Unveiling the rarity: ecological significance and distribution patterns of *Tuberoloxoconcha* spp.

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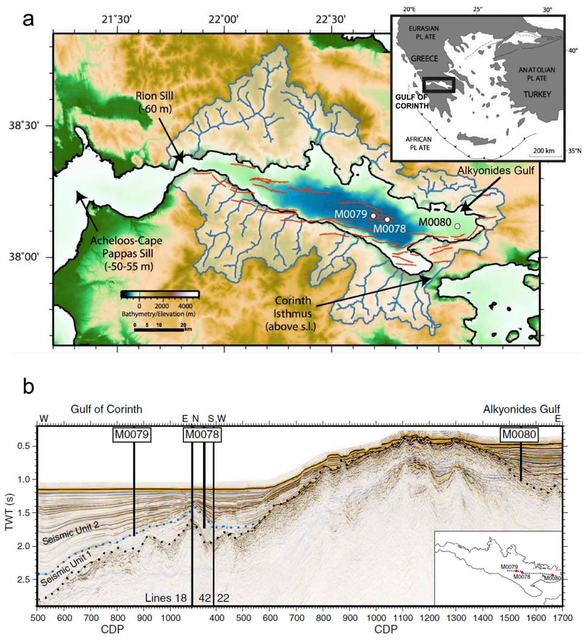
The study area and introduction



In 2017, sediment cores were retrieved from sites M0080, M0079, and M0078 in the Corinth basin during **IODP Expedition 381**. This study focuses on the Holocene and middle Pleistocene ostracod assemblages retrieved from sites **M0080**, in the Gulf of Alkyonides, and **M0078** in the Corinth Gulf. It explores the paleoenvironmental constraints that affected the *Tuberoloxoconcha* species' distribution in these two sites and investigates the stratigraphic appearance of the new species ***Tuberoloxoconcha aielloi*** in the Corinth basin during deglacial and glacial periods over the last 400,000 years (Parisi et al. 2024).

Figure 1. a. Map showing Gulf of Corinth and the Gulf of Alkyonides bathymetry, the main faults in the basin (red lines) and the location of IODP Leg 381 sites (McNeill et al., 2019). b. Composite seismic line and interpretations of basement (black dotted line) and boundary between seismic Unit 1 (below) and seismic Unit 2 (above) (blue dotted line). The current study focused on Site M0080 in the Gulf of Alkyonides and Site M0078 close to the depocenter of the Corinth basin.

Distribution map of *Tuberoloxoconcha* species

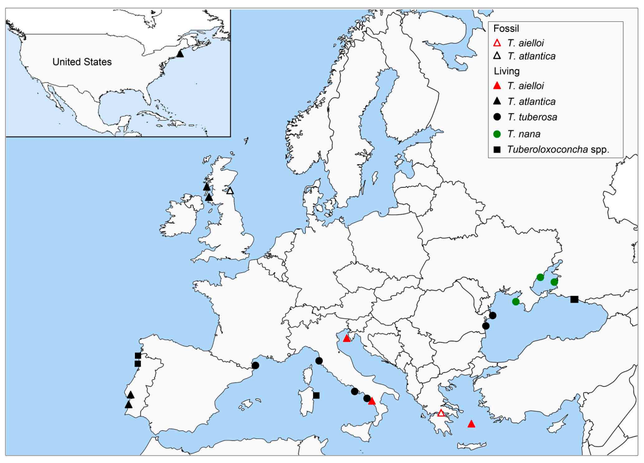


Figure 2. Empty triangles indicate fossil occurrences. Closed circles represent living or presumably living occurrences. *Tuberoloxoconcha* spp. groups all the species left in open nomenclature.

Data from a comprehensive literature survey show that **the genus lives in coastal environments** and has been found as fossils in Quaternary (middle Holocene) raised beach sediments in E Scotland (D.J. Horne, unpublished).
Living specimens of *Tuberoloxoconcha* are known from littoral and sublittoral interstitial habitats in surface sands, including sea caves.
Living *Tuberoloxoconcha* species have never previously been reported as abundant or dominant in an association. It is worth noting that many occurrences are characterised by brackish salinities or are reported close to submarine springs. In the Corinth Gulf, the abundant specimens of ***T. aielloi*** **always occur in brackish ostracod assemblages**.

