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First record of the brachiopod *Argyrotheca cuneata* from a nearshore habitat at the southern coast of Türkiye

Aydin Örstan

Research Associate, Section of Mollusks, Carnegie Museum of Natural History, Pittsburgh, PA, U.S.A

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Corresponding author:
Aydin Örstan;
Email: anothersnail@hotmail.com

Abstract

The brachiopod *Argyrotheca cuneata* (Brachiopoda: Megathyrididae) is reported for the first time from the southern coast of Türkiye. Twenty-three complete specimens were found in samples of shell grit taken from depths less than 5 m. The findings suggest that *A. cuneata* may be a common brachiopod species in shallow nearshore habitats along the southern coasts of the country. Widths of the largest and the smallest specimens were 3.7 mm and 0.71 mm, respectively. A comparison of shell dimensions of all specimens indicate an allometric change in the shape of *A. cuneata* during growth from being longer than wide to wider than long. The protegula preserved on the smallest specimens are described and illustrated possibly for the first time for this species.

Introduction

The recent brachiopod fauna of the coasts of Türkiye is poorly known. The most recent checklist consisted of four species all from the Sea of Marmara that had been compiled from publications dating to 1896 and 1952 (Çinar, 2014). A fifth species was found off the coast of the island of Gökçeada in the northern Aegean Sea (Gönülal and Güreşen, 2014). Logan (1979), Logan *et al.* (2002) and Bitner *et al.* (2022) gave records of brachiopods from near the Greek island of Kastellorizo located within ~2 km of the Turkish coast. Brachiopods have apparently never been collected closer to the mainland along the southern coasts of the country. Here, I report the species *Argyrotheca cuneata* (Risso, 1826) for the first time from depths less than 5 m from the southern coast of Türkiye.

Materials and methods

Samples were collected during a mollusc survey at various locations (extending from 36.5269° N, 30.5578° E to 36.5213° N, 30.5496° E) in two small bays off the antique city of Phaselis at the western shore of the Gulf of Antalya (Figure 1). Five samples (each ~400 ml) of shell grit (sand mixed with shells and shell fragments) were taken by hand from the sediment surface at water depths ranging from approximately 2 m to 4.5 m, in May 2022, October 2022 and October 2023. Samples were sieved using tap water through sieves with mesh openings of 4 mm, 2 mm and 0.5 mm. Resulting four fractions (including the material that had passed through the 0.5 mm sieve) from each sample were dried and then examined for mollusc and brachiopod shells either with the naked eye or under a stereomicroscope. Widths and lengths of ventral valves (Williams *et al.*, 1997), were measured with a stereomicroscope using a calibrated eyepiece reticle. No corrections were applied to account for broken edges of valves. Shells were photographed under microscopes at varying focus levels and stacked using Helicon Focus version 8.2 (Helicon Soft). Species identification was based on descriptions and photographs of extant Mediterranean brachiopods recorded from shallow habitats (Logan, 1979; Brunton, 1988; Bitner and Gerovasileiou, 2021). Fifteen specimens (CM 179561) have been deposited in the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.

Results

The sea bottom at the collection localities was covered with large boulders interspaced with small rocks, sand and shell grit (Figure 2). There were no *Posidonia* or other sea grasses. Caves, often inhabited by brachiopods, were not seen, although cavities could be spotted among and under rocks. Twenty-three complete specimens, three intact valves and several valve fragments of brachiopods were found in the samples. Fifteen of the complete specimens were from two samples collected from depths of 2.5 m and 4.5 m at a rocky reef (36.5269° N, 30.5578° E) ~300 m off the coast. The remaining specimens were from localities closer to the shore.

