is: urn:lsid:zoobank.org:pub:088D994A-9E1E-4324-A6DF-

107 FCCC2B0E3437. The online version of this work is archived and available from the following

108 digital repositories: PeerJ, PubMed Central and CLOCKSS.

109

110 **RESULTS**

111 **Systematic Account**

112 **Heterobranchia**

113 **Infraclass Opisthobranchia**

114 **Order Nudibranchia Cuvier, 1817**

115 **Superfamily Aeolidioidea Gray, 1827**

116 **Family Facelinidae Bergh, 1889**

117 **Genus *Phidiana* Gray, 1850**

118 **Type species** *Eolidea patagonica* d'Orbigny, 1836, by subsequent designation by Alder &

119 Hancock (1855).

120

121 ***Phidiana lottini* (Lesson, 1831)**

122 (Fig. 1A)

123 *Eolidia lottini* Lesson, 1831: 290, pl. 14, fig. 6.

124 *Cavolina lottini* (Lesson): d'Orbigny, 1837: 194.

125 *Phidiana lottini* (Lesson): Schrödl 1996a: 41, pl. II, fig. 13. pl. VII, fig. 41; Schrödl 2003: 83,

126 figs. 51, 63, 64, 88; Schrödl *et al*. 2005: 7, pl. 2, fig. 17; Uribe *et al*. 2013: 52, fig. 3. Schrödl &

127 Hooker 2014: 54, figs. 12, 13.

128 *Phidiana inca* (d'Orbigny, 1837): Gray, 1850: 108; Bergh, 1867: 100, pl. 3, figs. 1–13. Marcus,

129 1959: 79, figs. 184–190; Álamo & Valdivieso, 1997: 85.

130 A detailed chresonymy can be found in Schrödl (2003).

131 **Material examined:** Two specimens (MZUC XXXX); in a tidal pool in a rocky outcrop, Playa

132 Brava (27º03' S; 70º49' W), Caldera, Región de Atacama, Chile and one specimen (MZUC

133 XXXX); collected inside empty *Austromegabalanus psittacus* (Molina, 1782) shells in Calderilla

134 (27º05' S; 70º50' W), Caldera, Región de Atacama, Chile (MPCCL XXXX).

135 **Description:** Elongate body of white to sometimes reddish color, covered by 20-26 parallel rows

136 of conspicuous cerata. Dorsum with a white line. Cerata orange-brown and white in colour.

137 Rhinophores annulate, whitish. Oral tentacles long and pinkish-white. Anterior foot corners

138 slightly extended.

139 **Distribution:** *Phidiana lottini* has been recorded in Chile from Los Hornos (29º38' S; 71º20' W)

140 to the Guaitecas Islands (44° S), southern Chile (Schrödl & Hooker 2014). This species has also

141 been recorded from Ancash, Isla Santa, Lima, and Callao, central Peru (12º02' S) (Uribe *et al*.

142 2013; Schrödl & Hooker, 2014). This is the northernmost record for the species in Chile.

143 **Remarks:** *Phidiana lottini* is easily recognizable from other aeolid sea slugs because of the

144 cerata arranged in parallel rows and the presence of a white dorsal line between the rhinophores.

145

146 **Superfamily Doridoidea**

147 **Family Chromodorididae Bergh, 1891**

148 **Genus *Tyrinna* Bergh, 1898**

149 **Type species** *Tyrinna nobilis* Bergh, 1898, by monotypy.

150

151 ***Tyrinna delicata* Abraham, 1877**

152 **(Fig. 1B)**

153 *Doris delicata* (Abraham, 1877): 211, pl. XXX, figs. 20-22.

154 *Tyrinna nobilis* Bergh, 1898: 523, pl. 30, figs. 21–29, pl. 32, figs. 21–24; Marcus, 1959: 31, figs.

155 45–53; Muniaín, Valdés & Ortea, 1996: 265, figs. 2–6; Schrödl 1996a: 22, pl. 3, fig. 15; 1997:

156 41; Schrödl 2003: 31, figs. 15, 70; Schrödl *et al.* 2005: 4, pl. 1, fig. 8; Schrödl & Millen 2001:

157 1146, figs. 1–6; Uribe *et al.* 2013: 48, fig. 2A.

158 *Tyrinna pusae* Marcus, 1959: 33, figs. 54-64.

159 A detailed chresonymy can be found in Schrödl (2003: 31)

160 **Material examined:** One specimen (MZUC XXXX); under rocks at low tide, in tidal pools in

161 rocky outcrops, North of Obispito (26º45'51" S; 70º45'07" W), Caldera, Región de Atacama,

162 Chile.

163 **Description:** Body oval-elongate, translucent-whitish, with opaque white lines surrounding the

164 edges of foot and mantle. Dorsum smooth, lacking tubercles, with irregular and submarginal

165 rows of orange spots, absent from the central region of mantle. Oral tentacles longitudinally

166 enrolled. Anterior part of foot bilabiate, forming a thick lip. Posterior end of the foot extending

167 beyond the mantle in crawling individuals (After Uribe *et al.* 2013).

168 **Distribution:** From Valdés Peninsula, in the Atlantic Magellan Strait, to Los Piqueros Beach

169 (26º12' S; 70º39' W), Chañaral (Schrödl & Millen 2001). This species has been also recorded in

170 the Juan Fernández Islands, Chile and in Perú at San Juan de Marcona, Ica and Isla Blanca,

171 Arequipa (Uribe *et al.* 2013).

172 **Remarks:** This species is clearly distinguishable from other nudibranchs in the dorsal row of

173 orange spots, which are very visible in the mantle.

174

175 **Family Discodorididae Bergh, 1891**

176 **Genus *Baptodoris* Bergh, 1884**

177 **Type species** *Baptodoris cinnabarina* Bergh, 1884, by monotypy.

178

179 ***Baptodoris peruviana* (d'Orbigny, 1837)**

180 (Fig. 1C)

181 *Doris peruviana* d'Orbigny, 1837: 188, pl. XV, figs. 7–9.

182 *Doriopsis peruviana* Dall, 1909: 203.

183 *Platydoris punctatella* Bergh, 1898: 521, figs 12–20; Dall, 1909: 203; Schrödl, 1996a: 23, pl. IV,

184 fig. 27.

185   *Dendrodoris peruviana* (d'Orbigny, 1837): Álamo & Valdivieso, 1997: 85.

186   *Platydoris peruviana* (d'Orbigny, 1837): Schrödl, 2003: 34, figs. 17, 54, 71.

187   *Baptodoris peruviana* Fischer & Cervera, 2005a: 515, figs. 1–8.

188   *Baptodoris*? *peruviana* Schrödl & Hooker, 2014: 48, fig. 4.

