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1 **A new brittle star (Ophiuroidea: Ophiodermatina) from the Early Triassic**
2 **of Idaho (USA)**

3

4 Ben Thuy¹, Gilles Escarguel² and the Paris Biota team

5

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10

11 **Key words**

12 Ophiuroids, evolutionary history, modern clades, morphology, *Shoshonura brayardi*

13

14

15 **Abstract**

16

17 Our knowledge of the morphology of Early Triassic ophiuroids is very limited, in spite of the

18 relatively high number of described species. This hampers attempts to use morphology-based

19 phylogenetic analyses in order to explore the early diversification of modern ophiuroid clades

20 between the latest Paleozoic and early Mesozoic. Here, a new ophiuroid from the Early

21 Triassic of southern Idaho (USA) is described and assigned to the new taxon *Shoshonura*

22 *brayardi* gen. et sp. nov. It is part of an exceptional Early Triassic faunal assemblage recently

23 described as the Paris Biota. Based on the arm morphology, the shape of the arm spines and

24 the arm spine articulations, *Shoshonura brayardi* gen. et sp. nov. is considered a basal

25 member of the suborder Ophiodermatina.

26

27 **1. Introduction**

28

29 The Late Permian to Early Triassic interval was a time of global-scale environmental
30 perturbations, including the most devastating mass extinction to ever occur on Earth (e.g.
31 Sepkoski 1981; Erwin 1993). At the same time, however, it is considered a pivotal time in the
32 early evolution of many modern marine invertebrate groups, in particular setting the kick-off
33 for crown-group cladogenesis in echinoderms (e.g. Twitchett & Oji 2005).

34 With respect to the late Permian to Early Triassic fossil record, ophiuroids are certainly the
35 most prolific group. Chen and McNamara (2006) record as many as 14 ophiuroid species for
36 the boundary interval, which by far outnumbers the coeval fossil record of the other four
37 echinoderm classes (Twitchett & Oji 2005; Villier et al. in press). Regrettably, the majority of
38 the late Permian to Early Triassic ophiuroid occurrences are poorly known. Although
39 commonly named to species level, most records are based on insufficiently preserved
40 specimens and/or superficial descriptions (e.g. Detre & Mihaly 1987; Chen et al. 2004; Chen
41 & McNamara 2006). So far, the only Early Triassic ophiuroid species for which a reasonably
42 exhaustive description is available is *Praeaplocoma hessi* Broglio Loriga and Bert-Cavicchi,
43 1972 from the Italian Dolomites. Yet, even *P. hessi* remains poorly known with respect to its
44 higher systematic affinities and its position within ophiuroid evolutionary history.

45 The latest studies of ophiuroid phylogeny and evolution converge to a mid-Permian origin for
46 the crown group Ophiuroidea followed by a relatively quick radiation of the major extant
47 groups (O'Hara et al. 2014; Thuy & Stöhr 2016). Against this background, the poor state of
48 knowledge of Triassic ophiuroids is particularly unfortunate as it hampers a better
49 understanding of the crucial early cladogenesis of the group.

50 The present study describes a remarkable new ophiuroid from the Early Triassic of
51 southeastern Idaho, USA, previously highlighted as part of the so-called Paris Biota, a highly
52 diversified fossil assemblage documenting an unexpectedly rapid post-Permian recovery of
53 complex marine ecosystems (Brayard et al. 2017). The new ophiuroid allows for the
54 elucidation of at least a small part of the insufficiently known Triassic ophiuroid fossil
55 record.

56

57 **2. Geological context**

58

59 The described specimens were collected from the Early Triassic outcrops near the city of
60 Paris, southeastern Idaho, USA, that exposes thin-bedded mudstones of the Lower Shale unit
61 within the Lower Triassic Thaynes Group. The strata yielding the ophiuroid specimens were
62 dated to the early Spathian based on ammonoid and conodont evidence. The depositional
63 setting is interpreted as a distal upper offshore environment on a flat platform above storm-
64 wave base, originally in a near equatorial position on the western margin of Pangea. For
65 details of the geological setting of the ophiuroids, see Brayard et al. (2017).

66

67 **3. Material and Methods**

68

69 The described specimens are housed in the collections of the Université de Bourgogne, Dijon,
70 France (acronym UBGD). Part of the paratype specimen was detached from the slab,
71 mounted on an aluminium stub and gold-coated for scanning electron microscopy using a
72 Jeol Neoscope JMC-5000. Terminology follows Stöhr et al. (2012), Thuy and Stöhr (2011)
73 and Thuy and Stöhr (2016), and higher systematic classification follows O'Hara et al. (in
74 press).

75

76 **4. Systematic paleontology (B. Thuy)**

77

78 Class OPHIUROIDEA Gray, 1840

79 Subclass MYOPHIUROIDEA Matsumoto, 1913

80 Infraclass METOPHIURIDA Matsumoto, 1913

81 Superorder OPHINTEGRIDA O'Hara et al., in press

82 Order OPHIACANTHIDA O'Hara et al., in press

83 Suborder OPHIODERMATINA Ljungman, 1867

84

85 Genus *Shoshonura* nov. gen.

86

87 **Derivation of the name:** Name formed to honour the Shoshoni Native American tribe who
88 originally inhabited the southeastern part of Idaho where the fossil ophiuroid was discovered.

89

90 **Type species:** *Shoshonura brayardi* sp. nov., monotypic.

91

92 **Species included:** only the type species.

