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Calcareous Algae and Foraminifera from the Upper Capitanian/Lower Wuchiapingian (Middle/Upper Permian) transitional carbonates of the Chios Island (Greece). Biostratigraphic and paleogeographic implications

Gevorg Grigoryan¹, Taniel Danelian², Daniel Vachard², Theodora Tsourou³, Alexandra Zambettakis-Lekkas³

¹ Institute of Geological Sciences, National Academy of Sciences of Armenia, Bagramyan ave., 24, Yerevan, Armenia, gevgrigg@gmail.com

² Univ. Lille, CNRS, UMR 8198 - Evo-Eco-Paléo, F-59000 France, taniel.danelian@univ-lille.fr, daniel.vachard@free.fr

³ Department of Historical Geology-Paleontology, National and Kapodistrian University of Athens, Zografou, 15784, Athens, Greece, ttsourou@geol.uoa.gr, zambetaki@geol.uoa.gr

Corresponding author: Taniel Danelian taniel.danelian@univ-lille.fr

28 **Abstract**

29 A 3m thick carbonate sequence from northern Chios island is assigned here to the latest
30 Capitanian/earliest Wuchiapingian transitional interval. It is characterized by abundant
31 gymnocodiacean algae, associated with some miliolate, nankinellin and nodosariate
32 foraminifers. These strata display bioaccumulated perireefal microfacies with richthofeniid
33 brachiopods and inozoa calcisponges. They are biostratigraphically characterized by a
34 foraminifera assemblage composed of *Reichelina* cf. *simplex*, *Dunbarula?* sp., *Altineria*
35 *alpinotaurica* together with the genera *Labioglobivalvulina*, *Froncina* and *Robuloides*. Other
36 perireefal microfacies show abundant fragments of a new tubiphytid species, *Tubiphytella*
37 *guevenci* Vachard nov. gen. nov. sp. Based on this study, the paleogeographical distribution
38 of *Altineria alpinotaurica* now includes Chios, in addition to the Taurus and the NW and
39 central Iran, whereas primitive forms of the genus are also known in Tunisia and Armenia.
40 This paleobiogeographic distribution would suggest that all these regions still belonged to the
41 Perigondwana margin in the early Wuchiapingian times. Consequently, it is likely that the
42 opening of the Neotethys ocean did not begin prior to the late Wuchiapingian-early
43 Changshingian transitional interval.

44

45 *Keywords:* Chios Island; Foraminifers; Calcareous algae; Biostratigraphy; Perigondwana
46 margin, paleobiogeography

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51 1. **Introduction**

52 The Upper Paleozoic sedimentary and fossil record of Chios, a Greek island situated in
53 the eastern Aegean Sea (Fig. 1a), holds key evidence for the understanding of the complex
54 geological events that led to the opening of the Neotethys ocean and subsequent closure of the
55 Paleotethys. Nevertheless, as the geological structure of the island is the result of several pre-
56 alpine and alpine tectonic movements, its geological structure and history are very
57 complicated to decipher (Besenecker et al., 1968; Papanikolaou and Sideris, 1983; Robertson
58 and Pickett, 2000; Tselepidis and Rondoyanni, 2000).

59 The presence of Paleozoic sequences in Chios has long been recognised (see the historical
60 overview provided by Fryssalakis, 1985). Besenecker et al. (1968) synthesized a number of
61 local geological studies conducted on the island and they distinguished an upper and a lower
62 tectonostratigraphic units. The lower unit is autochthonous or subautochthonous and it is
63 composed of siliciclastic turbidites that contain olistoliths of various lithologies, ranging in
64 age from the Silurian to the Carboniferous. The siliciclastic sequence is overlain
65 unconformably by a Mesozoic carbonate sequence. According to Zanchi et al. (2003), the
66 Paleozoic sequence of the lower tectonostratigraphic unit is of Laurasian affinity. The upper
67 (allochthonous) unit is thrust over the lower unit and it is only preserved in a number of
68 isolated klippen. The allochthonous character of the upper tectonostratigraphic unit was
69 demonstrated by Besenecker et al. (1968) and Kauffmann (1969). Lithologically, it is
70 composed of Upper Carboniferous turbidites, Lower Permian sandy/marly limestones and
71 Middle Permian shallow-water carbonates, which are overlain by red siltstones and Jurassic
72 platform carbonates. Based on brachiopods, Angiolini et al. (2005) suggested a Gondwana
73 affinity for the upper unit.

