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**Late Carnian (Tuvalian, Tropites dilleri zone) ostracods
(Crustacea) from the Mufara Formation (Monte
Scalpello, Central-Eastern Sicily, Italy)**

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1 Late Carnian (Tuvalian, *Tropites dilleri* zone) ostracods (Crustacea) from the Mufara
2 Formation (Monte Scalpello, Central-Eastern Sicily, Italy).

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4

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11

12 **Abstract**

13 Ostracod association from the Upper Triassic (*Tropites dilleri* zone of the Carnian stage) of
14 the sedimentary succession (Mufara Formation) exposed along the east side of Monte Scalpello
15 (Catenanuova, central eastern Sicily) have been studied for the first time. The specimens, silicified,
16 are rare but well preserved and often consist of complete carapaces. They belonging to eight
17 families: Healdiidae, Cavellinidae, Bairdiidae, Acratiidae, Bythocyprididae, Pontocyprididae,
18 Judahellidae, Glorianellidae.

19 Twenty - three taxa have been listed; the family Bairdiidae is the most represented among all
20 the others with fifteen species. Four species are new: *Bairdia scaliae* n. sp., *Acratia maugerii* n. sp.,
21 “*Anchistrocheles*” *gemellaroi* n. sp. and *Judahella?* *montanarii* n. sp. Other species are left in
22 open nomenclature because of the lack of specimens.

23 **Résumé**

24 L'association d'ostracodes de la succession sédimentaire du Trias supérieur (Carnien,
25 *Tropites dilleri* zone, Mufara Formation) affleurant du côté oriental du Monte Scalpello
26 (Catenanuova, Sicile centre-orientale) a été étudiée pour la première fois. Les spécimens, silicifiés,

27 sont rares mais bien conservés et se composent souvent de carapaces complètes. Les espèces
28 appartiennent à huit familles: Healdiidae, **Cavellinidae**, Bairdiidae, Acratiidae,
29 Bythocyprididae, Pontocyprididae, Judahellidae, Glorianellidae. La famille Bairdiidae est la plus
30 représentée avec quinze espèces sur les vingt-trois répertoriées. Quatre espèces sont nouvelles:
31 *Bairdia scaliai* n. sp., *Acratia maugeri* n. sp., "*Anchistrocheles*" *gemmellaro* n. sp. et *Judahella?*
32 *montanarii* n. sp. D'autres espèces sont laissées en nomenclature ouverte.

33 **Keywords:** Ostracods: Late Triassic, Neo-Tethys, Central-Eastern Sicily, Mount Scalpello, Mufara
34 Formation, palaeoenvironmental reconstruction, new species.

35 **Mots-clefs:** Ostracodes: Trias supérieur, Néotéthys, Sicile centre-orientale, Mont Scalpello,
36 Formation Mufara, paléoenvironnement, nouvelles espèces.

37

38 1. INTRODUCTION

39 After the first studies on Mesozoic sediments cropping out in the Monte Scalpello area
40 carried out since the early 19th century ([Calcara, 1840, 1845](#); [Nelli, 1899a, b](#); [Marinelli, 1899](#);
41 [Gemmellaro, 1860, 1904](#)), the Upper Triassic fauna of "Clay-calcareous-arenaceous alternation"
42 ("Flysch Carnico" *Auct.*), best referring to the "Mufara Formation" ([Schmidt di Friedberg and](#)
43 [Trovò, 1962](#)) of the "Monte Judica Group" (Scalia, 1909) have been the subject of numerous
44 palaeontological detailed studies on invertebrates: the molluscs have been studied by [Scalia \(1907,](#)
45 [1909, 1910, 1912, 1914\)](#), the cnidaria by [Maugeri Patanè \(1934\)](#), the ammonites by [Lentini \(1974\)](#),
46 the foraminifers, chaetetids, sphinctozoans and other organisms by [Carrillat and Martini \(2009\)](#).

47 So far, ostracods (Crustacea) coming from the Mufara Formation in the Monte Scalpello
48 area never have been studied; the only references to these organisms are found in [Lentini \(1974\)](#)
49 which refers about a high level of the Mufara Formation rich in *Bairdiidae* and in [Carrillat and](#)
50 [Martini \(2009\)](#) which cite, only the presence of this organisms.

51 The present paper, therefore, wants to be a first contribution to the knowledge of the
52 ostracod fauna of the Mufara Formation clays outcropping in the Monte Scalpello area.

53 Furthermore, this analysis is an important step in the knowledge of the recovery of ostracod fauna
54 after the Permian – Triassic massive extinction. The data on Middle and early Late Triassic are rare.

55

56 **2. MATERIALS AND METHODS**

57 Monte Scalpello is located (Fig. 1) in central eastern Sicily in the right side of Dittaino
58 River

59

60 Fig. 1. Geographical location of the sampling area. Localisation géographique de la zone d'étude.

61

62 to the south east of the town of Catenanuova (EN), 40 Km west of Catania (F 633 IV NO of the
63 Carta d'Italia alla scala 1: 25.000). It is inserted, as part of the “Monte Judica Units” (Lentini, et
64 al., 1987), along the northern margin of the Gela Foredeep, in the geodynamic context (Fig. 2) of
65 the southern end of Fig. 2. Structural scheme of the central Mediterranean area with the location of the study area
66 (after Grasso, 2001 modified). Schéma structural de la Méditerranée centrale avec la localisation de la zone d'étude
67 (d'après Grasso, 2001 modifié).

68

69 the Maghrebian – Sicilian-Southern Apennine nappes and as such, it would dwarf the mildly
70 folded foreland (Hyblean Plateau) (Lentini et al., 1987; Grasso, 2001 inter alias).

71 The Monte Scalpello area is lithologically characterized by a Mesozoic-Cainozoic sediments
72 complex belonging to the so-called Imerese Succession (Lentini et al., 1987; Montanari, 1987; inter
73 alias) or Imerese-Sicano Succession (Carrillat and Martini, 2009; Di Paolo et al., 2012). This
74 sedimentary succession settled inside the pelagic Imerese Basin which had formed during the Meso-
75 Cenozoic extensional phases and which was delimited by the Panormide Carbonate Platform to the
76 west and the Trapanese Carbonate Platform to the east and to the south (Fig. 3) (Catalano and
77 D'Argenio, 1982; Montanari, 1987; Speranza and Minelli, 2014).