Tuberoloxoconcha aielloi Parisi, Mazzini and Cronin

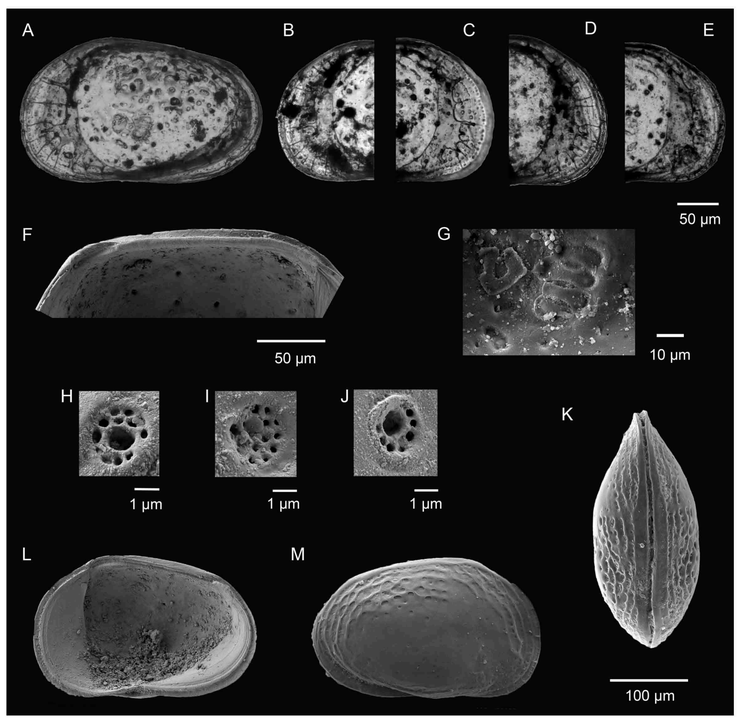


Figure 3. Small size T*uberoloxoconcha aielloi* n. sp. from Site M0078. A-E. Variability of the vestibulum and MPCs pattern in specimens from the same sample (21.02 m). A. Holotype, LV, ABMC 2024/028 (l 0.32 - h 0.20 mm); B. LV. C-E. RV; F. LV, hinge detail, sample 36.51 m; G. RV, central muscle scars, sample 85.59 m; H-J. LV, StPC, sample 21.02 m; K. Carapace, dorsal view, sample 85.59 m, (l 0.32 - h 0.20); L-M. RV, sample 36.51 m (l 0.33 - h 022). L. internal view, M. external view.

	Site M0078	Site M0080
Samples	150	291
Depth range	523.85 m - 1.69 m	119.20 m - 3.60 m
Taxa	87	41
T. aielloi from	42 samples	92 samples

The length to height ratio of 531 valves from Site M0078 and 35 from Site M0080 was measured and used for the description of the new species and to elaborate the Population Age Structure histograms (Aiello et al., 2024).

For Site M0078, each sample was fully observed and a total of **2379 valves of *T. aielloi* were picked**. Most of them (2066 valves) occur in the brackish interval from 85.59 m to 21.02 m (corresponding to MIS 2-3-4). Relative abundance in this interval ranges from 9.09 to 74.08 %, but the maximum is in the sample at 198.14 m (97,9%, 252 valves) (MIS 7). In the brackish interval 287.22 m to 260.93 m (MIS 10) the general frequency is low and only 45 valves of *T. aielloi* occur in the interval totalling from 4.70 to 81.30 %.
To assess the autochthony of the assemblages where *T. aielloi* is the dominant species, all the 128 valves from sample 31.02 m and 252 valves from sample 198.14 m from Site M0078 were measured.

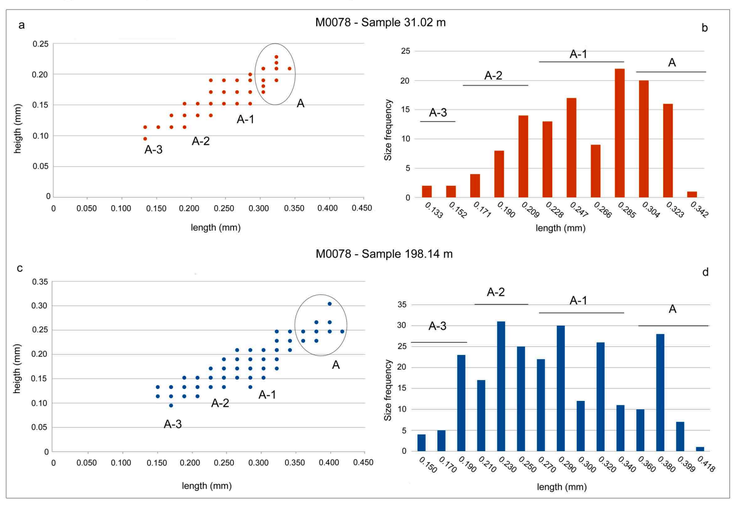


Figure 4. Comparison between Population Age Structure length-height diagrams (De Deckker, 2002) and size frequency distribution (Danielopol et al., 2008) of *Tuberoloxoconcha aielloi* a. – b. from sample 31.02 m; c. – d. from sample 198.14 m.