74 Regional geological syntheses were conducted by Fryssalakis (1985), Tselepidis and
75 Dondoyanni (2000) and Angiolini et al. (2005). More recently, Meinhold et al. (2007, 2008)

76 applied geochemical analyses to the detrital sequences present on the island in order to infer
77 their depositional setting.

78 The presence of Middle Permian carbonates in the Upper Unit was generally admitted,
79 especially in the area around the Marmaro Bay (Fig. 1b). More particularly, at the eastern part
80 of the Marmaro Bay there are excellent outcrops of highly fossiliferous limestones, which were
81 called “Gymnocodiaceen-Kalke” by Kauffman (1969). These outcrops display exceptional
82 richthofeniid brachiopod reef buildups. Richthofeniids grew under low-energy conditions as
83 these particular spine bearing brachiopods would live anchored by their spines, promoting
84 thus stabilization of the seafloor. These limestone outcrops were first studied in detail by Flajs
85 et al. (1996) where they distinguished five lithostratigraphical units. Furthermore, Larghi
86 (2002) studied the bivalves and Angiolini et al. (2005) the brachiopods. In addition to a
87 systematic update of brachiopods found around the Marmaro Bay, Angiolini et al. (2005) also
88 performed a quantitative paleogeographic analysis of them, which concluded that they have
89 “a clear Gondwana affinity”.

90 We here present a micropaleontological study of the foraminifera and algae present in the
91 Permian limestones of the Marmaro Bay, which allows us to specify their age assignment to
92 the late Capitanian–early Wuchiapingian boundary interval. Moreover, the North-Gondwana
93 affinity of some of the identified foraminifera reinforces previous suggestions to consider the
94 Permian deposits of the Upper Unit as located at the southern margin of Paleotethys, with
95 shallow marine connections still present between Tunisia and Iran.

96

97 2. Stratigraphic setting

98 The studied sequences were observed and sampled along the eastern coast of the Marmaro
99 Bay, situated in the north-eastern part of the Chios island (Fig. 1b; Kardamyla, N 38° 32'
100 29.76", E 26° 7' 5.67"). Here, the Permian limestones and marls of the upper unit are

101 unconformably overlain by Lower Jurassic shallow water limestones that display a red
102 terrigenous formation at their base (Fig. 2).

103 The area is easily accessible by car, as a settlement was developed recently. The total
104 length of the outcrop is 283 m but several small faults and landslides interrupt it. The overall
105 section is a monoclinic succession, where the beds strike N13W and dip 19°-30° eastward.
106 Two short intervals of Permian limestones were studied in detail; they correspond to the lower
107 part (intervals 1 and 2, Flajs et al., 1996) of the Marmaro section. They consist of dark
108 bituminous and fossiliferous limestones forming ca. 20-30 cm thick beds, with several marly
109 intercalations. More specifically, the section Marmaro **M** (Figs. 2 and 3) displays a 0.8 m-
110 thick limestone at the base, overlain by a 1.2 m-thick marly interval containing some thin
111 bedded limestone intercalations; it ends with thick bedded limestones. Section Marmaro **T**
112 (Figs. 2 and 3) displays a lower part made essentially of bedded limestones, followed upwards
113 by an essentially marly interval with several thick limestone intercalations.

114

115 3. Results

116 The limestones of the section **Marmaro M** are essentially composed of packstones with
117 abundant gymnocodiacean algae (*Permocalculus*, *Gymnocodium*; Fig. 4.1-2) and very few
118 dasycladale algae (*Mizzia*), whereas the smaller foraminifers are rare genera belonging to
119 globivalvulinids (*Globivalvulina*), miliolates (*Hemigordius*, *Neodiscus*, *Agathammina*, very
120 rare *Pseudovermiporella*), and nodosariates (*Nodosinelloides*, *Ichthyofrondina*, *Geinitzina*,
121 *Pachyphloia*, rare *Robuloides*). Given that very shallow water algae are found together with
122 deeper nodosariates, the faunal and floral assemblages, in combination with the observed
123 microfacies, suggest a tropical-subtropical and very shallow marine depositional environment
124 (Vachard et al., 2010).