Most of the larger specimens had pink-red coloration at various intensities between the ribs on their valves especially noticeable along the anterior edges (Figure 3A, B). This coloration is characteristic of the species *A. cuneata*. The morphology of the inner surfaces of the dorsal

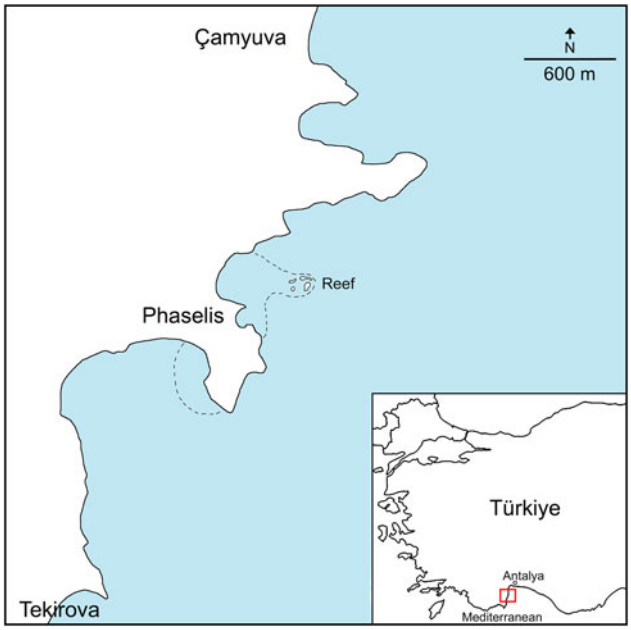

Figure 1. Map of the study area along the western shore of the Gulf of Antalya. Broken lines mark the approximate borders of the collection localities.

valves of the opened specimens also agreed with that of *A. cuneata* (Figure 3A). The largest specimen was 3.7 mm in width and 2.6 mm in length (Figure 3A). Five specimens were smaller than 1.0 mm, the smallest being 0.71 mm in width and 0.80 mm in length (Figure 3C-F), and had valves without noticeable red colour. The dorsal valves of all the specimens smaller than 1.0 mm had a median septum in various stages of development. For example, in the smallest specimen only a small protuberance medially located near the anterior edge and a very low ridge extending posteriorly were present (Figure 3F).

Some of the smallest specimens had seemingly intact protegula on both valves (Figure 3E). The protegulum on the dorsal valve was in the shape of a flat dome, while the one on the beak of the ventral valve formed a short protuberance (~0.1 mm), which under the light microscope appeared to have a tuberculated surface. The young shell following the protegulum on each valve had on its surface closely spaced fine concentric rings (Figure 3C). A mosaic pattern as well as a network of very fine canals was visible through the valves of the smallest specimen (Figure 3C).

Six shells with dimensions ~1 mm or smaller had approximately equidimensional or slightly longer than wide valves, whereas all larger specimens had valves that were wider than long (Figure 4).

Figure 2. Sampling of shell grit at a depth of ~4.5 m.

Discussion

I have considered the likelihood that some of the smallest specimens represented a species other than *A. cuneata*. One possible identification was *Gwynia capsula* (Jeffreys, 1859), a small (<1 mm) species that has been recorded in the Mediterranean (Logan *et al.*, 1997; Simon and Willems, 1999). However, the dorsal valve of *G. capsula* lacks a median septum, whereas all of my smallest specimens had variously developed septa on their dorsal valves (Figure 3F). The growth stages of *A. cuneata* have never been described, but in *Argyrotheca cistellula* (Wood, 1841) the median septum of the dorsal valve starts out as a small anterior protuberance (Logan *et al.*, 1997). Therefore, the presence of a medially located small protuberance near the anterior edge of the dorsal valve of the smallest specimen is a strong indication that it is a juvenile *Argyrotheca* (Figure 3F). In summary, despite the lack of colour on their valves, based on these considerations and also taking into account that all larger specimens were *A. cuneata*, I have identified all of the smaller specimens also as that species. This identification may be considered tentative, but it is the most reasonable one in light of the available evidence presented here. The pattern visible through the translucent valves of the smallest specimen, especially along the anterior margins, probably represents the mosaic structure of the secondary shell of brachiopods seen in SEM photographs (Logan *et al.*, 1997).