93

94 **Occurrence:** Paris Canyon, Bear Lake County, Idaho.

95

96 **Diagnosis:** as for species.

97

98 *Shoshonura brayardi* nov. sp.

99 Figs. 1-4

100

101 **Derivation of the name:** Species named in honour of Arnaud Brayard (Dijon, France) who
102 drew my attention to the new ophiuroid described herein, and who skillfully coordinated the
103 compilation of evidence from various taxonomic groups, including the ophiuroids, to unravel
104 the big picture behind the extraordinary Paris Biota.

105

106 **Type material:** Holotype UBGD 305651 (Fig. X-Y); A single paratype: UBGD 305652 (Fig.
107 X-Y);

108

109

110 **Type locality and horizon:** Paris Canyon, west of the city of Paris, Bear Lake County,
111 Idaho, United-States of America; Early Triassic, earliest Spathian (after Brayard et al., 2017).

112

113 **Occurrence:** only known as yet from the type locality.

114

115 **Diagnosis:** Large ophiuroid with disc interradii covered by minute spherical granules; two
116 genital slits per interradius, no genital papillae; single apical oral papilla; ventral midline of
117 arms depressed, forming a shallow radial furrow; proximal ventral arm plates with deeply
118 concave lateral edges bordered by an elevated ridge; tentacle pores rapidly decreasing in size
119 from proximal to median segments and reduced to within-plate perforations in distal
120 segments; lateral arm plates thick, with finely meshed stereom devoid of conspicuous
121 ornamentation on outer surface; at least five spine articulations sunken in depressions of
122 distal lateral arm plate portion in proximal arm segments; spine articulations composed of
123 proximally merged dorsal and ventral lobes forming an oblique horse-shoe-shaped ridge

124 encompassing small muscle and nerve openings; arm spines thick, conical, as long as half an
125 arm segment.

126

127 **Description:** Large, articulated specimen exposing the ventral side (Fig. 1), disc diameter of
128 14 mm; disc round, interradial areas convex and with small, rounded scales covered by
129 minute spherical granules (Fig. 2A-B). Two genital slits per interradius, approximately
130 equaling one third of the disc radius in length, no papillae or modified granules discernible on
131 edge of genital slit. One abradial genital plate visible in ventral view (Fig. 2C), long, sabre-
132 like with widened distal portion and straight to slightly convex adradio-distal edge, no groves
133 or perforations discernible.

134 Oral shields small (Fig. 2A-B), equaling one sixth of the disc radius in length, with nearly
135 right, rounded proximal angle and slightly narrower rounded, square-like distal portion.

136 Adoral shields (Fig. 2A-B) with a pointed proximal tip and a wider distal portion, densely
137 covered by granules extending on the edges of the oral shields. Jaws (Fig. 2A-B) slender and
138 elongate, covered by granules, bearing a single conical apical oral papillae; at least four
139 lateral oral papillae, the proximal ones conical and slightly larger than apical oral papillae,
140 and the median ones elongate with oblique distal tip and two to three times larger than apical
141 oral papillae; distalmost lateral oral papillae not unambiguously discernible. Second oral
142 tentacle openings and first and second ventral arm plates concealed by matrix.

143 Five arms completely preserved from the base to the tip, evenly tapering, composed of up to
144 53 segments each. Ventral midline of arms (Fig. 2D) slightly sunken and concealed by matrix
145 in most proximal to median segments; ventral arm plates separating lateral arm plates in arm
146 segments covered by disc and in the proximalmost quarter of the remaining arm segments;
147 proximal ventral arm plates widest distally (Fig. 2D), with slightly convex distal edge, deeply
148 concave lateral edges bordered by an elevated ridge, and obtuse proximal angle; median

149 ventral arm plates devoid of ridge bordering lateral edges. Ventral arm plates rapidly
150 decreasing in size from proximal to median arm segments, reduced to minute, round plates in
151 distal segments. Tentacle openings within disc and in proximalmost free arm segments very
152 large, covered by at least three small, rounded, elongate tentacle scales (Fig. 2D) on tentacle
153 notch of lateral arm plate and at least one slightly smaller, round tentacle scale at lateral edge
154 of ventral arm plate; tentacle pores reduced to small between-plate openings (Fig. 3D) in
155 median arm segments, and to within-plate perforations in distal segments.

156 Lateral arm plates thick (Fig. 3A), with ventro-distal tip prominent with respect to the ventral
157 arm surface; proximal edge lined by shallow dorso-ventral groove, presence of spurs
158 unknown; outer surface of lateral arm plates with finely-meshed stereom devoid of
159 conspicuous ornamentation; distal portion of lateral arm plates bulging; spine articulations
160 (Fig. 3B) sunken in depressions of distal lateral arm plate portion, evenly spaced, at least five
161 in proximal segments and four in median ones; spine articulations composed of slender,
162 evenly arched and proximally merged dorsal and ventral lobes forming an oblique horse-
163 shoe-shaped ridge encompassing small muscle and nerve openings; arm spines approximately
164 equal-sized, conspicuously thick, conical, pointed, as long as half an arm segment. Proximal
165 lateral arm plates with deeply concave tentacle notch lined by a shallow groove (Fig. 2D);
166 tentacle notch rapidly decreasing in size from proximal to median arm segments, and
167 replaced by within-plate perforation in distal arm segments.