125 The limestones of the section **Marmaro T** contain diverse metazoan bioclasts, which are
 126 identified as calcisponges (inozoa; Fig. 4.25), *Multithecopora* sp. (VR = very rare), bivalves,
 127 gastropods, microconchids (R = rare), worms *Terebella* sp. (VR and observed only at the
 128 level of sample T9), Bryozoa (fenestellids and other Zoaria), brachiopods (richthofeniids;
 129 Fig.4.26, productids, and other tests and spines), ostracodes, crinoids (R) and palechidnid
 130 radioles (VR).

131 Among the **algae** and **microproblematica**, *Gymnocodium nodosum* Ogilvie Gordon,
 132 1927 (Fig. 4.21), *Permocalculus plumosus* Elliott, 1955 and *Gyroporella?* sp. were identified,
 133 as well as the **algae incertae sedis** *Eotuberitina reitlingerae* Miklukho-Maklay, 1958 (R) and
 134 the new genus and new species *Tubiphytella guevenci* n. gen. n. sp. (VC = very common)
 135 (Fig. 4.7, 20-24)

136 **Foraminifera** are the most diverse clade recognised in our material. Among the
 137 Endothyrida were identified *Earlandia* p. (VR), *Lasiodiscus tenuis* Reichel, 1946 (R),
 138 *Altineria alpinotaurica* (Altiner, 1988) (R) (Fig. 4.5-7, 13), *A. cf. arpaensis* (Pronina and
 139 Gubenko, 1990) (R) (Fig. 4.3, 4), *Endoteba* sp. (R), *Climacammina* sp. (RC), *Tetrataxis* sp.
 140 (VR), *Abadehella* sp. (VR), *Globivalvulina* sp. (R), *Labioglobivalvulina cf. fortis* Gaillot and
 141 Vachard, 2007 (RC) (Fig. 4.15, 16, 19) and *Retroseptellina cf. decrouezae* (Köyliüoglu and
 142 Altiner, 1989) (VR) (Fig. 4.17). Amongst the Fusulinida were recognized *Nankinella* sp.
 143 (VR), *Reichelina cf. simplex* Sheng, 1963 (VR) (Fig. 4.8-10), and *Dunbarula?* sp. (VR) (Fig.
 144 4. 11). Amongst the Miliolida were recognized *Ammovertella* sp. (VR), *Pseudovermiporella*
 145 ex gr. *nipponica* Endo in Endo and Kanuma, 1954 (R) (Fig. 4.12), *Hemigordiellina* sp. (VR),
 146 *Agathammina asymmetrica* (Han, 1982) (VR), *A. sp.* (VR), *Neodiscus* sp. (VR) (Fig. 4.14)
 147 and *Multidiscus cf. arpaensis* Pronina, 1988 (RC) (Fig. 4.18, 21). Finally, among the
 148 Nodosariida were identified *Nodosinelloides* ex gr. *potievskayae* Mamet and Pinard, 1996
 149 (VR; Fig. 4.20), *Geinitzina taurica* Sellier de Civrieux and Dessauvagie, 1965, *Fronidina*

150 *permica* Sellier de Civrieux and Dessauvague, 1965 (VR), *Ichthyofrondina latilimbata* (Sellier
 151 de Civrieux and Dessauvague, 1965) (VR), *Ichthyolaria* sp. (VR), *Pachyphloia ovata* Lange,
 152 1925 (R), *Pachyphloia* ex gr. *schwageri* Sellier de Civrieux and Dessauvague, 1965 (VR) and
 153 *Pachyphloia* sp. 1 (R).

154 On the other hand, Cyanobacteria identified as *Girvanella* sp. were observed in abundance
 155 in sample T4.

156 In terms of microfacies, the lower part of the section (interval between samples T1 and
 157 T9) is dominated by algae, small foraminifera and fusulinids (*Dunbarula?* and *Reichelina*).
 158 Fragments of richthofeniid brachiopods are very rare in them. They are regarded as
 159 accumulation in inner platform environments.

160 The limestones situated at the upper part of the section (between samples T11 and T17)
 161 are rich in richthofeniid brachiopods and Inozoa sponges; they are regarded as reflecting
 162 accumulation in the proximity of the richthofeniid reef, likely in a back reef position.