189   **Material examined:** One specimen (MZUC XXXX); under rocks at very low tide, Playa

190   Ramada (27º00' S; 70º48' W) Caldera, Región de Atacama, northern Chile.

191   **Description:** Elevated, oval and slightly convex white-yellowish body, with minute brown spots

192   over the notum which is densely covered by very small rounded caryophyllidia. Rhinophores and

193   gills hyaline white, not elevated. Rhinophores are perfoliate with 7–10 lamellae. The branchial

194   tuft consists of 6 uni-bipinnate gills, which form a circle around the anus at the posterior end of

195   the body. Ventrally, the head is small with short digitiform oral tentacles. The foot is narrow,

196   with the anterior edge notched at the mid-line and grooved. The notal margin is white and wider

197   than the foot (After Fischer & Cervera, 2005a).

198   **Distribution:** According to Fischer & Cervera (2005a), this species has been recorded from

199   South of San Lorenzo Island, Lima, Peru to Valparaiso, (33º02' S; 71º38' W) Chile.

200   **Remarks:** The subtle granulose texture of the notum produced by the presence of very small

201   rounded caryophyllidia and their inconspicuous appearance is useful to difference this species

202   from all other sea slugs found in the area.

203

204   **Genus *Diaulula* Bergh, 1884**

205   **Type species** *Doris sandiegensis* (Cooper, 1863), by monotypy.

206

207   ***Diaulula punctuolata* (d'Orbigny, 1837)**

208   (Fig. 1D)

209   *Doris punctuolata* d'Orbigny, 1837: 187, pl- 16, figs. 4–6.

210   *Diaulula punctuolata* (d'Orbigny, 1837): Valdés & Gosliner 2001: 136, figs. 22, 23; Schrödl

211   2003: 39, figs. 20, 56, 74; Fischer & Cervera 2005b: 173. Detailed bibliography and synonymy

212   can be found in Schrödl (2003: 39)

213   **Material examined:** One specimen (MZUC XXXX); under rocks at very low tide, North of

214   Obispito (26º45' S; 70º45' W), 40 km N of Caldera, Región de Atacama, Chile.

215 **Description:** Whitish-yellowish body with minute black spots over the notum, which is densely
216 covered by small and narrow caryophyllidia. Wide free mantle rim. Rhinophoral and branchial
217 sheaths elevated, covered with caryophyllidia. Six to seven gills, ramified up to four-five times.
218 Oral tentacles long and digitiform. Foot bilabiate, with upper lip notched. Lip cuticle smooth.
219 Rhinophores have more than 15 lamellae (After Schrödl, 2003).
220 **Distribution:** According to Fischer & Cervera (2005b), this species has been recorded from
221 Valparaiso, Chile (33º02' S; 71º38' W) to the Argentinian Patagonia. This is the northernmost
222 record for the species in Chile.
223 **Remarks:** The velvety texture of the dorsum produced by the presence of caryophyllidia is
224 useful to difference this species from similar sea slugs.
225
226 **Genus *Peltodoris* Bergh, 1880**
227 **Type species** *Peltodoris atromaculata* Bergh, 1880, by subsequent designation by O'Donoghue
228 (1926)
229
230 ***Peltodoris marmorata* (Bergh, 1898)**
231 **(Fig. 1E)**
232 *Anisodoris marmorata* Bergh, 1898: 515, pl. 30, figs. 5–7 (non *Archidoris marmorata* Bergh,
233 1881). Marcus, 1959: 45, figs. 98–103.
234 *Anisodoris rudberghi* Marcus & Marcus, 1967: 69; Schrödl, 1996: 25, pl. IV, figs. 21–22.
235 *Peltodoris marmorata* (Bergh, 1898): Valdés & Muniaín, 2002: 349, figs. 1D, 4, 5.
236 *Diaulula variolata* (D'Orbigny, 1837): Schrödl, 2003: 41, figs. 21, 57, 75.
237 **Material examined:** Two specimens (MZUC XXXX); under rocks in very low tide, Calderilla
238 (27º05' S; 70º50' W), S of Caldera, Región de Atacama, Chile.
239 **Description:** Brownish-white body, a plain brownish mantle covered by very small rounded
240 tubercles of different sizes. Six to eight tri- to quadripinnate gills. Oral tentacles long and
241 digitiform. Foot bilabiate, with a notched anterior edge. Lip cuticle smooth (After Schrödl, 2003)
242 **Distribution:** This species has records in Chile from Arica (18° S) Schrödl (2003) to Bernardo
243 O'Higgins Park (51º S), Aysén (Aldea, Césped & Rosenfeld, 2011). This species was rare in the
244 area and it was found only in two places, under rocks in the lower intertidal zone.

245   **Remarks:** This is a very inconspicuous sea slug, some uncollected specimens were found under

246   large rocks among encrusting algae and bryozoans; they can be easily identified, however, by the

247   notched anterior edge and the plain, dark mantle. This species has a complex taxonomic history

248   and it is also regarded as a synonym of *Diaulula variolata* (d'Orbigny, 1837).

249

250   **Family Dorididae Rafinesque, 1815**

251   **Genus *Doris* Linnaeus, 1758**

252   **Type species** *Doris verrucosa* Linnaeus, 1758, by monotypy.

253

254   ***Doris fontainii* d'Orbigny, 1837**

255   *Doris fontainii* d'Orbigny, 1837: 189, pl. 15, figs. 1–3.

256   *Anisodoris fontaini* (d'Orbigny, 1837): Odhner, 1926: 85, figs. 70–72, pl. 3, figs. 47–49; Schrödl,

257   1996a: 24, pl. III, fig. 19. Schrödl, 2000b: 73, fig. 2–3.

258   *Doris fontainei* (d'Orbigny, 1837): Gay, 1854: 76; Valdés & Muniaín, 2002: 346, figs. 1A–B,

259   2A–C, 3 A–B. Uribe *et al*. 2013: 51, fig. 3E. Schrödl & Hooker, 2014: 47, fig. 2.

260   *Archidoris fontaini* (d'Orbigny, 1837): Schrödl, 2003: 45, figs. 24, 58, 76; Schrödl *et al*. 2005: 4,

261   pl. 2, fig. 9; Schrödl & Grau, 2006: 5, fig. 2A–B.