78

79 Fig. 3. Schematic palaeogeographic reconstruction of Pangaea and Neo-Tethys in Late Triassic times (after Speranza &
80 Minelli (2014), Golonka, 2007 and Preto et al., 2010 modified). Reconstruction paléogéographique schématique de la
81 Pangée et de la Néo-Téthys à la fin du Trias (d'après Speranza & Minelli, 2014; Golonka, 2007 et Preto et al., 2010
82 modifié).

83

84 The Imerese Basin, therefore, is represented by the transitional pelagic facies between the
85 Panormide and Trapanese shelf facies, on the one hand, and the bathyal facies of the Neo-Tethys,
86 on the other (Fig. 3).

87 The Imerese succession of Monte Scalpello (Fig. 4) starts with the “Carnian Flysh”
88 (Auctorum) or, according to [Schmidt di Friedberg and Trovò \(1962\)](#), the Mufara Formation. This
89 unit, outcropping in the southern slopes of the mount, is prevalently constituted by dark grey clays
90 rich in ammonites with rare interbedded levels of fossiliferous calcarenites and fibrous calcite with
91 *Halobia* spp. imprints.

92

93 Fig. 4. Geological map of the Monte Scalpello area (after Lentini, 1974 and Di Paolo et al. 2012, modified). Carte
94 géologique de la région de Monte Scalpello (d'après Lentini, 1974 and Di Paolo et al. 2012, modifié).

95

96 The detailed stratigraphic attribution of Mufara Formation has been the subject of different
97 opinions since the beginning of the twentieth century; [Calcara, 1841, 1845](#); [Nelli \(1899a, b\)](#),
98 [Gemmellaro \(1904\)](#), [Scalia \(1907; 1909; 1910 – 1914\)](#), [Maugeri Patanè \(1934\)](#), [Lentini \(1974\)](#) and
99 [Dal Sasso et al. \(2014\)](#) assigned these sediments to the Late Triassic (Carnian).

100

101 [Fig. 5. Carnian Ammonoid zones. \(After Lucas, 2010\). Zones à Ammonoïdés du Carnien \(d'après Lucas,](#)
102 2010)

103

104 [Lentini \(1974\)](#), on the basis of the ammonites fauna found, attributes the lowest levels of
105 Monte Scalpello section, to the *Trachyceras aonoides* ammonite zone of the Early Carnian;

106 nevertheless the presence of *Tropitidae* among the specimens coming out from this levels, excludes
107 that this formation belongs to the Early Carnian (Lucas, 2010; Jenks et al., 2015).

108 The subsequent sedimentary layers are attributed, again by Lentini (1974), to the *Tropites*
109 *subbullatus* zone; nevertheless the contemporary presence of specimens of *Trachyceratidae*
110 (?*Neoprotrachyceras*, *Trachysagenites*, *Pamphagosirenites*) found by the authors of the present
111 paper, and specimens of *Tropitidae*, suggests that both this fossiliferous horizons can be referred to
112 the *Tropites dilleri* zone (Lucas, 2010; Jenks et al., 2015). A confirmation of this datum comes from
113 Carrillat and Martini (2009) who, mostly on the basis of the foraminifers, refers the same clays of
114 Mufara Formation outcropping at Monte Gambanera, nine kilometers to the south of the studied
115 area, to the upper part of the Late Carnian (*Tropites subbullatus*/*Anatropites spinosus* zones).
116 According to Jenks et al. (2015) the base of Tuvalian Substage (upper part of the Carnian Stage) is
117 characterized by the appearance and radiation of the *Tropitidae*. Therefore the presence of
118 *Tropitidae* reported already by Gemmellaro (1904), Scalia (1909) and Lentini (1974) remove all
119 doubts about the attribution of this sedimentary levels out cropping, to the Tuvalian substage (Late
120 Carnian, *Tropites dilleri* zone) (Fig. 5).

121 Over the Mufara Formation follow conformably the Upper Triassic cherty limestone with
122 *Halobia*, the Jurassic - Cretaceous radiolarian cherts and unconformably the Eocene - Oligocene
123 limestone ("Scaglia"). The stratigraphic sequence is finally closed by Oligocene - Miocene clays
124 and glauconitic sandstones.

125 For the present work twenty kilograms of sediments were collected from one stratigraphic
126 level of the Mufara Formation cropping out in contrada Paraspora, two hundred meters southwest
127 of Masseria Mannino (37°32'56.86''N; 14°40'30.64''E) along the east side of Monte Scalpello,
128 (Figs. 1, 4). Sediments were routinely washed, dried in oven and sieved. Then, ostracod specimens
129 were picked out from the > 63µm fraction. The ostracod specimens were examined and measured
130 under a stereomicroscope, then photographed under an LMU Tescan Vega II SEM. The material is
131 housed in the Palaeontological Museum of the University of Catania. The repository number of the

132 holotypes and the paratypes are given in the systematic descriptions.

133

134

135 **3. RESULTS**

136 The sample taken results to be constituted mostly by pelitic sediments, indeed almost the
137 entire sediment is passed over the 63µm sieve. The poor washing residue (about 100 grams)
138 provided in order of abundance, gastropods, brachiopods, bivalves and crinoids, echinoids skeletal
139 fragments and small size ammonites. Microfauna is very poor in foraminifers represented
140 prevalently by the genera *Glomospira* and *Hemidiscus*; ostracods, the majority of which is
141 constituted by juvenile forms, are relatively abundant.

142

143

144 **Systematic palaeontology**

145 Ostracods from a sample of clay of the Mufara Formation taken at the base of Monte
146 Scalpello are systematically listed. The specimens belong to the Order Metacopida Sylvester-
147 Bradley, 1961 and Podocopida Sars, 1866, and eight families Healdiidae Harlton, 1933,
148 Cavellinidae Egorov, 1950, Bairdiidae Sars, 1866, Acratiidae Gründel, 1962, Bythocyprididae
149 Maddocks, 1969, Pontocyprididae Müller, 1894, Judahellidae Sohn, 1968, Glorianellidae Snejder,
150 1960.