163

164 **4. Systematic Paleontology**

165 The Permian microfauna and microflora, found in this study, are relatively well known,
 166 with the exception of a new genus and a new species of the *incertae sedis* group
 167 Tubiphytidae, which is new to science and therefore described here in detail. All type
 168 specimens described here are housed in the public paleontological collections of the
 169 University of Lille.- Science and Technology (USTL).

170

171 Family **Tubiphytidae** Vachard, Krainer and Lucas, 2012

172 The tubiphytids are more or less strongly transformed consortial associations of tubular
 173 miliolate foraminifers with cyanobacterial algae. Poorly transformed tubular miliolates still
 174 exhibit sagittiform cavities evocating uniseriate series of chambers. Strongly transformed

175 tubiphytid consortia appear as masses of a rounded, thick-walled skeletons pierced by a small
 176 rounded cavity, central or excentred (Razgallah and Vachard, 1991; Senowbari-Daryan and
 177 Flügel, 1993).

178 *Tubiphytes* is probably derived from the nubecularioid foraminifer *Palaeonubecularia*, during
 179 the Middle Pennsylvanian (latest Moscovian). The lineage Tubiphytidae is composed
 180 successively of *Latitubiphytes*, *Tubiphytes*, *Ramovsia*, *Epimonella*, *Tubiphytella* n. gen.,
 181 *Plexoramea*, *Porferitubus*, *Ladinella* and *Crescentiella*. This lineage is represented from Late
 182 Pennsylvanian to Late Jurassic.

183

184 Genus *Tubiphytella* Vachard n. gen.

185 **Type species:** *Tubiphytella guevenci* n. gen. n. sp.

186 **Synonyms:** *Tubiphytes* Maslov, 1956 (pars); *Cordiformis* Güvenç, 1965 (nom. nud.)

187 **Diagnosis:** Tubiphytidae with numerous sagittiform central cavities, more or less uniseriate.
 188 Wall dark moderately thick to thin. Possible proloculus are conspicuous (already mentioned
 189 by Nguyen Duc Tien, 1979 p. 145, and Vachard et al., 2003, p. 348).

190 **Included species:** Several taxa in open nomenclature are probable representatives of
 191 *Tubiphytella* n. gen.: *Tubiphytes* sensu Glennie et al., 1974, fig. 4.7-4.9; *Incertae sedis 5 sensu*
 192 Nguyen Duc Tien, 1979, pl. 32, figs. 14-20; *Cordiformis* sensu Vachard and Montenat, 1981,
 193 pl. 13, fig. 10; Foraminifera ? *sensu* Vuks and Chediya, 1986, pl. 10, fig. 12; *Tubiphytes*
 194 *obscurus sensu* Vachard and Ferrière, 1991, pl. 1, figs. 3, 4; *Tubiphytes* sensu Flügel et al.,
 195 1991, pl. 48, fig. 4; *Tubiphytes obscurus sensu* Vachard et al., 1993, pl. 3, fig. 4 and sensu
 196 Vachard et al., 2001, figs. 3, 5, 8?, 9?; *Tubiphytes ex gr. obscurus sensu* Vachard et al., 2003,
 197 pl. 27, figs. 1, 4-5.

198 **Comparison:** *Tubiphytella* n. gen. differs from *Tubiphytes* by the thinner wall and the regular
 199 chambers; from *Crescentiella* by the thinner wall, and from *Ramovsia* by the shape of the
 200 tubular chamber.

201 **Occurrence:** Capitanian?-Lopingian; Palaeotethyan and Neotethyan (Cambodia; Oman;
 202 Afghanistan; Primorie (Russia); New Zealand; Sicily; Greece (Chios, Hydra).

203

204 *Tubiphytella guevenci* Vachard n. sp.

205 (Fig. 4. 7, 20-24)

206 **Derivation of the name:** From Tuncer Güvenç, who illustrated the taxon in Turkey.

207 **Holotype:** Fig. 4.22 (USTL 3210).

208 **Paratypes:** Figs. 4.7 (USTL 3220), 4.20 (USTL 3223), 4.21 (USTL 3204), 4.23 (USTL
 209 3217), 4.24 (USTL 3224).

210 **Material:** Several dozens of sections (especially in section T between samples T1 and T16).