262   **Material examined:** Two specimens (MZUC XXXX); in tidal pools at El Jefe Beach (27º03'46"

263   S; 70º49' W), Bahía de Caldera, Región de Atacama, Chile.

264   **Description:** Orange to brownish body coloration, with a highly arched body. Notum covered

265   with many small (up to 5 mm in diameter) rounded tubercles. Five to seven tri- to quadripinnate

266   gills. Gills and rhinophores surrounded by elevated sheaths with small tubercles. Oral tentacles

267   triangular, grooved. Foot broad, anteriorly bilabiate and notched. Lip cuticle smooth (After

268   Schrödl, 2003).

269   **Distribution:** This species has been recorded from Ancash, Islote Ferrol, Peru (Uribe *et al*.

270   2013) to northern Argentina (Valdés &Muniaín, 2002).

271   **Remarks:** This species is easily recognizable due to its large size, brilliant orange body color

272   and a mantle covered with conspicuous rounded tubercles. Of the examined specimens, none had

273   the dark brown pigment between the tubercles, which Schrödl *et al*. (2005), regarded as

274   characteristic of central and northern Chilean specimens. This was the most common species in

275   the area; they are usually found in the subtidal zone but specimens were also collected from tidal

276   pools at low tide. According to some commercial divers this species is common below 3 m depth

277   near Bahía Inglesa (27°07′ S; 70°52′ W), south of Caldera.

278

279   **Order Pleurobranchomorpha Schmekel, 1985**

280   **Superfamily Pleurobranchoidea Gray, 1827**

281   **Family Pleurobranchidae Gray, 1827**

282   **Genus *Berthella* Blainville, 1824**

283   **Type species** *Bulla plumula* Montagu, 1803, by original designation.

284

285   ***Berthella schroedli* sp. nov.**

286   (Figs. 2A-C, 3A-D, 4, 5C)

287

288   **Type material:** Holotype: 22 mm alive, 18 x 7 mm, preserved in ethanol, Playa El Pulpo (27°

289   01′ 22” S; 70º 48’ 30” W), Caldera, Regioón de Atacama, Chile, intertidal under sunken rocks in

290   rocky coast, 1 m depth, 29 December 2012, coll. & leg. JF Araya, MZUC XXXX. Paratypes 1-3

291   LACM XXX-XXX, paratypes 4-6 MPCCL XXX-XXX. All the type material is preserved in

292   ethanol 96%.

293   **Diagnosis:** *Berthella* with a dark brown-reddish shell decorated with pale radial lines; visible

294   through the translucent yellowish mantle, with an oval and slightly crenulated margin and very

295   small tubercles covering the notum.

296   **Description:** Body reaching lengths up to 25 mm in fully extended living specimens (Figs. 2A,

297   2B, 5A). Body uniformly pale yellowish, translucent; with an internal shell of brownish-reddish

298   color, visible through the mantle. Mantle with a smooth appearance, but with very small

299   tubercles covering the dorsum which gives the animal, at high magnification, a somewhat

300   wrinkled appearance. The mantle processes do not show obvious spicules. Dark and minute eyes

301   located at the base of the rhinophores, hidden beneath the anterior edge of the mantle (Fig. 2B).

302   Notum wide, oval and slightly crenulated, with a broad free margin around. Gill and foot covered

303   by the notum in living specimens, and oral veil and rhinophores partially covered in their

304   posterior part. Mantle lacking an anterior notch. Rhinophores short and stout, joined together at

305   the base. Foot bilabiate anteriorly. Oral veil trapezoidal, protruding from the mantle. Gill located

306   on the right side of the body, lying longitudinally between the mantle and the foot; it is attached

307   to the body for more than half of its length. Gill bipinnate, with 13 pinnae on either side of the

308   rachis. Rachis smooth, lacking tubercles. Anus located dorsal to the central area of the gill. Egg

309   masses are small white spiral ribbons, up to about 25 mm in diameter (Fig. 4A).

310   *Shell*: Shell fully internal, flattened, rectangular/oval in shape, elongate and located

311   centrally in the dorsal area, where it covers completely the viscera. Shell reddish brown in color,

312   somewhat nacreous/iridescent, with radial rays of pale yellowish which are visible through the

313   mantle in living specimens. Margins of shell sharp and fragile. Protoconch of about 300 μm in

314   diameter, smooth under low magnification. Teleoconch with fine concentric ridges crossed by

315   very fine radial striae, the first whorls have a cancellated sculpture (Fig. 2C). *Radula*: Jaws with

316   elongate cruciform elements rather slender, elongate and lanceolate with a narrower base; each

317   element consisting of a central cusp flanked by 2-3 denticles on either side of a prominent central

318   cusp (Fig. 3D). Radular formula: 50 x 45.0.45. Radular teeth hook-shaped lacking denticles (Fig.

319   3A). Innermost lateral teeth slightly smaller than those from the middle portion of the half row

320   (Fig. 3B).Outermost lateral teeth with a much more elongate cusp than the mid laterals (Fig. 3C).

321   *Reproductive system*: The ampulla is long and muscular, merging proximally into the female

322   gland complex. The penis is wide, with an elongate tip; it connects proximally into a short

323   deferent duct that splits into the prostate and the elongate, muscular penial gland. The prostate is

324   convoluted and connects proximally to the female gland complex. The vagina is elongate,

325   straight; it narrows and connects to the round and large bursa copulatrix. The seminal receptacle

326   is elongate, muscular and about twice as long as the bursa copulatrix; it connects to the vagina

327   before it enters the bursa copulatrix. A uterine duct could not be observed (Fig. 4).

328   **Habitat:** This species is found exclusively under rocks sunken at low tide in an almost infaunal

329   habitat; it can be found associated to encrusting sponges, bryozoans, encrusting algae and to

330   communities of micromollusks including *Acar pusilla* (Sowerby, 1833), *Brachidontes granulata*

331   (Hanley, 1843), *Liotia cancellata* Gray, 1848 and *Mitrella unifasciata* (Sowerby, 1832). This

332   particular habitat is also unique for the endemic minute chitons *Callistochiton pulchellus* (Gray,

333   1828) and *Calloplax vivipara* (Plate, 1899) (Araya & Araya, 2014).

334   **Distribution:** This species is somewhat rare but broadly distributed in the area of study; small

335   populations were found only in four localities, in about 40 km of coast, always under rocks (table

336   1). According to Schrödl (2003) this genus has records in South America from the southernmost

337   Patagonian shelf (Burdwood Bank), south-eastern Atlantic Ocean to southern Chile and north to

338   Quiriquina Island, central Chile. The genus thus extends its distribution in Chile more than 1100

339   km to the north.