168

169 **Paratype supplements:** UBGD 305652 is an articulated arm portion (Fig. 4A) associated
170 with external molds of two further arms, all preserving median to distalmost segments,
171 situated on the edge of the slab with the holotype specimen. The physically preserved
172 articulated arm portion exposing the ventral side and showing a median to distal arm
173 morphology similar to that seen in holotype specimen. Scanning electron microscopy of

174 median arm segments corroborating the absence of conspicuous outer stereom ornamentation
175 on the outer surface of the lateral arm plates and the arm spines. Arm spine articulations (Fig.
176 4B) forming an oblique horse-shoe-shaped ridge composed of slender, evenly arched dorsal
177 and ventral lobes proximally merged by a lower, less sharply defined ridge, encompassing
178 small muscle and nerve openings. Single, large, leaf-shaped tentacle scale.

179

180 **5. Discussion**

181

182 The specimens described herein add to the rather long list of ophiuroid occurrences known
183 from the Early Triassic (e.g. Chen & McNamara 2006; Twitchett et al. 2005). The new
184 material stands out, however, when it comes to body size; with a disc diameter of 14 mm, the
185 holotype specimen by far exceeds all other currently known Lower Triassic ophiuroids
186 (Twitchett et al. 2005). With respect to skeletal morphology, exhaustive comparison with
187 previously described species is hampered by the superficial state of knowledge of most Early
188 Triassic ophiuroids (e.g. Chen & McNamara 2006). Nevertheless, judging from the amount
189 of information available, none of the currently known species shows a radial depression on
190 the ventral side of the arms combined with swollen lateral arm plates bearing conspicuously
191 thick, short arm spines. The specimens at hand are thus described as the new genus and
192 species *Shoshonura brayardi* nov. gen. et nov. sp.

193 The higher systematic position of *Shoshonura brayardi* nov. gen. et nov. sp. was briefly
194 outlined in the supplementary materials of Brayard et al. (2017). The most compelling
195 evidence of systematic value is provided by the arm spine morphology, unequivocally
196 placing *Shoshonura* nov. gen. in the order Ophiacanthida. Unfortunately, the holotype and
197 only known complete specimen of *Shoshonura* nov. gen. does not expose the dorsal side,
198 making many characters of diagnostic relevance for the position within the Ophiacanthida

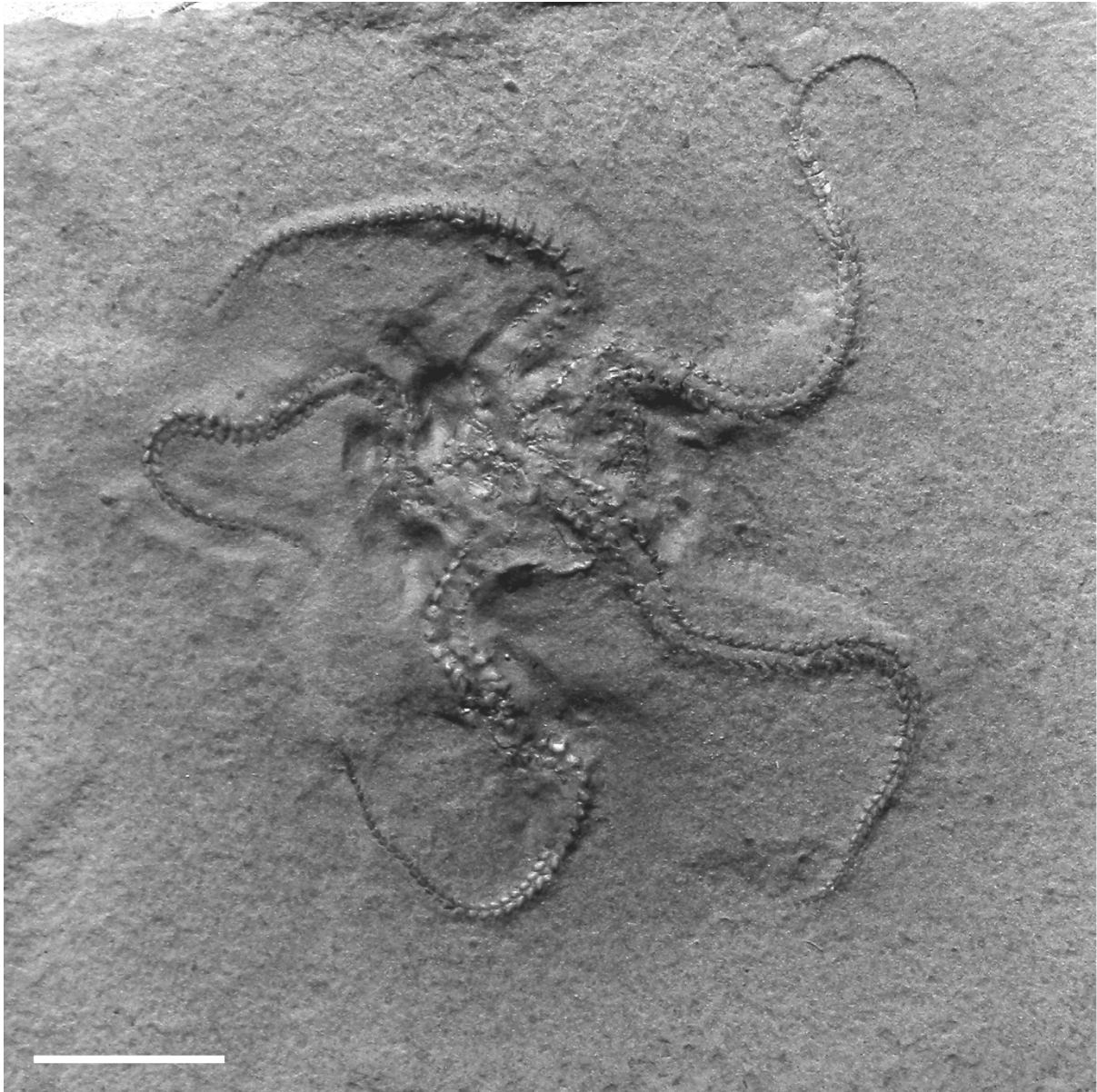
199 inaccessible, at least for the time being. Novel non-destructive techniques, in particular
200 micro-computed tomography, might provide insights into these hidden structures.
201 In spite of these limitations, the morphological evidence available effectively excludes the
202 living members of the suborder Ophiacanthina, especially on account of the short, non-erect
203 arm spines, the thick, non-constricted lateral arm plates and the spine articulations sunken
204 into shallow depressions of the distal lateral arm plate edge. These same characters, in
205 contrast, strongly favour assignment to the suborder Ophiodermatina. However, because
206 crucial features of the dorsal disc skeleton are unknown, the family-level position of
207 *Shoshonura* is left open for the time being. The radial furrow along the ventral midline of the
208 arms and the tentacle openings developed as within-plate perforations in distal arm segments
209 seem to represent plesiomorphic character states (Thuy et al. 2015), suggesting a basal
210 position of *Shoshonura* nov. gen. within the Ophiodermatina. These character states are
211 unknown from any living member of the Ophiodermatina, and instead favour assignment to a
212 new, extinct family.