211 **Type Locality and horizon:** Capitanian/Wuchiapingian boundary interval of Chios island
 212 (Greece).

213 **Diagnosis:** Similar to that of the genus.

214 **Description:** As previously mentioned by Vachard et al. (2003), a characteristic section of
 215 this genus displays different parts: (1) a possible initial stage with a proloculus and some
 216 multiseriate and/or coiled initial chambers; (2) an uniseriate part with a series of chambers
 217 sagittiform, more or less similar to those of the foraminiferal genus *Nodophthalmidium*; (3) a
 218 first disorder of this uniseriate part; (4) a possible terminal part (the connection is not still
 219 really observed) resembling typical *Tubiphytes*. The part 2 corresponds to *Cordiformis*
 220 (*nomen nudum*). On the other hand, this probably erected habitus can be found with a second
 221 habitus which is developed around or along a substrate preserved or not. (Fig. 4.7 (left), 4.21

222 (bottom), 4.22 (right)). In our material, such a substrate is often a spine of productoid
223 brachiopod (sample T2, T6, T9, T11).

224 **Measurements:** Total length = 2000-5000 μm ; width of the tubular, terminal part = 150-
225 600 μm ; width of the inflated, initial part = 200–800 μm ; inner width of chambers = 90-
226 400 μm ; inner height of chambers = 200-800 μm , wall thickness = 30-200 μm ; number of
227 chambers in the tubular part = 5-10.

228 **Remarks:** Contrary to *Tubiphytes*, *Tubiphytella* n. gen. is not regarded as a taxon that had the
229 capacity to build microreefs, and is more likely to have constituted meadows at the bottom of
230 the sea.

231 **Occurrence:** Greece (Hydra, Chios); Sicily.

232

233 5. Discussion

234 Angiolini et al (2005) assigned a Wordian age to the Permian limestones cropping out at the
235 Marmaro Bay, based essentially on the presence of the fusulinid genus *Verbeekina*. However,
236 we have not found this genus in our material. It is worth noting that due to its large size and
237 spherical shape *Verbeekina* may be confused with *Staffella* or *Sphaerulina* which are common
238 taxa in the Lopingian limestones. In addition, it has been recently established in China that
239 *Verbeekina* is still present in the Capitanian (Huang et al., 2015a-b). Thus, its age ranges the
240 Murgabian-Midian (= Wordian-Capitanian) interval.

241 *Altineria alpinotaurica* is a species known originally from upper Capitanian to lower
242 Wuchiapingian strata of southern Turkey (Altiner, 1988). This species was found consistently
243 in the lower and middle parts of the Marmaro T section (samples T2 to T13). In terms of
244 biochronology it is amongst the most important foraminiferan species for our study, as the
245 recent synthesis established by Vachard (2018) suggests that it may be considered as a marker
246 species for the Capitanian/Wuchiapingian boundary interval.

247 In addition, the genera *Labioglobivalvulina*, *Fronkina* and *Ichthyofronkina* are late Capitanian
248 and Lopingtonian in age (Gaillot and Vachard, 2007; Arefifard and Vachard unpublished data);
249 *Retroseptellina decrouezae* is considered as late Capitanian to early Changhsingian in age
250 (Köyliüoglu and Altiner, 1989; Gaillot and Vachard, 2007). *Nankinella* sp. occurs during the
251 entire Middle and Late Permian. However, after the disappearance of the giant and complex
252 fusulinids at the end-Guadalupian mass extinction, it becomes proportionally more abundant
253 during the Wuchiapingian-Changhsingian. The dunbarulin fusulinids (Fig. 4.11) appear in the
254 latest Capitanian of Tunisia (Ghazzay et al., 2015).

255 The paleogeographical distribution of *Altinaria alpinotaurica* now includes Chios, in addition
256 to the Taurus and NW and central Iran, whereas primitive forms of the genus are also known
257 from Tunisia and Armenia. All these areas were part of the Perigondwana margin during the
258 Wuchiapingian. After that, several terranes (including Turkey, Afghanistan, Karakorum,
259 Qiantang, South Pamir, western Thailand and Malaysia), formed a narrow and elongated
260 continental strip known as Cimmerian Continent. This continent was located in the eastern
261 margin of the Gondwana until its rifting in Early Permian and the opening of the Neotethys in
262 the Late Permian and then drifted northward across the Paleotethys ocean from southern
263 Gondwana paleolatitudes to subequatorial paleolatitudes by the Middle Permian to Early
264 Triassic. Finally, it collided with Eurasian margin causing the Cimmerian Orogeny (Sengör,
265 1984; Besse et al., 1998; Metcalfe, 1999, 2006; Ruban et al., 2007; Muttoni et al., 2009a, b;
266 Torsvik and Cocks, 2013; Fergusson et al., 2016; Hassanzadeh and Wernicke, 2016).