340   **Etymology:** Named in honor of Michael Schrödl (Zoologische Staatssammlung München,

341   Münich, Germany), for his extensive contributions to the Chilean Opisthobranchia.

342   **Remarks:** Of the 16 valid species of *Berthella* known worldwide (Hermosillo & Valdés, 2008),

343   only two have been reported for southern South America: *Berthella patagonica* (d'Orbigny,

344   1837) and *Berthella platei* (Bergh, 1898). The western Atlantic *Berthella patagonica*, distributed

345   from Central Argentina to Peninsula Valdés, southern Argentina (Schrödl, 2003), differs from

346   the new species in having smaller body dimensions, with a very narrow free mantle rim and a

347   notum apparently lacking a porous texture and not covering completely the foot which, in

348   contrast to the new species, has a quadrangular outline (Schrödl, 1999, 2003). The Magellanic

349   *Berthella platei*, distributed from the Burdwood Bank, southeastern Atlantic Ocean to Quiriquina

350   Island, Central Chile (Schrödl, 1999), differs from the new species in having a more translucent

351   body, of uniform pale pink to pale orange or whitish coloration of living animals (Fig. 5A, 5B), a

352   higher number (15-24) of branchial lamellae versus 11-14 in *B. schroedli* sp. n. and a paler

353   internal shell, translucent brown to greyish in color, in contrast to the reddish-brown shell with

354   faint whitish axial streaks of the new species. The radular formula and the elements of the jaws

355   also differ; *Berthella schroedli* sp. n. have fewer radular rows and less teeth per half row than *B.*

356   *platei*, and it has also larger elongate and lanceolate elements with a narrower base and thin

357   denticles, while *B*. *platei* have smaller and more triangular elements with a broader base and

358   slightly broader denticles (see Schrödl, 1999). The shell length in relation to the body size in *B.*

359   *schroedli* is also comparatively larger than in *B. platei*. In regard to their habitat; the new species

360   has been found almost solely under sunken rocks in relatively shallow water in the intertidal;

361   while *Berthella platei* is found only subtidally, living in the ocean floor usually under 5 m depth

362   (Dirk Schories pers. comm.)

363   Other Eastern Pacific species of *Berthella* include *Berthella agassizi* (MacFarland, 1909);

364   *Berthella californica* (Dall, 1900); *Berthella grovesi* Hermosillo & Valdés, 2008; *Berthella*

365   *martensi* (Pilsbry, 1896); *Berthella stellata* (Risso, 1826) and *Berthella strongi* (MacFarland,

366   1966). All these species differ from *Berthella schroedli* sp. n. chiefly in their external coloration,

367   by having opaque white spots (*B. agassizii*, *B. strongi*) or light brown spots and/or an orange

368   body with dark brown lines and spots (*B. martensi*), a marginal notal band (*B. californica*), dark

369   spots in the middle of thick opaque white ringlets (*B. grovesi*) or a dorsal streak of white running

370   perpendicularly across the notum, which is translucent white or honey colored (*B. stellata*).

371

372   **Order Sacoglossa Ihering, 1876**

373   **Superfamily Limapontioidea Gray, 1847**

374   **Family Limapontiidae Gray, 1847**

375   **Genus *Ercolania* Trinchese, 1872**

376   **Type species** *Ercolania siottii* Trinchese, 1872, by original designation.

377

378   ***Ercolania evelinae* (Marcus, 1959)**

379   (Fig. 1F)

380   *Stiliger* (*Stiliger*) *evelinae* Marcus, 1959: 22, figs. 28–33. *Ercolania evelinae* Schrödl, 1996a: 44,

381   fig. 2.

382   **Material examined:** One specimen photographed alive (not collected); on filamentous algae in

383   tidal pool at very low tide, Playa Brava (27º03' S; 70º49' W), Caldera, Región de Atacama,

384   Chile.

385   **Description:** Body minute, up to about 5 mm in examined specimen, with an elongated body,

386   narrowed anteriorly; of brown to deep greenish-black color, with two clear areas at the sides of

387   the head. Two rows of longitudinal cerata in the border of the mantle, with up to six cerata per

388   row (After Schrödl, 1996a).

389   **Distribution:** *Ercolania evelinae* has a discontinuous distribution from Paracas (13° S), Peru to

390   the Magallanes Strait (55° S) in Chile (Schrodl & Hooker, 2014). This is the northernmost

391   distribution record of this species in the country.

392   **Remarks:** This tiny saccoglosan is one of the smallest and most inconspicuous sea slug in the

393   area.

394

395   **Order Systellommatophora Pilsbry, 1948**

396   **Superfamily Onchidioidea Rafinesque, 1815**

397   **Family Onchidiidae Rafinesque, 1815**

398   **Genus *Onchidella* J. E. Gray, 1850**

399 **Type species** *Onchidium nigricans* Quoy & Gaimard, 1832, by subsequent designation by

400 Fischer and Crosse (1878).

401

402 ***Onchidella marginata* (Couthouy in Gould, 1852)**

403 *Peronia marginata* Couthouy in Gould, 1852: 292; atlas, 1856: pl. 22, figs. 386a–c. *Onchidium*

404 *chilense* Gay, 1854: 120. *Onchidella marginata* Marcus, 1959: 16, fig. 17–20. Dayrat, 2009: 13.

405 Rosenfeld & Aldea, 2010: 35, figs. 1A–B. A more complete synonymy can be found in Dayrat

406 (2009).

407 **Material examined:** Twenty specimens (four of them at MZUC XXXX); under small rock slabs

408 at low tide, Playa El Pulpo (27º03' S; 70º49' W), Caldera, Región de Atacama, Chile.

409 **Description:** Body elongate ovate, narrowed anteriorly; back very convex, deep greenish-black,

410 very thickly covered with minute tubercles; margin ornamented with alternate bars of black and

411 white; head broad, bilobed in font, and projecting considerably beyond the mantle when the

412 animal is in motion, of a pale yellow color, tinted bluish about the mouth; tentacles rather long,

413 and bulbous at the extremity, pale slate-color, except at the tips, which are back; under side of

414 the mantle pale yellowish, becoming greenish at the margin, where it shows alternate bands of

415 green and pale yellow (After Gould, 1852).

416 **Distribution:** *Onchidella marginata* has a discontinuous distribution from Iquique (20° S) to the

417 Magallanes Strait (55° S) in Chile, and to the Isla de los Estados in the South Atlantic of

418 Argentina.

419 **Remarks:** This is the only pulmonate sea slug found in Chile (Valdovinos, 1999; Dayrat, 2009);

420 it is usually found in small communities living in under rocks and camouflaging against their

421 surroundings. In the area under study this species share its habitat with other molluscs as the

422 limpet *Lottia orbignyi* (Dall, 1909), and the chitons *Chaetopleura peruviana* (Lamarck, 1819)

423 and *Radsia barnesi* (Gray, 1828). This species is easily identifiable from similar intertidal

424 gastropods in the region due to the absence of a shell, the alternating white and green bands in

425 the edge of the mantle and its small size.