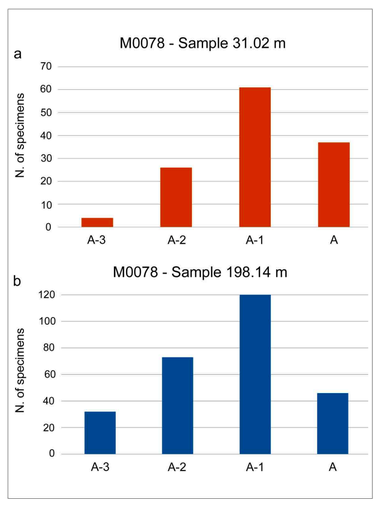
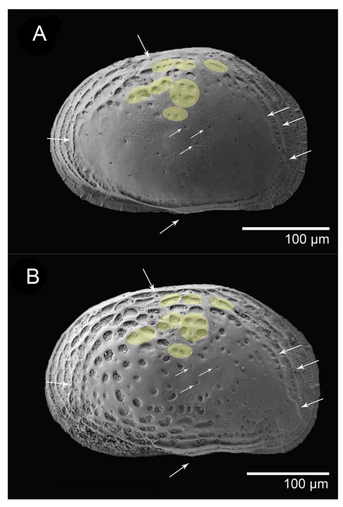


Figure 5. *Tuberoloxoconcha aielloi* age structure histograms a. from sample 31.02 m; b. from sample 198.14 m.



The same ornamentation features are highlighted in both valves;
in the central and dorsal area the arrows indicate the pore canals in the same position;
in the posterior and anterior area arrows indicate the same position of muri;
in the central-ventral area the arrows indicate the ventral convexity of valves margin.

Figure 6. Comparison between valves of *Tuberoloxoconcha aielloi* valves from Site M0078 with different degrees of calcification: A. RV, sample 21.02 m, (l 0.34 - h 0.22 mm); B. RV, sample 198.14 m, (l 0.38 - h 0.25)

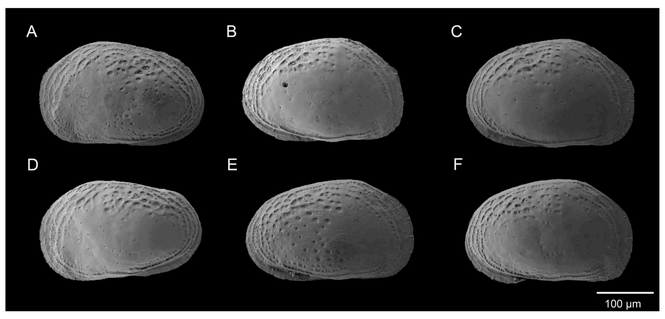


Figure 7. Small size *Tuberoloxoconcha aielloi* n. sp. from Site M0078, external view. A. Paratype, LV, ABMC 2024/029, sample 21.02 m, (l 0.33 - h 0.22 mm); B. RV, sample 36.51 m, (l 0.32 - h 0.21 mm); C. Paratype, RV, ABMC 2024/030, sample 21.02 m, (l 0.34 - h 0.22 mm); D. LV, sample 36.51 m, (l 0.32 - h 0.20 mm); E. RV, sample 21.02 m, (l 0.32 - h 0.21 mm); F. RV, sample 21.02 m, (l 0.32 - h 0.21 mm).

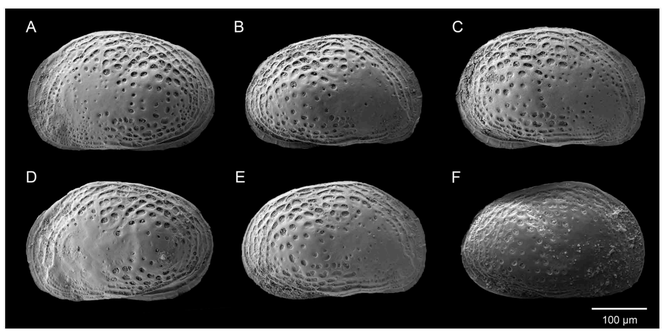


Figure 8. Large size *Tuberoloxoconcha aielloi* n. sp., external view. From Site M0078: A. LV, sample 198.14 m, (l 0.40 - h 0.27); B. RV, sample 198.14 m, (l 0.38 - h 0.24); C. RV, sample 198.14 m, (l 0.40 - h 0.27); D. Paratype, LV, ABMC 2024/032, sample 198.14 m, (l 0.39 - h 0.26); E. Paratype, RV, ABMC 2024/033, sample 198.14 m, (l 0.38 - h 0.25); F. RV, sample 269.39 m, (l 0.39 - h 0.25).