267 The resemblance of Permian foraminiferal assemblages recovered from Chios, Taurus,
268 Armenia and the Abadeh area in Iran suggests that all these areas were situated close to each
269 other, which allowed easy faunal exchange between them. Furthermore, paleobiogeographical
270 affinities are also remarkable between Armenia and South China, and less marked with
271 currently adjacent areas, such as Alborz, Tabas, Afghanistan, Saudi Arabia and Oman.

272 Several taxa advocate the continuity of the northern Perigondwana margin (i.e., the southern
273 Neotethyan margin), already mentioned by Stampfli et al. (2001, fig. 16), from Armenia to
274 Himalaya. Due to the paleobiogeographical affinities, this Perigondwana continuity probably
275 existed up to the early Wuchiapingian. After that, the paleogeography was modified and the
276 northern Perigondwana margin, limited to the South by the “Neotethys break-up line” of
277 Stampfli et al. (2013, their fig. 9) became the southern Cimmerian margin. Consequently, it is
278 likely that the opening of the Neotethys did not begin prior to the late Wuchiapingian-early
279 Changhsingian transitional interval. A first suggestion of this dating was given by Vachard
280 (2014) who indicated that the lineage of the well-known nodosariate *Colaniella* begun in the
281 Perigondwana and finished in the Cimmerian terranes. Conversely, the whole evolution of
282 *Altineria* occurred on the Perigondwana margin.

283

284 **6. Conclusion**

285 The micropaleontological record of the lower part of the richthofeniid buildup occurring in
286 the eastern part of Marmaro Bay suggests that accumulation took place in a
287 tropical/subtropical sea, sometimes at very shallow depths (section M) or in an inner platform
288 depositional environment or else at the back of the richthofeniid reef.

289 The age of the richthofeniid reef buildup preserved in Marmaro Bay is younger than
290 previously thought; it is now correlated with the Capitanian/Wuchiapingian boundary interval
291 and not to the Wordian, as had previously been suggested).

292 The discovery of *Altineria alpinotaurica* confirms the Gondwana affinity of the Permian
293 reefal carbonates of Chios and suggests that, during the Middle/Late Permian boundary
294 interval, there was still a paleogeographic continuity between Tunisia, Chios, the Taurus
295 mountains, the south Armenian block, and Iran. This implies that the opening of the
296 Neotethys ocean did not begin prior to the Late Permian and more precisely to the

297 Wuchiapingian-Changhsingian transitional interval and that it was only really marked from
298 the late Changhsingian.

299

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305

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438 **Figure captions**

439 Fig. 1: a) Position of the Chios island in the eastern part of the Aegean Sea; b) Location of the
440 studied sections on a geological map of the Marmaro Bay.

441

442 Fig. 2: Field photograph of the two studied sections.

443

444 Fig. 3: Stratigraphic columns of the two studied sections.

445

446 Fig. 4. Microphotographs of the most important microfossils identified in the studied sections.

447 Scale bars = 500 microns for 1, 2, 24, 25, and 200 microns for the other photos.

448 **1.** Packstone with very abundant *Gymnocodium* ex gr. *bellerophontis* (Rothpletz, 1894).

449 Sample M9.

450 **2.** Packstone with abundant *Permocalculus* ex gr. *plumosus* Elliott, 1955. Sample M11.

451 **3-4.** *Altineria* cf. *arpaensis* (Pronina and Gubenko, 1990). 3: sample T7. 4: sample T4.

452 **5-7, 13.** *Altineria alpinotaurica* (Altiner, 1988). 5: sample T2 6: sample T9. 7: arrow with

453 “A”, sample T11. 13: sample T11.