151 Abbreviations. L: length; H: height; T: thickness; RV: right valve; LV: left valve; DB:
152 dorsal border; VB: ventral border; AB: anterior border; PB: posterior border; PVB: postero-ventral
153 border; AVB: antero-ventral border; PDB: postero-dorsal border; PVB: postero-ventral border.

154

155 Class Ostracoda Latreille, 1806

156 Order Metacopida Sylvester-Bradley, 1961

157 Suborder Metacopina Sylvester-Bradley, 1961

158 Superfamily Healdioidea Harlton, 1933

159 Family Healdiidae Harlton, 1933

160 Genus *Ogmoconchella* Gründel, 1964 emend Michelsen, 1975

161 Type species: *Healdia aspinifera* Drexler, 1958

162 *Ogmoconchella felsooersensis* (Kozur, 1970)

163 Fig. 6 a - b

164 1970 *Healdia (Healdia) felsooersensis* n. sp. - Kozur, p. 409, pl. 3, fig. 13, pl.4, figs; 1 - 6

165 1995 “*Hungarella*” *felsooersensis* (Kozur, 1970) – Monostori, p. 40 - 41, pl. 1, figs. 2 - 4

166 1996 *Healdia (Healdia) felsooersensis* Kozur, 1970 - Crasquin-Soleau and Gradinaru, pl. 9,

167 fig. 14

168 2013 *Healdia (Healdia) felsooersensis* Kozur, 1970 - Sebe et al., pl. 4, fig. 14

169 2013 *Hungarella problematica* (Méhes, 1911) - Monostori and Toth, p. 308, Pl. 4, Figs. 14 -

170 17

171 **Material:** 2 complete carapaces.

172 **Dimensions** (figured specimen): L= 790-810 µm; H= 580 µm; T= 380 µm.

173 **Stratigraphic and geographic range:** Early Anisian of Felsőörs, Balaton Highland,

174 Hungary (Kozur, 1970, Monostori, 1995), Early Anisian of Dobrogea, Romania (Sebe et al., 2013),

175 Late Carnian (*Tropites dilleri* zone), Mufara Formation outcropping in the east side of Monte

176 Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this work).

177 **Remarks:** A great confusion exists in the systematics of Late Permian – Triassic Healdiidae
178 genera *Hungarella* – *Ogmoconcha* – *Ogmoconchella*.

179 Some authors consider *Hungarella* Méhes, 1911 (which has not type material –Monostori,
180 1995, p. 40) and *Ogmoconcha* Triebel, 1941 as synonyms (Moore, 1961; Anderson, 1964). Shaver (*in*
181 Moore 1961) and Sohn (1968) don't agree with this synonymy. In fact the two genera are extremely

182 close. The third genus *Ogmoconchella* was introduced by [Gründel \(1964\)](#) and emended later by
183 [Michelsen \(1975\)](#) mainly on the presence of a spine at PVB. We use here this character to attribute the
184 species *felsooersensis* to *Ogmoconchella*.

185

186 Genus *Healdia* Roundy, 1926

187 Type species *Healdia simplex* Roundy, 1926

188 *Healdia?* sp.

189 Fig. 6 c - d

190 **Material:** 2 complete carapaces.

191 **Dimensions:** fig. 6c:L = 660 µm; H = 580 µm; fig.6d: L= 680 µm, T = 310 µm.

192 **Stratigraphic and geographic ranges:** Late Carnian (*Tropites dilleri* zone), Mufara

193 Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E),

194 Sicily, Italy (this work).

195 **Remarks:** In right lateral view, the carapace has all the characteristics of the genus *Healdia*.

196 However the dorsal view is very far from this genus. Indeed, here the carapace is biconvex with a

197 maximum of thickness at mid-L (in *Healdia* genus the posterior part of the carapace is truncated)

198 and here there is only one spine at RV (in *Healdia* genus spines are present at PVB of both valves)

199 As far as the muscle scars cannot be observed, the figured specimens are dubiously attributed to the

200 genus *Healdia*.

201 Superfamily Cavellinoidea Egorov, 1950

202 Family Cavellinidae Egorov, 1950

203 Genus *Bektasia* [Özdikmen, 2010](#)

204 Type species. *Reubenella avnimelechi* [Sohn, 1968](#)

205 *Bektasia* sp.1

206 Fig. 6 e

207 **Material:** 1 carapace.

233 **Stratigraphic and geographic range:** Early Carnian of South Tirol, Italy ([Kristan-](#)
234 [Tollmann, 1976; 1978](#)), Late Carnian (*Tropites dilleri* zone; this work), Rhaetian of Austrian Alps
235 ([Kristan-Tollmann, 1970](#)) and Central Iran ([Kristan-Tollmann, 1979](#)).

236 **Remarks:** the Triassic genus *Hiatobairdia* [Kristan-Tollmann, 1970](#) and the Permian genus
237 *Kempfina* Crasquin, 2010 (in [Crasquin et al., 2010](#)) differ from other bairdiidae by the “acratian
238 beak” at AVB, and the two symmetric valves. The surface of the carapace is often punctuated.

239 *Hiatobairdia subsymmetrica* is characterized by its fine ridge underling the VB, a H/L = 0.53 –
240 0.56; the dorsal outline biconvex and the regularly punctuated carapace.

241

242 Genus *Bairdia* M'Coy, 1844

243 Type species *Bairdia curta* M'Coy, 1844

244 *Bairdia cf. humilis* Monostori, 1995

245 Fig. 6 i - j

246

247 **Material:** 2 complete carapaces

248 **Dimensions:** specimen figured in fig. 6 i: L = 1280 µm; H = 580 µm

249 **Stratigraphic and geographic range:** Late Carnian (*Tropites dilleri* zone). Mufara

250 formation outcropping in the east side of Monte Scalpello (Lat. 37°32'56.86''N; Long.

251 14°40'30.64''E), Sicily, Italy (this work)

252 **Remarks:** The present specimens differ from *Bairdia humilis* [Monostori, 1995](#) from Late
253 Anisian of Balaton Highland, Hungary, only by a radius of curvature of AB a little larger here.