Adult shells of *A. cuneata* usually have wider than long valves. However, the plots of lengths against widths of *A. cuneata* shells in Evangelisti *et al.* (2014) had some specimens (larger than 1.5 mm) with longer than wide valves. Moreover, the slopes of the best-fit lines in their plots suggest that at least some specimens smaller than 1 mm would have longer than wide valves. Likewise, Logan's (1979) plot of lengths against widths of *A. cuneata* shells had two specimens smaller than 1 mm with equidimensional or slightly longer than wide valves. All of my specimens larger than 1 mm had shells that were wider than long, but the shells with dimensions ~1 mm or smaller had approximately equidimensional or slightly longer than wide valves (Figure 4). My data, supported by the data of Logan (1979) and Evangelisti *et al.* (2014), indicate an allometric change in shell shape during growth of *A. cuneata*. Interestingly, a corresponding change in shell shape was not observed in fossil *A. cuneata* (Bitner, 1990).

Evangelisti *et al.* (2014) compared the dimensions of *A. cuneata* specimens from coralligenous substrates, *Posidonia* meadows and sand channels. They found the largest specimens (up to 3.8 mm in width) in sand channels. The largest specimen (3.7 mm in width) I found in shell grit is comparable in dimensions. I was able to find specimens smaller than 1 mm thanks to the use of a 0.5 mm sieve.

Habitats of *A. cuneata* have been given in the literature as caves, boulders, coralligenous structures and *Posidonia oceanica* meadows at depths from about 2 to 150 m (Logan, 1979; Logan *et al.*, 2004; Albano and Stockinger, 2019; Bitner and Gerovasileiou, 2021). General characteristics of the collection spots of the present study (Figure 2) fall within this broad range of habitats. Exactly what types of specific substrates *A. cuneata* adheres to in the study area remains to be determined.

The only previously published records of *A. cuneata* from Türkiye were from the 19th century and pertained to finds from depths exceeding 50 m in the Sea of Marmara (Çinar, 2014). The presence of colour on the valves of most specimens collected during the present study at much shallower habitats is a strong indication that the specimens were of recently died individuals. The relative abundance of *A. cuneata* specimens in the total sample of 2 L suggests that the species may be common in