454 **7, 20-24.** *Tubiphytella guevenci* n. gen. n. sp. 7: Paratype, arrow with “T”, USTL 3220

455 (bottom, left) sample T11. 20: Paratype, USTL 3223(top left). Sample T11. 21. Paratype,

456 USTL 3204 (bottom right) with *Gymnocodium nodosum* Ogilvie Gordon, 1927 (top right).

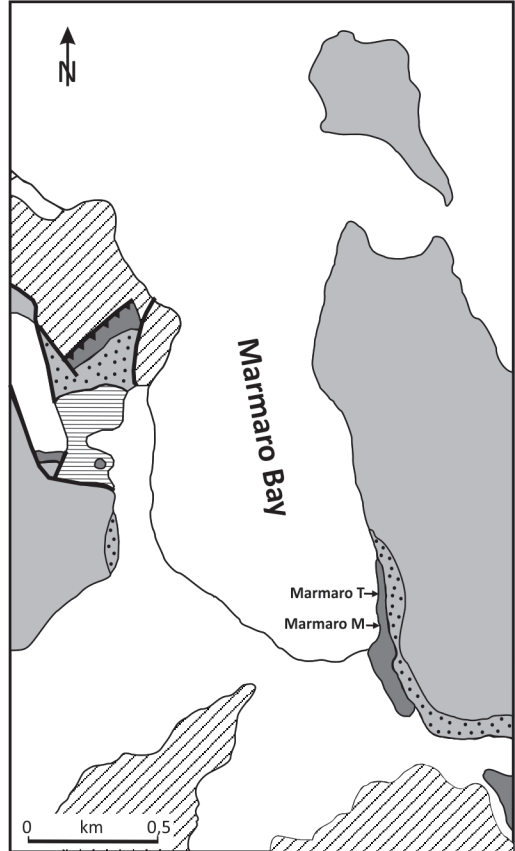
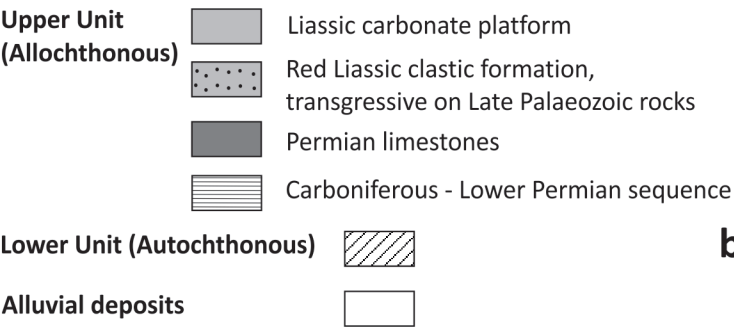
457 Sample T8. 22. Holotype, USTL 3210; sample T16. 23. Paratype, USTL 3217; sample T6. 24.

458 Paratype, USTL 3224; sample T1.

459 **8-10.** *Reichelina* cf. *simplex* Sheng, 1963. 8. Sample T8. 9. Sample T7. 10. Sample T9.

460 **11.** *Dunbarula?* sp. Sample T2.

- 461 **12.** *Pseudovermiporella* ex gr. *nipponica* Endo in Endo and Kanuma, 1954 (bottom, left).
462 Sample T8.
- 463 **14.** *Neodiscus* sp. Sample T11.
- 464 **15, 16, 19.** *Labioglobivalvulina* cf. *fortis* Gaillot and Vachard, 2007. 15. Sample T16. 16.
465 Sample T11. 19. Sample T11.
- 466 **17.** *Retroseptellina* cf. *decrouezae* (Köyliüoglu and Altiner, 1989). Sample T6.
- 467 **18, 21.** *Multidiscus* cf. *arpaensis* Pronina, 1988. 18. Sample T11. 21. Neosparitized axial
468 section (top center) with *Tubiphytella guevenci* n. gen. n. sp. (bottom, right) and
469 *Gymnocodium nodosum* (top right). Sample T8.
- 470 **20.** *Frondicularia?* sp. (center) with *Tubiphytella guevenci* n. gen. n. sp. (top left). Sample
471 T11.
- 472 **21.** *Gymnocodium nodosum* Ogilvie Gordon, 1927. Sample T8.
- 473 **25.** Inozoa. Sample T11.
- 474 **26.** Richthofenid. Sample T6.





Liassic carbonate platform

← Red formation

Permian formation

Marmaro T

Marmaro M