254

255 *Bairdia cf. deformata* [Kollmann, 1963](#)

256 Fig. 6 k - l

257 **Material:** 2 carapaces

258 **Dimensions:** specimen figured in fig. 6 k: L = 910 µm; H = 622 µm

284 *dilleri* zone); Mufara Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N;
285 14°40'30.64''E), Sicily, Italy (this work)

286

287

288 ***Bairdia* sp. 1**

289 Fig. 6 n - o

290 **Material:** 2 carapaces

291 **Dimensions:** L = 830 µm; H = 480 µm

292 **Stratigraphic and geographic range:** Late Carnian (*Tropites dilleri* zone), Mufara

293 Formation of east side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this
294 work).

295

296 ***Bairdia balatonica* Méhes, 1911**

297 Fig. 6 p

298 1911 *Bairdia balatonica* n. sp. - Méhes, p. 13 - 14, pl. 1, figs. 8 - 11

299 1911 *Bairdia badayi* n. sp. - Méhes, p. 17 - 18, pl. 1, figs. 29 - 30

300 ?1965 *Bairdia balatonica* Méhes var. 1911 - Széles, p. 414, fig. 4

301 1965 *Bairdia dadayi* Méhes, 1911 - Széles, p. 412 - 413, fig. 1

302 1978 *Bairdia* cf. *balatonica* Méhes - Kristan-Tollmann, p. 81, pl. 1, figs. 1 - 3

303 1995 *Bairdia balatonica* Méhes, 1911 - Monostori, p. 42, pl. 2, fig. 1 (non figs. 2 and 3)

304 2011 *Bairdia balatonica* Méhes, 1911 - Forel and Crasquin, p. 252, fig. 5 A

305 2013 *Bairdia balatonica* Méhes, 1911 - Monostori and Tóth, p. 309, figs. 1 - 5

306 **Material:** 1 carapace

307 **Dimensions:** L = 860 µm; H = 545 µm

308 **Stratigraphic and geographic range:** Spathian - Anisian of South Tibet (Forel and

309 Crasquin, 2011), Anisian (Monostori, 1995), Ladinian (Monostori and Tóth, 2013) and Early

310 Carnian (Méhes, 1911; Széles, 1965;) of Hungary, Early Carnian of Southern Alps, Italy (Kristan-
311 Tollmann, 1978), Late Carnian (*Tropites dilleri* zone). Mufara Formation outcropping in the east
312 side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this work)

313

314 ***Bairdia scaliai* n.sp.**

315 Fig. 6 q - r

316 **Etymology:** The species is named in memory of Salvatore Scalia (1874-1923),
317 palaeontologist at Catania University, for his scientific engagement in the Mesozoic fauna of Monte
318 Scalpello.

319 **Material:** four complete carapaces.

320 **Holotype:** complete carapace figured in Fig. 6 r (PMC. O 17 H 11/4/2017), dimensions: L =
321 740 µm; H = 445 µm

322 **Paratype:** complete carapace figured in Figure 5 q (PMC. O 65-67 P 10/4/2017).

323 **Type locality:** East side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E),
324 Catenanuova, Sicily, Italy

325 **Type horizon:** Late Carnian (*Tropites dilleri* zone) in the dark grey clays of the Mufara
326 Formation.

327 **Diagnosis:** A species of *Bairdia* with compact carapace AB with large radius of curvature,
328 PB short, with small radius of curvature and maximum of curvature located high, all dorsal parts
329 regularly arched, strong overlap at DB.

330 **Description:** Carapace compact (H/L = 0.57 – 0.58); DB regularly arched with PDB, DB
331 and ADB in a regular arc of a circle at LV, ADB slightly concave at RV; AB with large radius of
332 curvature with maximum of curvature located a little below mid - H, a very fine ridge underlines the
333 AB; VB quite horizontal to very slightly concave; PB short, with very small radius of curvature and

334 maximum of curvature located around lower 1/3 of H, presence of the very thin ridge along the PB;
335 bairdiid beak poorly expressed but present; strong overlap of LV on RV along all the dorsal margin
336 with maximum at DB; overlap weak on all other parts of the carapace; surface smooth.

337 **Remarks:** This species is quite different from all the other species recognized in the
338 Triassic. It could be compared to *Bairdia jeancharlesi* Forel, 2011 from the Smithian – Anisian of
339 Tibet (Forel and Crasquin, 2011) but here the PB is shorter and the AB has a larger radius of
340 curvature. *Bairdiacypris triassica* Kozur, 1971 from Late Anisian of Hungary (Kozur, 1971) has the
341 same radius of curvature at PB and AB but L is really greater.

342 **Stratigraphic and geographic range:** Late Carnian of Sicily, Italy.

343
344 *Bairdia cf. finalyi* (Méhes, 1911)

345 Fig. 6 s

346 **Material:** 2 carapaces

347 **Dimensions:** figured specimen L = 858 µm; H = 570 µm

348 **Stratigraphic and geographic range:** Late Carnian (*Tropites dilleri* zone). Mufara
349 Formation in the east side of Monte Scalpello; (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this
350 work).

351 **Remarks:** The present specimens are very close to *Bairdia finalyi* (Méhes, 1911) from the
352 Smithian – Ladinian of Balaton Highland, Hungary (Méhes, 1911; Kozur, 1971; Monostori, 1995),
353 West Carpathians (Salaj and Jendrekova, 1984), Guangxi, South China (Crasquin et al., 2006),
354 Tibet (Forel and Crasquin, 2011). They differ only by a larger radius of curvature of AB here.

355
356 *Bairdia? sp. 2*

357 Fig. 6 t

358 **Material:** 1 carapace

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Fig. 7 a

1960 *Ptychobairdia kristanae* n. g. n. sp. - Kollmann, p. 99 - 100, pl. 25, figs. 6 - 9.

1960 *Ptychobairdia medwenitschi* n. g. n. sp. - Kollmann, p. 101 - 102, pl. 26, figs. 1 - 11.

1963 *Ptychobairdia kristanae* Kollmann - Kollmann, p. 181

Material: 1 carapace

Dimensions: L = 1180 µm; H = 763 µm

Stratigraphic and geographic range: Late Carnian (*Tropites dilleri* zone). Mufara Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E) (this work), Rhaetian - Early Jurassic of Austria (Kollmann, 1960; 1963).