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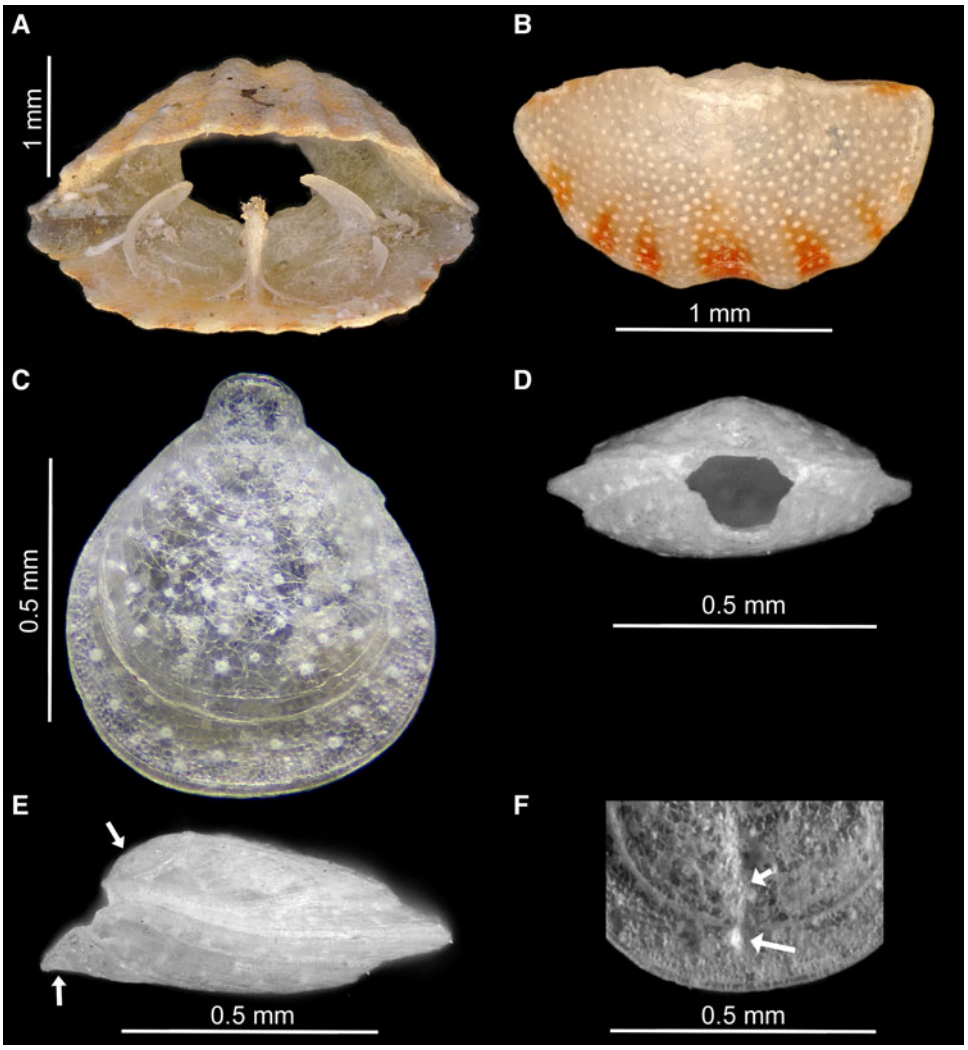

Figure 3. Representative specimens of *Argyrotheca cuneata*. (A) Largest specimen, inside of dorsal valve (bottom); (B) Another specimen with distinct colours, dorsal view; (C) Smallest specimen, ventral view; (D) Smallest specimen, posterior view; (E) Smallest specimen, lateral view (arrows point to protegula); (F) Smallest specimen, inside of dorsal valve showing protuberance near anterior edge (long arrow) and low ridge (short arrow).

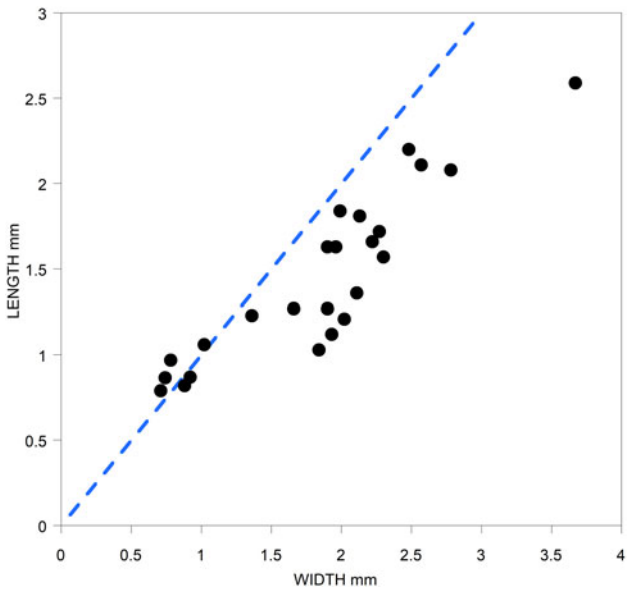

Figure 4. Scatter plot of lengths against widths of 23 complete specimens and one ventral valve. The broken line represents equal widths and lengths.

nearshore habitats at depths as shallow as 2.5 m along the southern coasts of Türkiye.

Data availability. The dataset of measurements used for Figure 4 is available upon request.

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Competing interests. None.

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