213 The existing knowledge of the late Paleozoic and early Mesozoic fossil record of the
214 ophiuroids is too sparse to assess the phylogeny of the early diversification of modern
215 ophiuroid clades. Many more studies, particularly on Early Triassic ophiuroids, are necessary
216 to assess this crucial interval of the ophiuroid evolutionary history. Future works should
217 specifically aim at an exhaustive analysis of the skeletal features in order to allow for an
218 inclusion in morphology-based phylogenetic estimates.

219

220 **Acknowledgments**

221 B. Thuy thanks Arnaud Brayard (Dijon, France) for providing the opportunity to study the
222 Paris Biota ophiuroids and to include this article in this special volume. Roby Weis
223 (Luxembourg-city, Luxembourg) helped us with the preparation of the type specimen.



224

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228 Clow (Ogden, Utah) for allowing access to the studied exposures.

229

230

231 **References**

232

233 Brayard, A., Krumenacker, L.J., Botting, J.P., Jenks, J.F., Bylund, K.G., Fara, E., Vennin, E.,
234 Olivier, N., Goudemand, N., Saucède, T., Charbonnier, S., Romano, C., Doguzhaeva, L.,
235 Thuy, B., Hautmann, M., Stephen, D.S., Thomazo, C., Escarguel, G., 2017. Unexpected
236 Early Triassic marine ecosystem and the rise of the Modern evolutionary fauna. *Science*
237 *Advances* 3, e1602159.

238

239 Broglio Loriga, C., Berti Cavicchi, A., 1972. *Praeaplocoma hessi* n. gen., n. sp., un Ofiura
240 del Werfeniano (Trias Inferiore) del Gruppo della Costabella, Dolomiti. *Memorie*
241 *Geopaleontologiche dell' Universita di Ferrara* 2(1), 185-197.

242

243 Chen, Z. Q., McNamara, K. J., 2006. End-Permian extinction and subsequent recovery of the
244 Ophiuroidea (Echinodermata). *Palaeogeography, Palaeoclimatology, Palaeoecology* 236(3-
245 4), 321-344.

246

247 Chen, Z.Q., Shi, G.R., Kaiho, K., 2004. New ophiuroids from the Permian/Triassic boundary
248 beds of South China. *Palaeontology* 47, 1301-1312.

249

250 Detre, C., Mihály, S., 1987. Két Újabb Ophiuroida Lelet A Balaton-Felvidék Triászából. A
251 Magyar Állami Földtani Intézet Évi Jelentése Az 1985 1987, 449–452.

252

253 Erwin, D.H., 1993. *The Great Paleozoic Crisis: life and death in the Permian*. Columbia
254 University Press, NewYork.

255

256 Gray, J.E., 1840. Room II. In: *Synopsis of the contents of the British Museum*. British
257 Museum, London.

258

259 Ljungman, A.V., 1867. Ophiuroidea viventia huc usque cognita. Öfversigt af Kungliga
260 Vetenskaps-Akademiens Förhandlingar 1866 23, 303–336.

261

262 Matsumoto, H., 1913. Evolutionary history of the class Ophiuroidea and a note on the new
263 classification of the class. Zoological Magazine 25, 521–527. [In Japanese]

264

265 O’Hara T.D., Hugall A.F., Thuy B., Moussalli A., 2014. Phylogenomic Resolution of the
266 Class Ophiuroidea Unlocks a Global Microfossil Record. Current Biology 24, 1874–1879.

267

268 O’Hara, T.D., Stöhr, S., Hugall, A.F., Thuy, B., Martynov, A., in press. Morphological
269 diagnoses of higher taxa in Ophiuroidea (Echinodermata) in support of a new classification.
270 European Journal of Taxonomy.

271

272 Sepkoski, J.J. Jr., 1981. A factor analytic description of the Phanerozoic marine fossil record.
273 Paleobiology 7, 36–53.