Remarks: The types figured by Kollmann (1960, Pl. 25, figs 6 - 9) have a ventral bulge more pronounced than here but intraspecific variations are very common in bairdiids

Genus *Bairdiacypris* Bradfield, 1935

Type species *Bairdiacypris deloi* Bradfield, 1935

Bairdiacypris cf. *aequisymmetrica* Mette, Honigstein et Crasquin .,2014

Fig. 7 b

Material: 1 incomplete carapace

Dimensions: L = 905 µm; H = 390 µm

Stratigraphic and geographic range: Late Carnian (*Tropites dilleri* zone). Mufara Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this work).

Remarks: the specimen discovered here is quite close to *Bairdiacypris aequisymmetrica* Mette et al., 2014 from the Middle Anisian of Austria (Mette et al., 2014) by the general outline of the carapace. Unfortunately, the PB is broken here and the doubt stays.

Bairdiacypris cf. *mirautae* Crasquin-Soleau and Gradinaru, 1996

411 (Fig. 7 c)

412 **Material:** 1 carapace.

413 **Dimensions:** L = 730 µm; H = 350 µm.

414 **Stratigraphic and geographic range:** Late Carnian (*Tropites dilleri* zone). Mufara Fm.

415 outcropping in the east side of Monte Scalpello (37°32'56.86''N, 14°40'30.64''E) Sicily, Italy (this
416 work).

417 **Remarks:** the specimen discovered here is quite close in general outline to *Bairdiacypris mirautae*
418 Crasquin-Soleau and Gradinaru, 1996 from the Early Anisian of Dobrogea (Romania; Crasquin-
419 Soleau and Gradinaru, 1996) and Ladinian of Hungary (Monostori and Tóth, 2013). Here the
420 carapace is shorter and the PB is less tapering.

421

422 Genus *Anchistrocheles* Brady and Norman, 1889

423 **Type species** *Anchistrocheles fumata* Brady, 1890

424 "*Anchistrocheles*" *gemmellaro* n. sp.

425 Fig. 7 d - f

426 **Etymology:** The species is named in memory of the palaeontologist Gaetano Giorgio
427 Gemmellaro (1832-1904).

428 **Material:** Seven complete carapaces (three adults and four juveniles).

429 **Holotype:** A complete carapace (fig. 7 e), PMC. O 18 H 10/4/2017 (L = 742 µm; H =
430 440µm).

431 **Paratypes:** Two complete carapaces (fig. 7 d: L = 690 µm; H = 420 µm and fig. 7 f: L = 800
432 µm; H = 490) and other not figured (PMC. O 68-73 P 10/4/2017).

433 **Type locality:** East side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy

434 **Type level:** Late Carnian (*Tropites dilleri* zone) in the dark grey clays of the Mufara
435 Formation.

436 **Diagnosis:** A species attributed to “*Anchistrocheles*”, with bairdioid carapace sub
437 trapezoidal, with rows of spines at AB, PVB and PB, flanks parallel in dorsal view.

438 **Description:** Bairdioid carapace sub trapezoidal in lateral view, with DB, PDB and ADB
439 straights at both valves; AB with large radius of curvature; ventral margin concave at both valves;
440 PB short and with a small radius of curvature; AB, PVB and PB strongly compressed laterally,
441 without reticulation and ornamented with marginal spines at both valves; LV overlaps RV all
442 around the carapace with maximum at dorsal parts; In dorsal view, flanks parallel (like in
443 *Orthobairdia* genus), extremities strongly compressed laterally, a small sulcus is observable in front
444 of mid-L; surface reticulated and small tubercles are observed on the surface in ADP and DP.

445 **Remarks:** This species is attributed to the genus “*Anchistrocheles*”. It is clear that is not this
446 genus which is a recent one and for which the specific determinations are made on soft parts. This
447 generic attribution with “?” was used in the past, particularly for Triassic - Jurassic specimens
448 exhibiting row of spines along AB and PB (Carnian, Late Triassic of Turkey ([Forelet et al., 2018](#));
449 Rhaetian, Late Triassic of Austria ([Bolz, 1971](#)), Sinemurian, Early Jurassic of Germany and
450 Switzerland ([Beher et al., 2001](#); [Beher, 2004](#)), Bathonian, Early Jurassic of France ([Sheppard, 1981](#)
451 [PhD MS](#)). A revision of all these species and of the definition of a new genus is in preparation
452 ([Crasquin and Forel](#), work in progress).

453 “*Anchistrocheles*” *gemmellaro* n. sp. could be compared to *Bairdia marginosulcata* Bolz,
454 1971 from the Late Norian – Rhaetian of Austria ([Bolz, 1971](#)) which presents a biconvex carapace
455 in dorsal view and a smaller radius of curvature at AB. The new species is very close from
456 *Anchistrocheles? spinosa* from the Bathonian, Middle Jurassic of North-Western France with the
457 flanks parallel and compressed extremities in dorsal view, with spines along AB and PVB and PB.
458 This species was described and illustrated in the PhD thesis of [Sheppard \(1981\)](#). It seems that this
459 species was never published and is considered here as invalid. “*Anchistrocheles*” *gemmellaro* n.
460 sp. has a AB with larger radius of curvature, and dorsal parts straighter.

461

462 Genus *Nodobairdia* Kollmann, 1963.

463 Type species *Nodobairdia mammillata* Kollmann, 1963

464 *Nodobairdia mammillata* Kollmann, 1963

465 Fig.7 g

466 1963 *Nodobairdia mammillata* n. g. n. sp. - Kollmann, p. 174, pl. 7, figs. 6 - 15

467 1971 *Nodobairdia mammillata* Kollmann, 1963 - Kristan-Tollmann, p. 63, pl. 1, fig. 1

468 1971 *Triebelina (Nodobairdia) triassica* n. sp. - Bolz 1971, p. 216, pl. 16, figs. 229 – 232

469 1978 *Nodobairdia mammillata* Kollmann, 1963 - Kristan-Tollmann, p. 84, pl. 8, figs. 1 - 6

470 **Stratigraphic and geographic range:** Late Ladinian of Alps, Austria (Kollmann, 1963;

471 Kristan-Tollmann, 1971), Late Carnian of Alps, Austria (Kristan-Tollmann, 1978). *Tropites dilleri*

472 zone of the Mufara Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N;

473 14°40'30.64''E) Sicily, Italy (this work); Norian – Rhaetian of Alps, Austria (Bolz, 1971).