426

427 **DISCUSSION**

428 The present work updates the knowledge on the marine fauna of northern Chile; from the 65

429 species of sea slugs (only including Nudibranchia and Pleurobranchoidea) recorded to live in

430   Chilean waters (Schrödl, 2003), nine species were recorded in the Region of Atacama,

431   accounting for about 15 % of the Chilean sea slug fauna. All of the species occurring in the area

432   have widespread ranges in the southeastern Pacific Ocean, from Ancash, Peru to the Strait of

433   Magellan, in southern Chile and in the South Atlantic Ocean, to Peninsula Valdés, in Argentina.

434   With the exception of *Berthella schroedli* sp. n., all of the species found in the Region of

435   Atacama also occur in central and southern Chile. The absence of species previously cited for the

436   area (Schrödl, 1996a, 2003; Schrödl & Hooker, 2014), for example *Corambe lucea* Marcus

437   1959; *Janolus rebeccae* Schrödl, 1996; *Okenia luna* Millen, Schrödl, Vargas & Indacochea, 1994

438   and *Thecacera darwini* Pruvot-Fol, 1950, among others) could be explained due to the limit of

439   sampling depth, which was restricted to the lower intertidal areas with a maximum of 2 m depth.

440   Heterobranch sea slugs have been rarely treated in studies reviewing the biodiversity of

441   mollusks from northern Chile in general (e. g. Marincovich, 1973; Guzmán *et al*. 1998), despite

442   the comparatively high number of species recorded in the country. This is in part explained by

443   the current lack of experts working actively in the field and the difficulties involved in collecting

444   and preserving marine slugs. The preservation of specimens usually changes some characteristics

445   of the slugs, mostly their colors. The finding of a new species of *Berthella* in northern Chile also

446   highlights the need of further studies in the area or in northern Chile in general, which have

447   recently revealed new invertebrate species (Reiswig & Araya, 2013; Collado, 2015) or new

448   distributions for obscure or rare species, both from shallow and deeper waters (Araya & Araya,

449   2015b; Araya & Aliaga, 2015; Araya *et al*. 2015).

450

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458

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1

Figure 1. Species of Heterobranchia sea slugs found near Caldera, Atacama region, northern Chile (all specimens photographed in situ).

A. *Phidiana lottini* (Lesson, 1831), Calderilla Beach, inside a valve of *Argopecten purpuratus* (Lamarck, 1819), L= 23 mm; B. *Tyrinna nobilis* Bergh, 1898, Obispito Bay, L= 10 mm; C. *Baptodoris peruviana* (d'Orbigny, 1837), Ramada Beach, L= 23 mm; D. *Diaulula punctuolata* (d'Orbigny, 1837), El Pulpo Beach, L= 34 mm; E. *Peltodoris marmorata* (Bergh, 1898), Calderilla Beach, inside a valve of *Semele solida* (Schumacher, 1817), L= 16 mm; F. *Ercolania evelinae* (Marcus, 1959), Brava Beach, specimen found among filamentous algae in tidal pool, L about 4 mm.

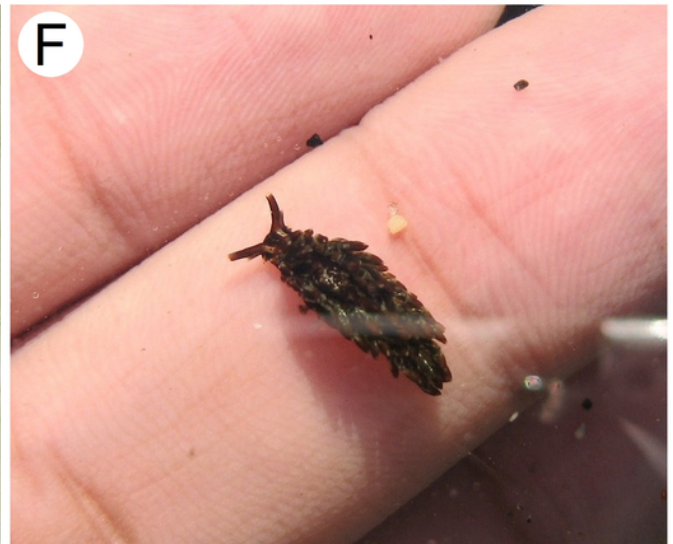
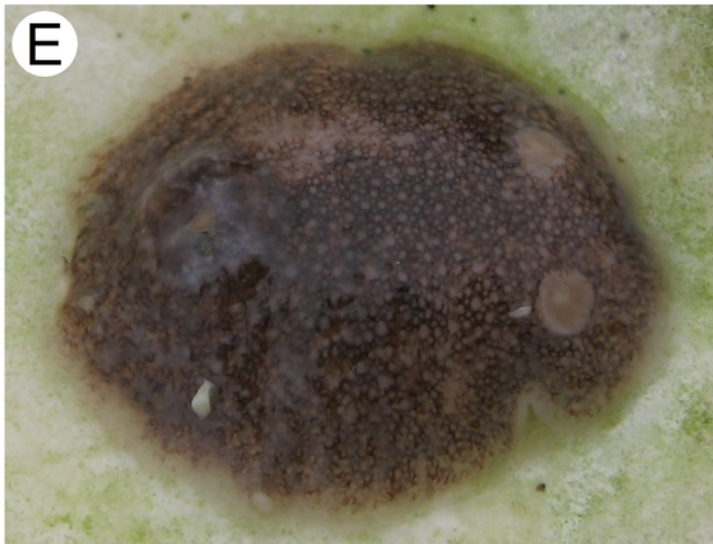
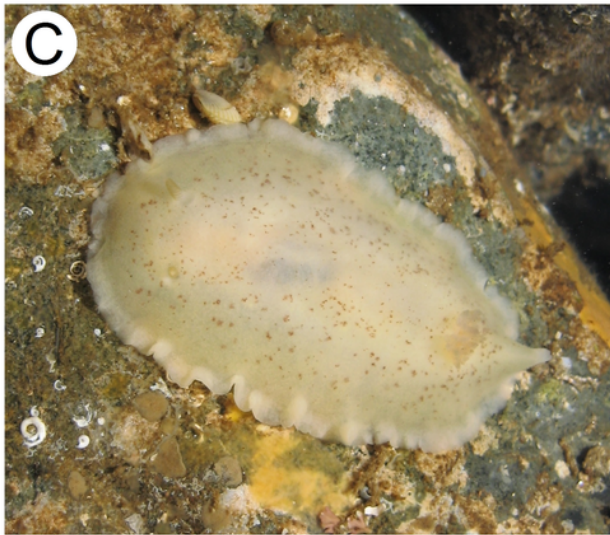



Figure 2. *Berthella schroedeli* sp. nov.