274

275 Stöhr S., O’Hara T.D., Thuy B., 2012. Global diversity of brittle stars (Echinodermata:
276 Ophiuroidea). PLoSOne 7(3), e31940

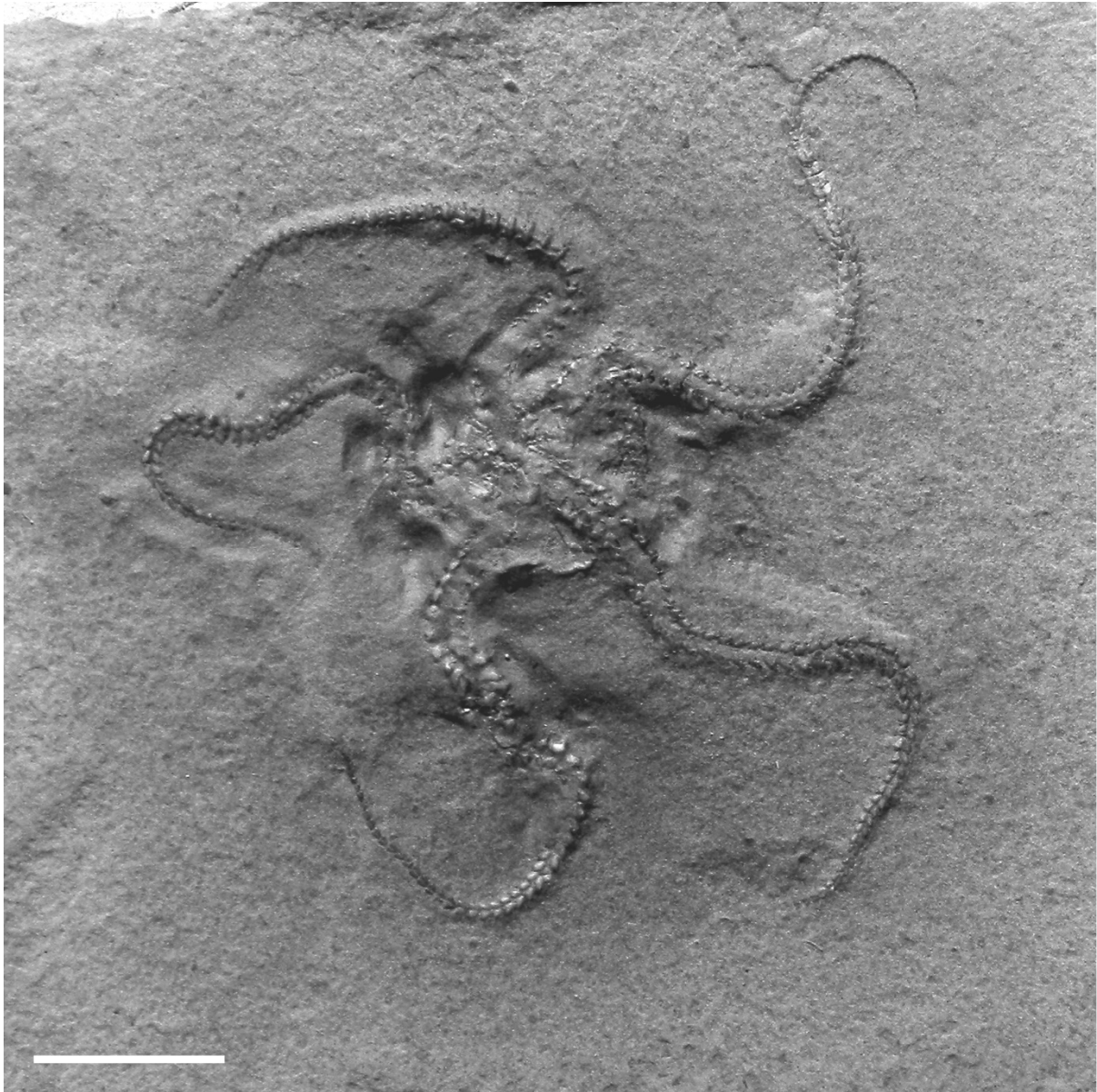
277

278 Thuy B., Stöhr S., 2011. Lateral arm plate morphology in extant brittle stars (Echinodermata)
279 and its application in micropalaeontology. Zootaxa 3013, 1–47.

280

281 Thuy B., Stöhr S., 2016. A New Morphological Phylogeny of the Ophiuroidea
282 (Echinodermata) Accords with Molecular Evidence and Renders Microfossils Accessible for
283 Cladistics. PLoS ONE 11(5), e0156140.
284
285 Thuy, B., Kutscher, M., Płachno, B., 2015. A new brittle star from the early Carboniferous of
286 Poland and its implications on Paleozoic modern-type ophiuroid systematics. Acta
287 Palaeontologica Polonica 60(4), 923-929.
288
289 Twitchett, R.J., Oji, T., 2005. Early Triassic recovery of echinoderms. Comptes Rendus
290 Paleovol 4, 531-542.
291
292 Twitchett, R.J., Feinberg, J.M., O'Connor, D., Alvarez, W., McCollum, L.B., 2005. Early
293 Triassic Ophiuroids: their Paleoeecology, Taphonomy, and Distribution. Palaios 20, 213-223.
294
295 Villier, L., Brayard, A., Bylund, K.G., Jenks, J., Escarguel, G., Olivier, N., Stephen, D.A.,
296 Vennin, E., Fara, E., in press: *Superstesaster* gen. nov. *promissor* sp. nov., a new starfish
297 (Asteroidea, Echinodermata) from the late middle Smithian (Early Triassic) of Utah (U.S.A.),
298 filling a major gap in the phylogeny of asteroids. Journal of Systematic Palaeontology.
299