474
475 Family Acratidae Gründel, 1962

476 Genus *Acratia* Delo, 1930

477 **Type species** –*Acratia typica* Delo, 1930

478 *Acratia maugerii* n. sp.

479 Fig. 7 h - j

480 1991 *Acratia* sp. -Kristan-Tollmann, p. 196, pl.1, fig. 1

481 2013 *Acratia goemoeryi* (Kozur, 1970) - Monostori and Tóth, p. 6-7, pl. 4, only fig. 2

482 **Etymology:** The species is named in memory of Giuseppe Maugeri-Patanè palaeontologist
483 in Catania University for his scientific engagement in Mesozoic palaeontology.

484 **Material:** Three complete carapaces.

485 **Holotype:** One complete carapace (fig. 7h, j), PMC. O 19 H 10/4/2017 (L = 1110 µm; H =
486 490 µm).

487 **Paratypes:** Two complete carapaces, one figured PMC. O 74 P 10/4/2017 (fig. 7i: L=805
488 μm , H=380 μm).

489 **Type locality:** East side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy.

490 **Type level:** Late Carnian (*Tropites dilleri* zone), Mufara Formation.

491 **Diagnosis:** A new species of *Acratia* with short carapace (H/L = 0.45 – 0.46 for the
492 measured specimens), quite semicircular valves, straight VB and PB a little slender for the genus;
493 acratian beak clearly expressed.

494 **Description:** Carapace short (H/L = 0.45 – 0.46 for the measured specimens), quite
495 semicircular in lateral view with PB more acute and slightly longer than AB. Ventral margin almost
496 straight, anteriorly ending with a pronounced acratian beak. Caudal process acute. Left valve wider
497 than the right. Strong overlap especially in centro-ventral and antero-dorsal margin. Outer surface
498 smooth. Carapace biconvex in dorsal view.

499 **Stratigraphic and geographic range:** Late Ladinian of NE Iran ([Kristan-Tollmann, 1991](#))
500 and Balaton Highland, Hungary ([Monostori and Tóth, 2013](#)) -Late Carnian (*Tropites dilleri* zone),
501 Murfa Formation, Sicily, Italy (this work).

502 **Remarks:** the figured specimens are put in synonymy with *Acratia* sp., from the Late
503 Ladinian from NE Iran ([Kristan-Tollmann, 1991](#)) and one specimen figured by [Monostori and Tóth](#)
504 ([2013](#)) from Ladinian of Balaton Highland, Hungary. *Acratia triassica* [Kozur, 1970](#) (figs. 2—5
505 only, not fig. 1) is very close from the new species. However here the carapace is more rounded in
506 dorsal part with a PB less acuminate.

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508 Family Bythocyprididae Maddocks, 1969

509 Genus *Bythocypris* Brady, 1880

510 Type species *Bythocypris reniformis* Brady, 1880

511 *Bythocypris?* sp. 1

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Fig. 7 k

Material: 1 carapace.

Dimensions: L = 568 μm ; H = 300 μm .

Stratigraphic and geographic range: Late Carnian (*Tropites dilleri* zone), of the Mufara Formation outcropping in the east side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy (this work).

Remarks: a specimen attributed with doubt (this genus is a Recent one defined on soft parts) to the genus *Bythocypris*. It is quite close to *Bythocypris* sp. B in Bolz, 1971 from the Norian - Rhaetian of Austria which has a very similar outline except here a VB more convex. We have not enough material to go further in determination.

Superfamily Cypridoidea Baird, 1845

Family Pontocyprididae Müller, 1894

Genus *Pontocypris* Sars, 1866

Type species *Cypris serrulata* Sars, 1863

***Pontocypris rara* Méhes, 1911**

Fig. 7 l

1911. *Pontocypris rara* n.sp. –[Méhes, 1911](#), p.13, pl. 1, fig.5

Material: 1 carapace.

Dimensions: L = 662 μm ; H = 288 μm .

Stratigraphic and geographic range: Late Carnian of Balaton Highland, Hungary ([Méhes, 1911](#)) and Monte Scalpello (*Tropites dilleri* zone), (37°32'56.86''N, 14°40'30.64''E) Sicily, Italy (this work).

536 Family Judahellidae Sohn, 1968

537 Genus *Judahella* Sohn, 1968

538 Type species *Judahella tsorfatia* Sohn, 1968

539 *Judahella? montanarii* n. sp.

540 Fig. 7 m - n

541 **Etymology:** The species. is named in memory of Loris Montanari geologist in Catania

542 University. **Material:** Two complete carapaces.

543 **Holotype:** A complete carapace figured in Fig. 7m (PMC O 20 H 10/4/2017) (L = 450 µm;
544 H = 200 µm).

545 **Paratype:** A complete carapace figured in fig. 7n (PMC O 76 P 10/4/2017).

546 **Type locality:** East side of Monte Scalpello (37°32'56.86''N; 14°40'30.64''E), Sicily, Italy.

547 **Type level:** Late Carnian (*Tropites dilleri* zone) in the dark grey clays of the Mufara
548 Formation.

549 **Diagnosis:** *Judahella? montanarii* n. sp. is characterized by subrectangular elongate
550 carapace with a long straight DB ended by a caudal process, presence of lateral ridges and tubercles
551 on valve surface.

552 **Description:** Lateral view: small carapace elongate subrectangular (Fig. 7m, n); long
553 straight DB ended by a short caudal process. Upper part of AB straight with an angle of 110° with
554 DB; maximum of convexity of AB located below mid-H; VB slightly convex, surface of valves are
555 ornamented by large ridges and nodes reticulated; dorsal ridges overpass hinge line; the largest and
556 strong ridge is arched and shows variable thickness through its length; it begins in the antero-
557 dorsal margin, moves downwards until reaching the centre of the ventral margin and back again
558 towards the postero-dorsal margin initially curved and then straight and facing forward. Another
559 thinner ridge is present along the outer edge of the anterior margin of the valves. Two stubby
560 nodes are present in the posterior dorsal and in the central anterior area.