A. Specimens photographed in situ, under rocks at low tide, Aguas Verdes; B. Detail of specimen; C. SEM imagen of shell (LACM XXXX).

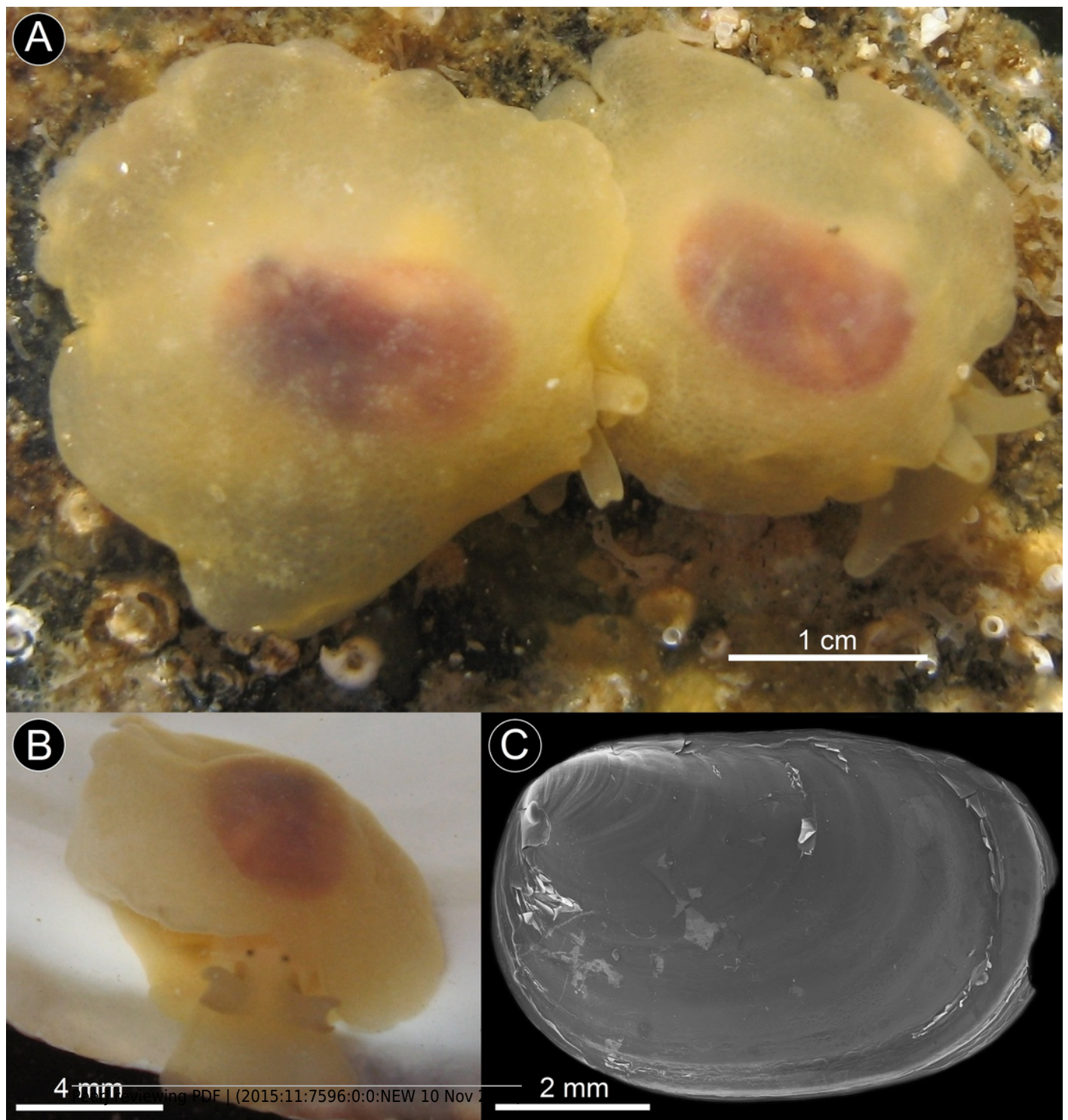



Figure 3. *Berthella schroedeli* sp. nov. (LACM XXXX), SEM micrographs.

A. Radular teeth, central portion of the radula, B. Outermost radular teeth, C. Lateral teeth, middle portion of the half row, D. Detail of the Jaw platelets.