Bergmann's rule - The occurrence of the two *T. aielloi* morphotypes, the small one in MISs 2-3-4-5a and the large one in MISs 7d- 9-10, in different deglacial, glacial or cool interglacial phases is interesting.
Qualitatively estimating past changes in temperatures could be of great benefit for validating paleoclimate models and for putting recent and projected changes in sea temperature into context.
Temperature influences the development and body size of ostracods: at warm temperatures, the development processes of organisms are accelerated, the time of successive moults and the calcification of the carapace are reduced, and consequently, especially in the adult stage, a reduction in the average size of the carapace is observed.

The **variability in surface ornamentation** occurs mainly in the small morphotype and is more evident in the assemblages from Site M0078. This could reflect different chemistry of the waters in the Gulf of Alkyonides (Site M0080), compared to the centre of the Corinth basin (Site M0078).

The paleoenvironmental meaning of the *T. aielloi* assemblages

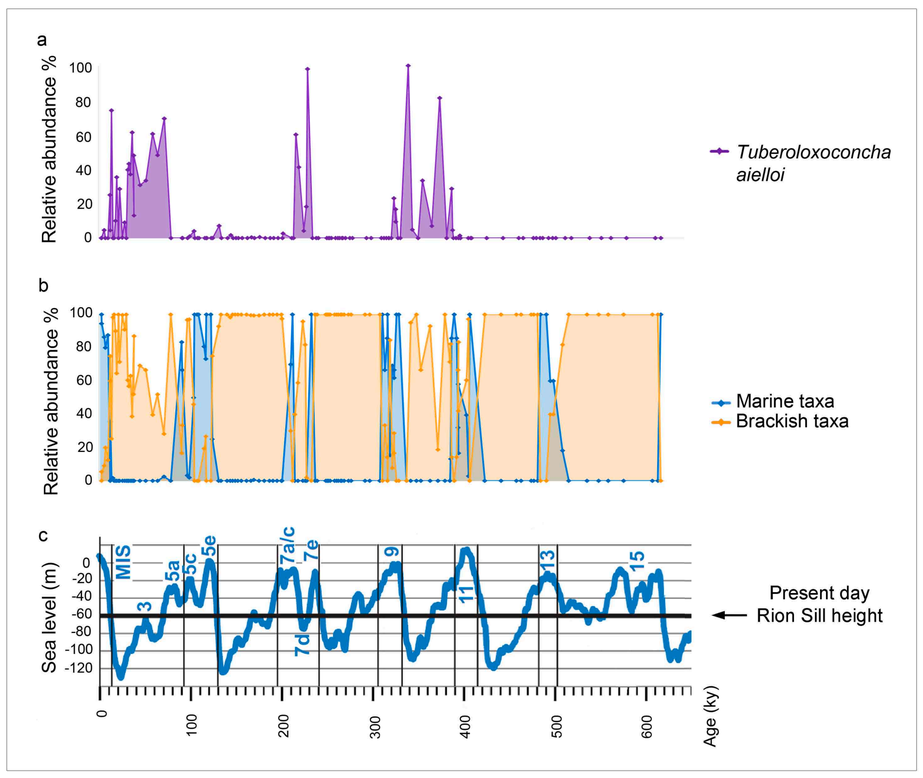


Figure 9. Frequencies of selected ostracod assemblages in Site M0078: a. *Tuberoloxoconcha aielloi*; b. Marine Mediterranean taxa and brackish assemblages; c. Correlation with eustatic sea-level (after Spratt and Lisiecki, 2015) and marine isotope stages (MIS) (after Gawthorpe et al., 2022).

All living *Tuberoloxoconcha* species have been found in littoral-intertidal settings, we consider the occurrence of *T. aielloi* in core samples to be **indicative of littoral phases in the history of the Corinth basin**. Glacioeustatic sea-level changes and tectonic uplift caused constant shifts of the coastline seaward or landward, and their imprint is well documented in the M0080 and M0078 ostracods where Mediterranean marine and brackish assemblages alternate.

The peculiar *T. aielloi*-dominated assemblage appear at ~ 393 ky in M0078 and ~ 373 ky in M0080. It characterizes some of **the deglacial and glacial phases only after 400 ky** when the marine connection through the Rion Strait began to develop (Gawthorpe et al., 2022).

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