561 Dorsal view: hinge line long and straight; caudal process strongly compressed laterally;

562 ridges and nodes very prominent by absence of ventro-lateral swollen process
563 **Remarks:** The new species is attributed to *Judahella*? The doubt comes from the presence of the
564 posterior caudal process never described in the genus. The present specimens could be compared
565 to *Judahella tsorfatia* Sohn, 1968 from the Ladinian of Eastern France (Sohn, 1968) by their
566 similar subrectangular lateral outline. But here the nodes are gathered in ridges and there is a
567 caudal process. *Judahella tuberculifera* (Gümbel, 1869) from Carnian of Italian Alps (Gümbel,
568 1869; Lieberman, 1979), Anisian – Ladinian of Poland (Styk, 1958), Ladinian of France (Sohn,
569 1968), Anisian of Germany (Knüpfer and Kozur, 1968), Ladinian of Spain (Kozur et al., 1974) and
570 Anisian of South China (Kristan-Tollmann, 1983) has a general dorsal outline which can evoke the
571 new species.

572
573 Family Glorianellidae Snejder, 1960 emend. Kozur 1970

574 Genus *Mockella* Bunza and Kozur, 1971

575 Type species *Mockella marinae* (Kozur, 1970)

576 *Mockella muelleri* Bunza and Kozur, 1971

577 Fig. 7 o - p

578 1971 *Mockella muelleri* n. sp. - Bunza and Kozur, p. 8 - 9, pl. 1, fig. 12

579 **Material:** 2 carapaces, 1 figured.

580 **Dimensions:** L = 390 µm; H = 235 µm (figured specimen).

581 **Stratigraphic and geographic range:** Late Carnian of Tyrol, Austria (Bunza and Kozur,
582 1971) and east side of Monte Scalpello (37°32'56.86''N, 14°40'30.64''E) Sicily, Italy (this work).

583

584

585 Fig. 7. Carnian ostracods from Monte Scalpello. Scale bar= 200µm (a – l); 100µm (m – p). Ostracodes du Carnien du
586 Monte Scalpello. Barre d'échelle 200µm (a-l), 100µm (m-p).

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588

589 **Conclusion.**

590 Carnian Ostracods are known worldwide, from Alaska (Sohn, 1968), Alps (Kristan-
591 Tollmann, 1969, 1978; Kollmann, 1963), Austria (Kristan-Tollmann, 1971, 1973, 1988; Bunza and
592 Kozur, 1971), British Columbia (Arias and Lord, 2000), Germany (Gründel, 1965; Bunza and
593 Kozur, 1971), Hungary (Kristan-Tollmann et al., 1991; Kozur 1971, 1972; Bunza and Kozur, 1971),
594 Indonesia (Kristan-Tollmann and Hasibuan, 1990), Israel (Sohn, 1968; Gerry et al., 1988; Bunza
595 and Kozur, 1971); Italy (Kristan-Tollmann, 1971, 1973, 1982, 1983; Liebermann, 1979), Slovenia
596 (Kolar-Jurkovsek ,1990) and Turkey (Forel et al., 2018). The turn-over between Palaeozoic and
597 Mesozoic ostracod fauna is long, at least 14 My, began in the early Late Permian (in the Early
598 Wuchiapingian) and is considered to be ended in the Anisian (Crasquin and Forel, 2013). However,
599 some Palaeozoic genera are still present in the Carnian: three Kirkbyidae (*Carinaknightina*,
600 *Kirkbya*, *Tubulikirkbyia*?) in Turkey deep environment (Forel et al., 2018) and *Acratia*, discovered
601 as well in Turkey (Forel et al., 2018) whose presence is confirmed here.

602 The paleoecological interpretation of the Carnian ostracods association of Monte Scalpello
603 is not easy. It is necessary to consider both the structure, composition and taphonomic
604 characteristics of the association found, as well as the sedimentological characteristics of the
605 sedimentary Unit and its position in the palaeogeographic context at that time.

606 First of all the strong shelled forms and absence of typical deep water species it would seem
607 to indicate a not deep waters association. From the taphonomic point of view, it is very interesting
608 to note that the ostracods specimens are predominantly represented by integer carapaces and rare
609 valves. This could suggest a rapid burial *in situ* in a high sedimentation rates environment, since the
610 valves, after the death of the specimens, tend to open in a few hours (Guernet & Lethiers, 1989).
611 Similar taphonomic characteristics were also found by Pokorny (1964) and Oertli (1971) for pelitic
612 layer associations deposited in extremely rapid distal sedimentation basins.

613 Another important datum concerns the size of all the found skeletal remains. Gastropods,
614 bivalves, crinoids and brachiopods remains are all of the same little size; also the ostracod
615 thanatocoenosis structure is characterized by abundance of juveniles and rare adults; according to
616 van Harten (1986), all that would suggest strong phenomena of dimensional selection and,
617 therefore, displaced of faunas and sediments ().

618 From the sedimentological point of view the study area is characterized by the extreme
619 abundance of pelitic sediments with interbedded sandy levels sometimes rich in oolites. Sometimes
620 this sediments shown in the outcrop, particular sedimentary structures as parallel lamination, wavy
621 lamination and vortices structures, all features that make one think of a high-energy sedimentation
622 environment.

623 From a palaeogeographic point of view, the Mufara Formation outcropping in the studied
624 area, is located inside the pelagic Imerese Basin that is delimited by the carbonate platforms of
625 Complesso Panormide to the west and the Complesso Trapanese to the east and to the south (Fig. 3)
626 (Catalano and D'Argenio, 1982; Montanari, 1987; Speranza and Minelli, 2014). All the materials
627 produced by the erosion of the carbonate platforms were conveyed in this basin (Carillat and
628 Martini, 2009).