300 **Figure captions**

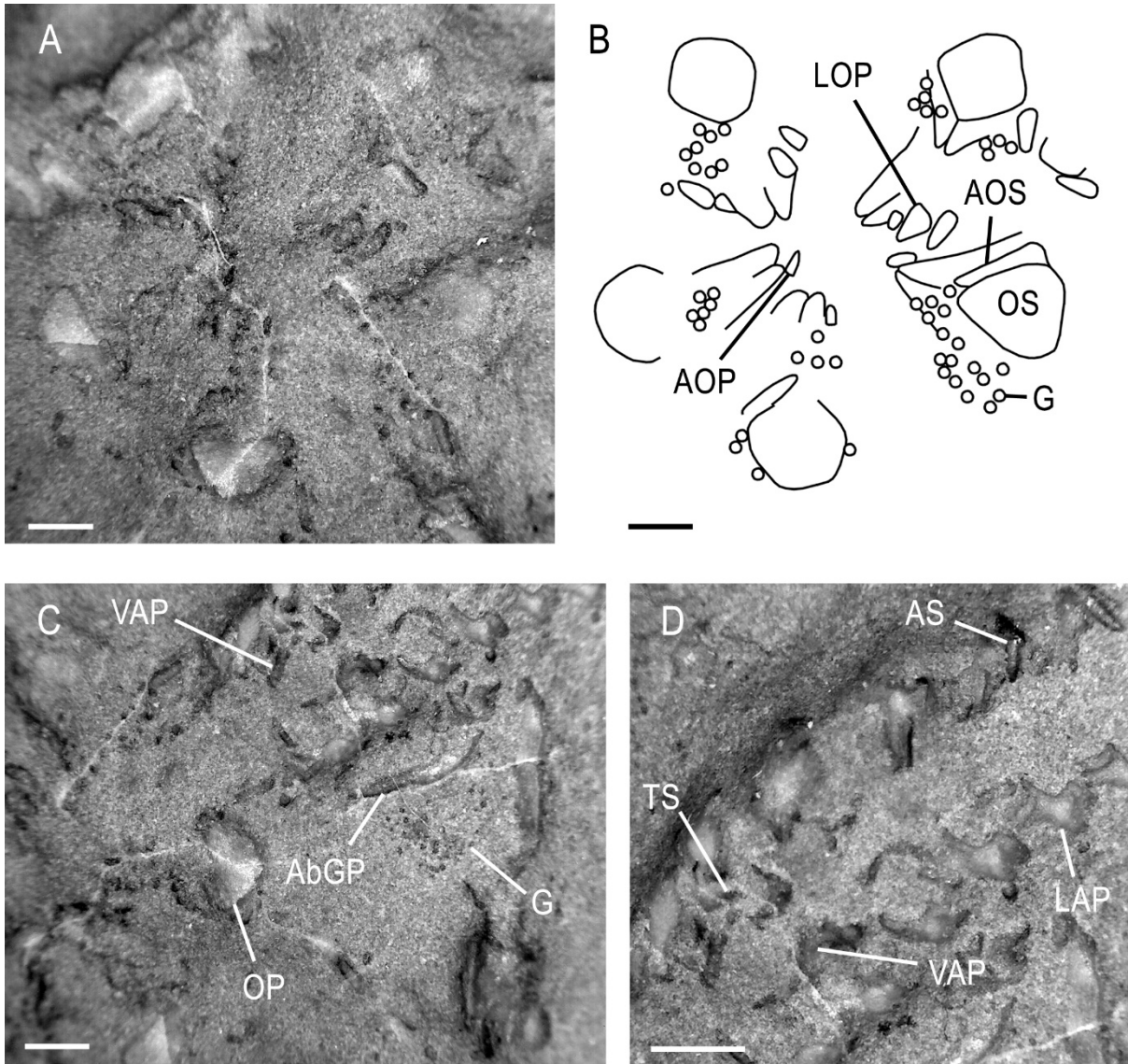


301

302 **Figure 1:** *Shoshonura brayardi* nov. gen. et nov. sp., articulated ophiuroid in ventral view,
303 UBGD 30565 (holotype); Lower Shale unit, Thaynes Group, earliest Spathian, Early Triassic;
304 Paris Canyon, Bear Lake County, Idaho, USA. Scale bar equals 1 cm.