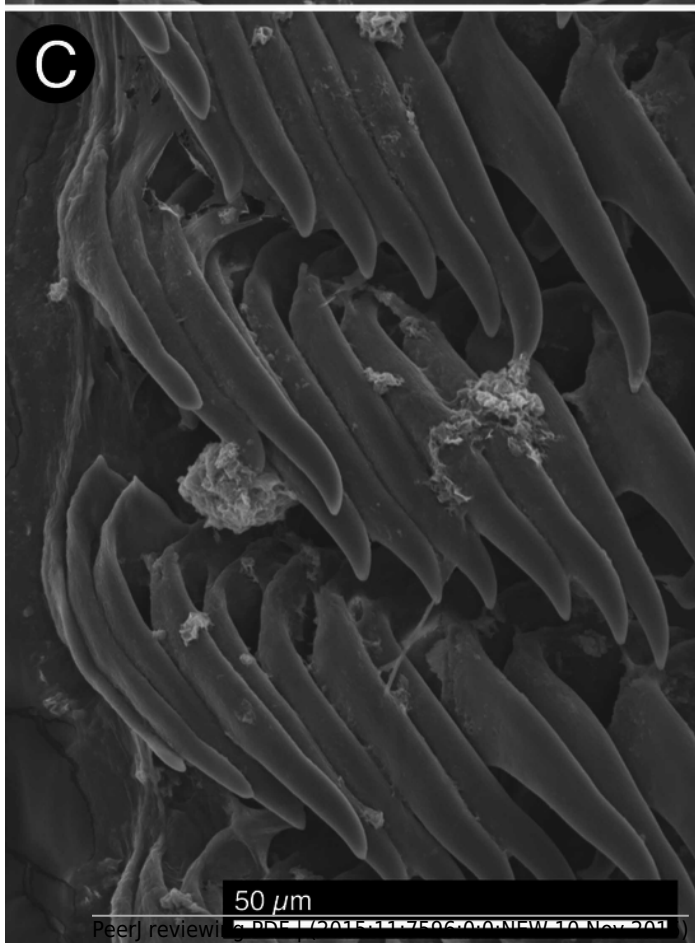
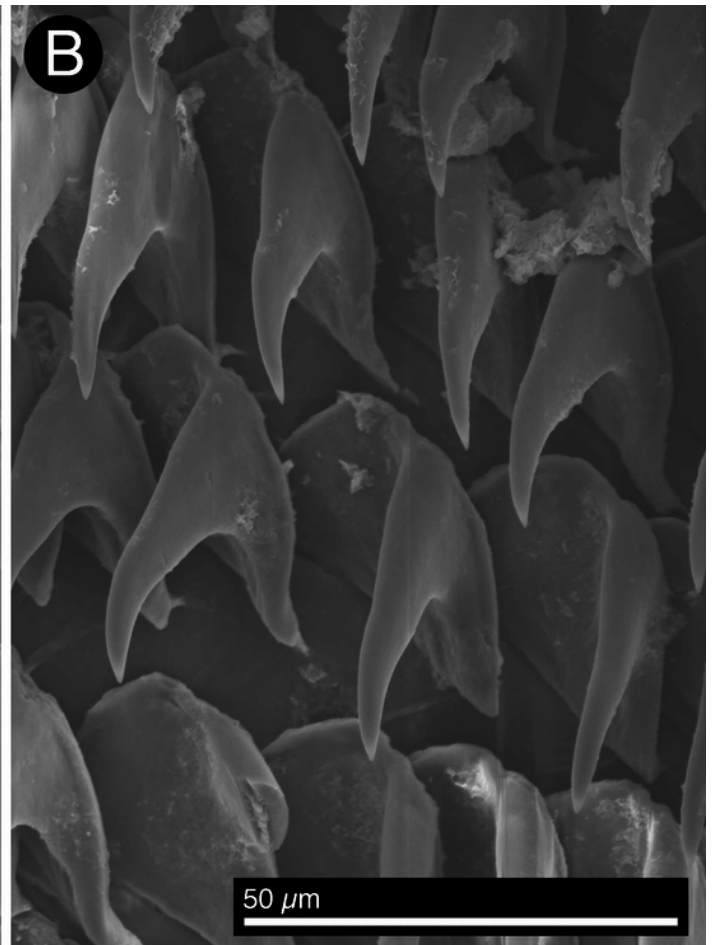
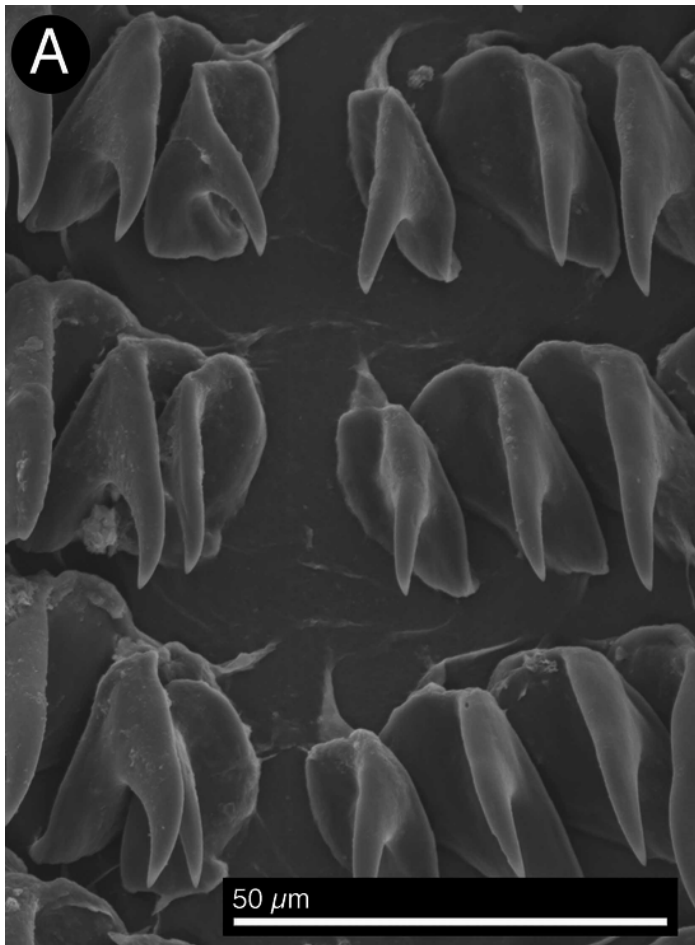



Figure 4. Reproductive anatomy of *Berthella schroedli* sp. nov.

A. Dorsal view of the reproductive system. B. Detail of some organs covered by the prostate and penial gland. Abbreviations: am, ampulla; bc, bursa copulatrix; fgc, female gland complex; pe, penis; pg, penial gland; pr, prostate; sr, seminal receptacle; vg, vagina.