629 On the basis of all these data it is possible to hypothesize for the ostracods association an
630 environment characterized by high sedimentation rates and high depositional energy, features that
631 controls strongly, today as in the past, the colonization of the bottom as well as the composition and
632 structure of the populations (cf. Di Geronimo & Robba, 1989; Sciuto, 2014). According to Carillat
633 and Martini (2009), the Monte Scalpello area, it could be a probably, distal turbiditic sedimentary
634 environment not necessarily very deep (Fig. 8). The collection of further faunistic and
635 sedimentological data (whose finding and observation is made extremely difficult by the intense
636 agricultural activity) can lead to more detailed information on the Triassic palaeo-environment of
637 the Monte Scalpello area.

638

639

640 Fig. 8. Schematic palaeoenvironmental model for the Late Carnian Mufara Formation (see also Fig. 3). Modèle
641 paléoenvironnemental schématique de la Formation Mufara du Carnien supérieur (voir également fig. 3)

642

643 Declaration of interest.

644 The authors declare that they do not have any links of interest.

645

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908 Captions. Légendes

909 Fig. 1. Geographical location of the sampling area. Localisation géographique de la zone
910 d'étude.

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912 Fig. 2. Structural scheme of the central Mediterranean area with the location of the study area
913 (after Grasso, 2001 modified). Schéma structural de la Méditerranée centrale avec la
914 localisation de la zone d'étude (d'après Grasso, 2001 modifié)

915

916 Fig. 3. Schematic palaeogeographic reconstruction of Pangaea and Neo-Tethys in Late
917 Triassic times (after Speranza & Minelli (2014), Golonka, 2007 and Preto et al., 2010

918 modified). Reconstruction paléogéographique schématique de la Pangée et de la
919 Néo-Téthys à la fin du Trias (d'après Speranza & Minelli, 2014; Golonka, 2007 et
920 Preto et al., 2010 modifié).

921

922 Fig. 4. Geological map of the Monte Scalpello area (after Lentini, 1974 and Di Paolo et al.
923 2012, modified). Carte géologique de la région de Monte Scalpello (d'après Lentini,
924 1974 et Di Paolo et al. 2012, modifié)

925

926 Fig. 5. Carnian Ammonoid zones (after Lucas 2010 modified). Zones à ammonoidés du
927 Carnien (d'après Lucas 2010, modifié).

928

929 Figure 6. Carnian ostracods from Monte Scalpello. Scale bar 200µm. Ostracodes du Carnien
930 du Monte Scalpello. Barre d'échelle 200µm.

931 a - b. *Ogmoconchella felsooersensis* (Kozur, 1970). **a.** Complete carapace, right external lateral
932 view; **b.** Complete carapace, dorsal view.

933 c - d. *Healdia* sp. **c.** Complete carapace, right external lateral view; **d.** Complete carapace, dorsal
934 view.

935 **e.** *Bektasia* sp. 1. Complete carapace, left external lateral view.

936 f - h. *Hiatobairdia subsymmetrica* Kristan-Tollmann, 1970. **f.** Complete carapace, right external
937 lateral view; **g.** Complete carapace, right external lateral view; **h.** Complete carapace,
938 dorsal view.

939 i - j. *Bairdia* cf. *humilis* Monostori, 1995. **i.** Complete carapace, right external lateral view; **j.**
940 Complete carapace, dorsal view.

941 k - l. *Bairdia* cf. *deformata* Kollmann, 1963. **k.** Complete carapace, right external lateral view; **l.**
942 Complete carapace, dorsal view.

943 m. *Bairdia cassiana* (Reuss, 1869), complete carapace, right external lateral view.

944 n, o. *Bairdia* sp. 1. Complete carapace, right external lateral view.

945 p. *Bairdia balatonica* Méhes, 1911. Complete carapace, right external lateral view.

- 946 q - r. *Bairdia scaliai* n. sp. **q**. Paratype, complete carapace, left external lateral view; **r**. Holotype,
947 complete carapace, right external lateral view.
- 948 s. *Bairdia* cf. *finalyi* (Méhes, 1911). Complete carapace, right external lateral view.
- 949 t. *Bairdia?* sp. 2. Complete carapace, right external lateral view.
- 950 u. *Bairdia* sp. 3. Complete carapace, right external lateral view.
- 951
- 952 Fig. 7. Carnian ostracods from Monte Scalpello. Scale bar = 200µm (a – l); 100 µm (m – p).
953 Ostracodes du Carnien du Monte Scalpello. Barre d'échelle 200 µm (a - l), 100 µm
954 (m - p).
- 955 a. *Ptychobairdia kristinae* Kollmann, 1960. Complete carapace, right external lateral view.
- 956 b. *Bairdiacypris* cf. *aequisymmetrica* Mette et al.,2014. Complete carapace, right external lateral
957 view .
- 958 c. *Bairdiacypris* cf *mirautae* Crasquin-Soleau and Gradinaru, 1996. Complete carapace, right
959 external lateral view.
- 960 d - f. "*Anchistrocheles*" *gemmellaro*i sp. nov. **d**. Paratype, complete carapace, left external lateral
961 view ,
- 962 **e**. "*Anchistrocheles*" *gemmellaro*i sp. nov. Holotype, complete carapace, right external lateral view.
963 **f**. Paratype, complete carapace, dorsal view.
- 964 g. *Nodobairdia mammillata* Kollmann, 1963. Complete carapace, right external lateral view.
- 965 h - j. *Acratia maugerii* n. sp. **h**. Holotype, complete carapace, right external lateral view; **i**. Paratype,
966 complete carapace, left external lateral view; **j**. Paratype, complete carapace, dorsal view.
- 967 k. *Bythocypris?* sp. 1. Complete carapace, right external lateral view.
- 968 l. *Pontocypris rara* Méhes, 1911. Complete carapace, left external lateral view.
- 969 m - n. *Judahella?* *montanarii* n. sp. **m**. Holotype, left valve, external lateral view; **n**. Paratype,
970 complete carapace, dorsal view.

971 o - p. *Mocklella muelleri* Bunza and Kozur, 1971. **o**. Complete carapace, left external lateral view;
972 p. Complete carapace, dorsal view.

973

974 Fig. 8. Schematic palaeoenvironmental model for the Late Carnian Mufara Formation basin
975 (see also Fig. 3). Modèle paléoenvironnemental schématique de la Formation Mufara du Carnien
976 supérieur (voir également fig. 3)

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