305

306



307

308 **Figure 2:** *Shoshonura brayardi* nov. gen. et nov. sp., details of ophiuroid shown in figure 1,

309 UBGD 30565 (holotype); Lower Shale unit, Thaynes Group, earliest Spathian, Early Triassic;

310 Paris Canyon, Bear Lake County, Idaho, USA. A: detail of mouth plating; B: interpretative

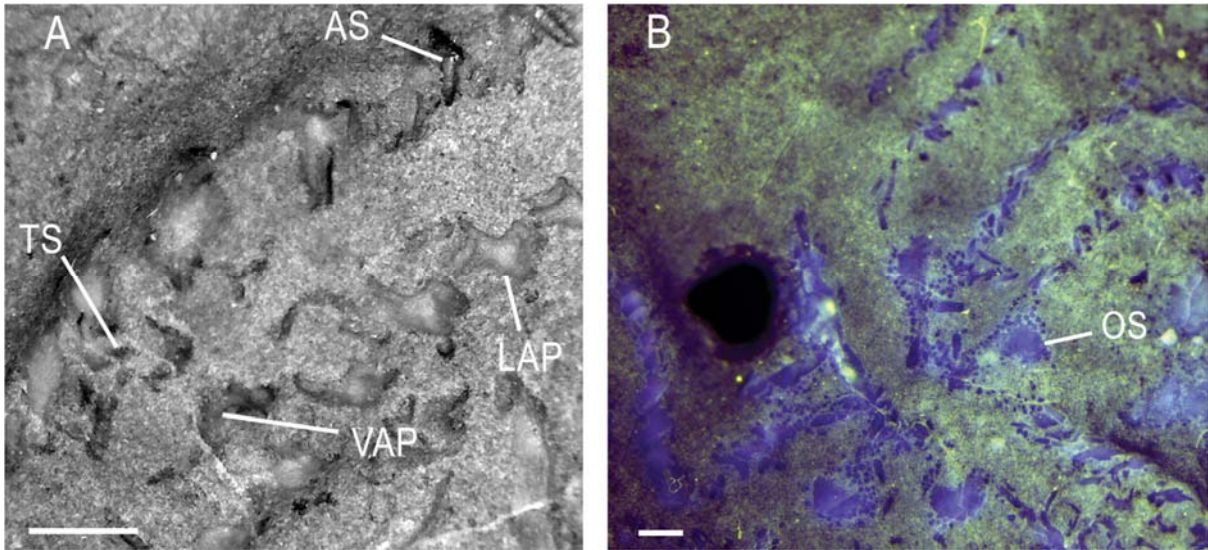
311 drawing of detail shown in A; C: detail of basal arm segments with disc margin; D: detail of

312 basal arm segments. Abbreviations: AbGP: abradial genital plate; AOP: apical oral papilla;

313 AOS: adoral shield; AS: arm spine; G: granule; LAP: lateral arm plate; LOP: lateral oral

314 papilla; OS: oral shield; TS: tentacle scale; VAP: ventral arm plate. Scale bars equal 1 mm.

315



316

317 **Figure. 3.** *Shoshonura brayardi* Thuy nov. gen. et nov. sp., UBGD 30565 (holotype): details

318 of the ophiuroid specimen shown in Fig. 1; Lower Shale unit, Thaynes Group, early

319 Spathian, Early Triassic; Paris Canyon, Bear Lake county, Idaho, USA. A. Detail of basal

320 arm segments. B. 980 × 980-pixel area from a 1024 × 1024-pixel false color RGB

321 composite of the mouth area and basal arm segments. Image was spatially registered and each

322 color corresponds to the following illumination/detection spectral ranges:

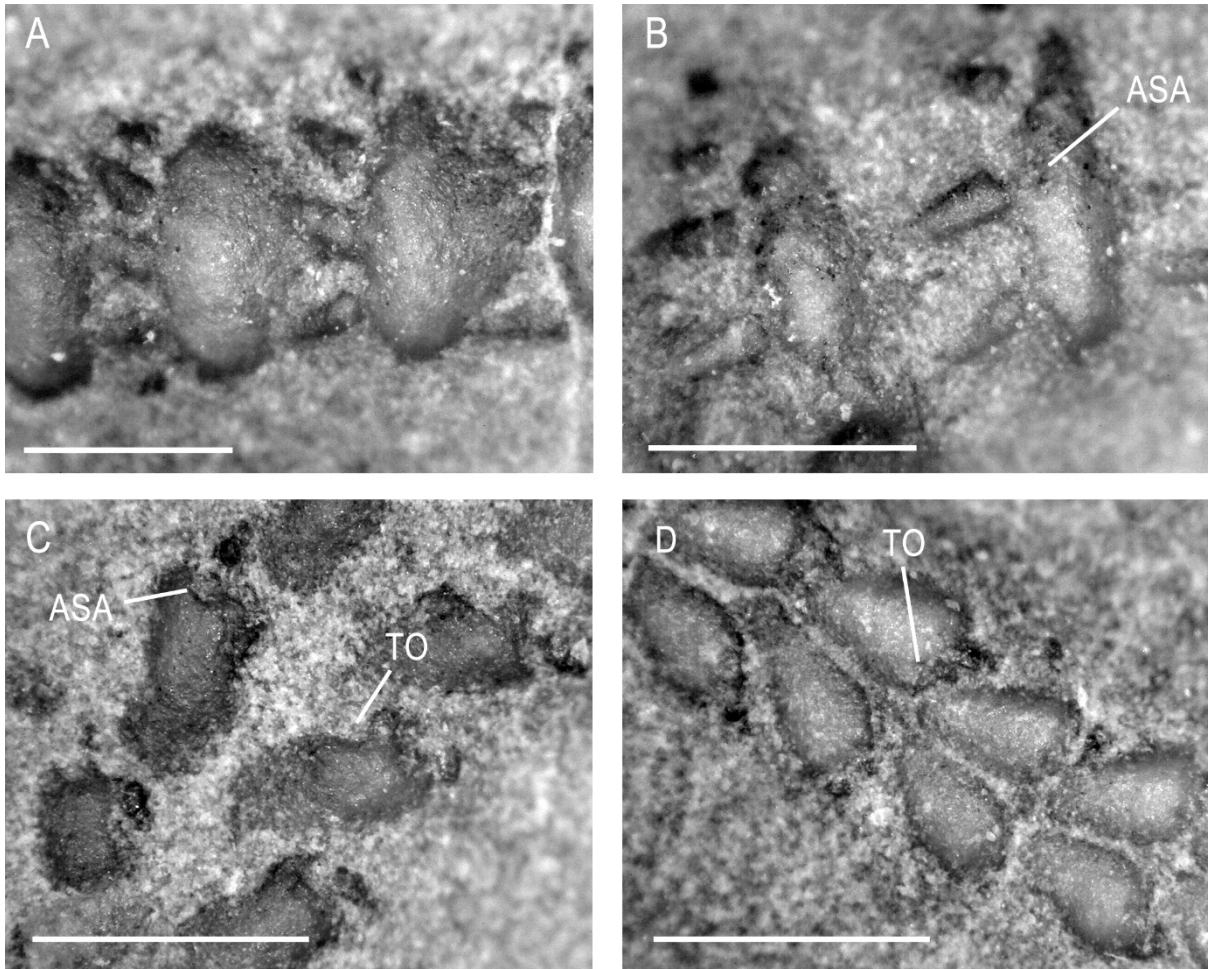
323 blue: 435 nm/435 nm, 70 nm FWHM; green: 385 nm/650 nm, 60 nm FWHM; red: 365