1 mm

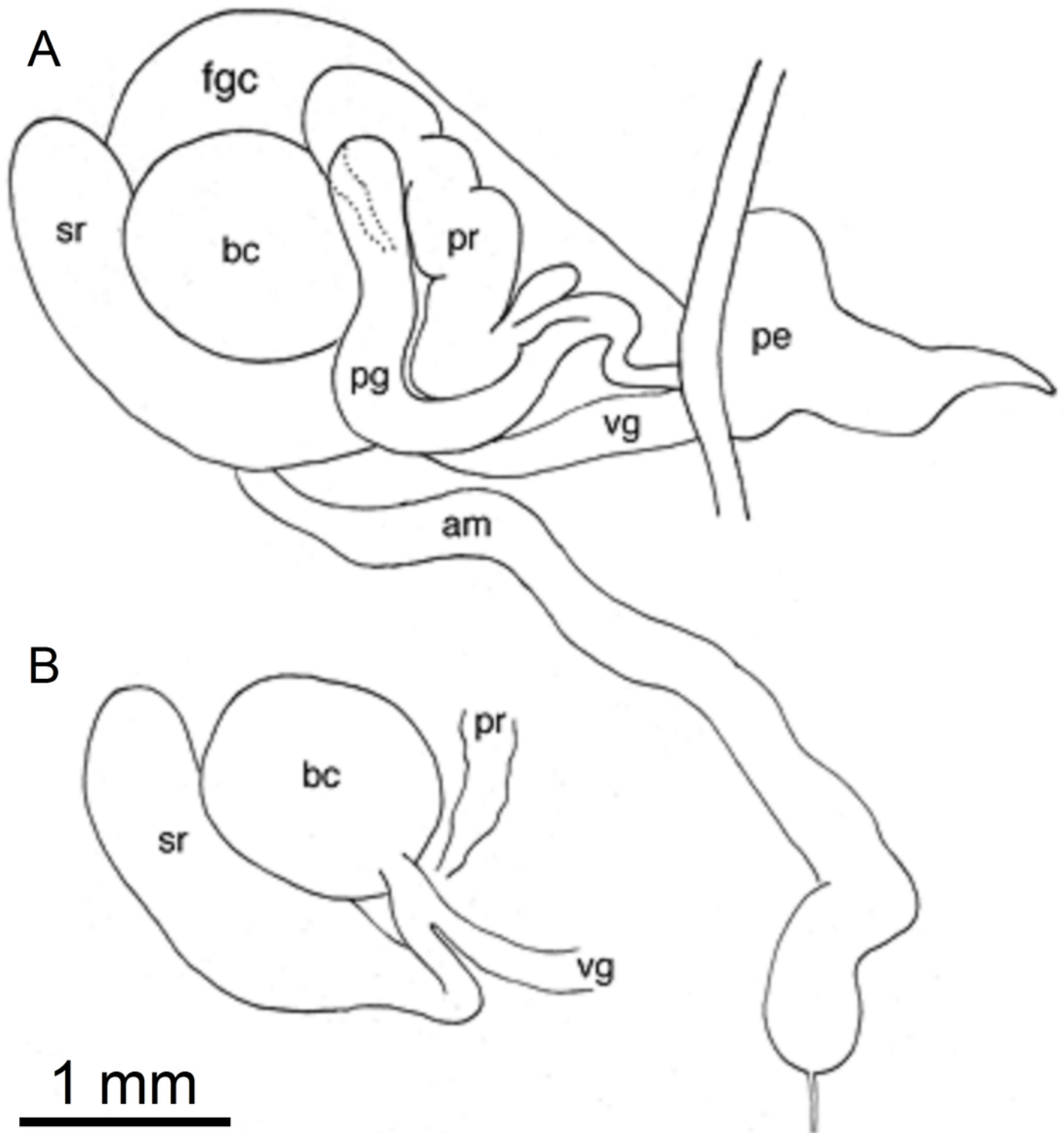
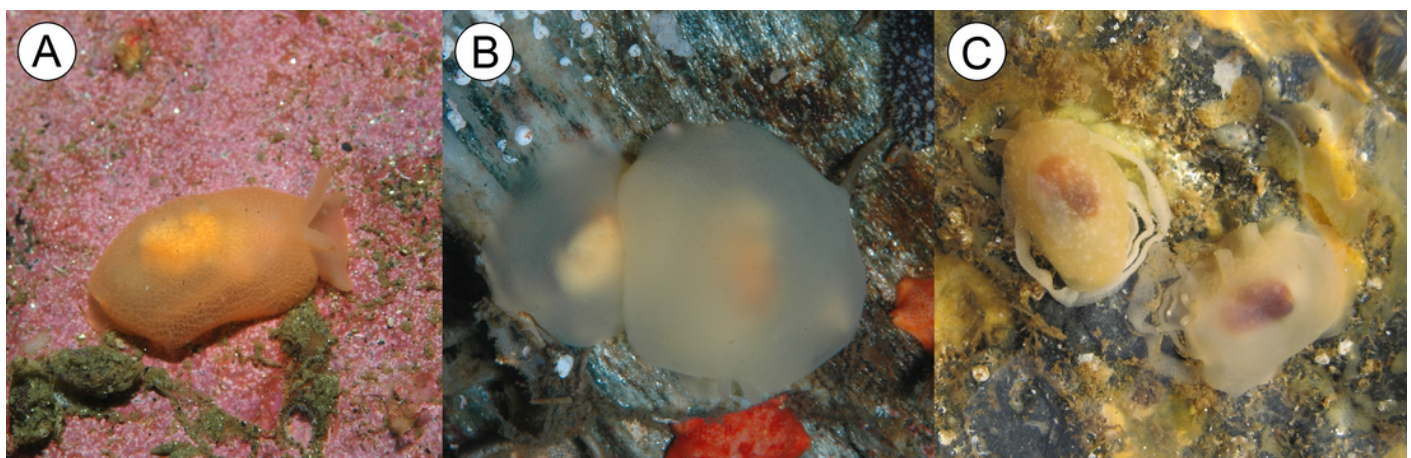



Figure 5. Chilean *Berthella* species.

A. and B. specimens of *Berthella platei* (Bergh, 1898) photographed in situ, Caleta de Arena, 20 m depth and Valdivia respectively (photos B and C courtesy of Dirk Schories); C. *Berthella schroedli* sp. nov. Specimen sitting on egg masses, Obispito, Caldera.

Distribution of Heterobranch sea slugs found in the Region of Atacama, northern Chile.

Occurring species involve species cited by Marcus (1959), Schrödl (2003), and material examined in this work.

1   **Table 1.** Distribution of Heterobranch sea slugs found in the Region of Atacama, northern Chile.

2   Occurring species involve species cited by Marcus (1959), Schrödl (2003), and material examined

3   in this work.

Species	Distribution	Ecology	References
Baptodoris peruviana (d'Orbigny, 1837)	San Lorenzo, Peru to Valparaiso, Chile (33° 02' S, 71° 38' W)	Sea floor, epifaunal, subtidal	Fischer & Cervera 2005
Berthella schroedli sp. n.	Caldera (27° S), Region of Atacama, Chile	Under sunken rocks, infaunal, subtidal	This work
Diaulula punctuolata (d'Orbigny, 1837)	Caldera (27° S), Chile to the Argentinian Patagonia	Sea floor, epifaunal, subdtidal	Fischer & Cervera 2005 and this work
Doris fontainei (d'Orbigny, 1837)	Islote Ferrol (09°08'22" S; 78°37'15" W), Ancash, Peru to northern Argentina.	Sea floor, epifaunal, subtidal	Uribe *et al.* (2013) and Valdés & Muniaín (2002)
Onchidella marginata (Couthoy in Gould, 1852)	Iquique (20° S) Chile to Isla de los Estados (coordinates), Argentina	Under rocks, epifaunal, intertidal	Rosenfeld & Alea (2010)
Peltodoris marmorata (Bergh, 1898)	Arica (18° S) to Bernardo O'Higgins park (51° S), Aysén	Sea floor, epifaunal, subtidal	Aldea, Césped & Rosenfeld, 2011
Phidiana lottini (Lesson, 1831)	Caldera (27° S) to Comau Fjord (42° 15′ S; 72°25′12′ W), Chile, also in Callao , Peru	Sea floor, epifaunal, subtidal	Schrödl *et al.* (2005) and this work
Tyrinna nobilis Bergh, 1898	San Juan de Marcona, Ica and Isla Blanca, Arequipa to Valdés Peninsula, Argentina.	Sea floor, epifaunal, subtidal	Schrödl & Millen 2001, Uribe *et al.* 2013.