324 nm/650 nm, 60 nm FWHM. Image intensity levels in each channel were adjusted using a

325 Gaussian stretch (ENVI software, EXELIS). Abbreviations: AS: arm spine; LAP: lateral arm

326 plate; OS: oral shield; TS: tentacle scale; VAP: ventral arm plate. Scale bars: 1 mm.

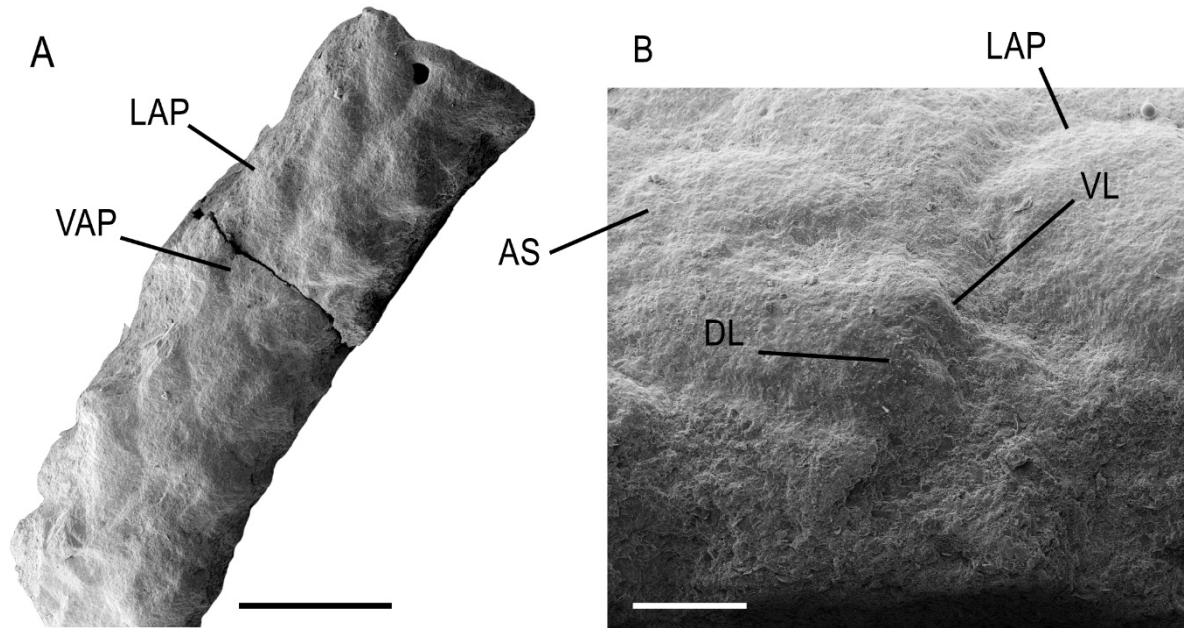
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329

330 **Figure 4:** *Shoshonura brayardi* nov. gen. et nov. sp., details of ophiuroid shown in figure 1,
 331 UBGD 30565 (holotype); Lower Shale unit, Thaynes Group, early Spathian, Early Triassic;
 332 Paris Canyon, Bear Lake county, Idaho, USA. A: proximal arm segments in lateral view; B:
 333 proximal arm segments in lateral view; C: median arm segments in ventral view; D: distal
 334 arm segments in ventral view. Abbreviations: ASA: arm spine articulations; TO: tentacle
 335 opening. Scale bars equal 1 mm.



336

337 **Figure 5:** *Shoshonura brayardi* nov. gen. et nov. sp., ophiuroid arm fragment, UBGD 30566
 338 (paratype); Lower Shale unit, Thaynes Group, earliest Spathian, Early Triassic; Paris Canyon,
 339 Bear Lake County, Idaho, USA. A: arm fragment in ventral view; B: detail of A showing arm
 340 spine articulation in latero-ventral view. Abbreviations: AS: arm spine; DL: dorsal lobe;
 341 LAP: lateral arm plate; VAP: ventral arm plate; VL: ventral lobe. Scale bars: 500 μ m (A),
 342 200 μ m (B).