www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 14: 255-260 (2014) DOI: 10.4194/1303-2712-v14_1_27

SHORT PAPER

Additions to the Knowledge of the Molluscs of the Aegean Sea with Three Species: *Crepidula fornicata* (Linnaeus, 1758), *Anadara polii* (Mayer, 1868) and *Arcuatula senhousia* (Benson in Cantor, 1842)

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Received 26 July 2013
Accepted 10 January 2014

Abstract

Within the frame of surveys conducted in Izmir Bay (Aegean Sea) in November 2008, April 2009 and April-May 2012, three mollusc species (*Crepidula fornicata*, *Anadara polii* and *Arcuatula senhousia*) have been recorded. Of the identified species, *A. senhousia* is new record for the molluscan fauna of the Aegean Sea and the calyptraeid gastropod *C. fornicata* is new report for the Turkish mollusc fauna. Besides, diagnostic features of *A. polii*, a rare arcid species, is given based on specimens from Izmir Bay.

Keywords: New records, Gastropoda, Bivalvia, Turkey, Aegean Sea, alien mollusc.

Crepidula fornicata (Linnaeus, 1758), _Anadara polii_ (Mayer, 1868) ve _Arcuatula senhousia_ (Benson in Cantor, 1842): Üç Tür ile Ege Denizi Mollusk Bilgilerine Katkılar

Özet

İzmir Körfezi'nde Kasım 2008, Nisan 2009 ve Nisan-Mayıs 2012 tarihlerinde yapılan incelemelerde, üç Mollusca türü (*Crepidula fornicata*, *Anadara polii* ve *Arcuatula senhousia*) saptanmıştır. Bu türlerden, *A. senhousia* Ege Denizi Mollusca faunası için yeni kayıt, bir calyptraeid gastropod olan *C. fornicata* ise Türkiye'nin Mollusca faunası için yeni kayıttır. Ayrıca, nadir dağılımlı Arcidae türü olan *A. polii*'nin, İzmir Körfezi'nden elde edilen bireylere dayanılarak diyagnostik özellikleri verilmiştir

Anahtar Kelimeler: Yeni kayıt, Gastropoda, Bivalvia, Türkiye, Ege Denizi, yabancı tür

Introduction

Izmir Bay which is located in the Aegean Sea is divided into three parts (inner part, middle part and outer part) regarding its faunistic and hydrographic features (Kocataş, 1978; 1980). The inner part, where Alsancak Harbor is located, has been suffered from intense pollution of different origins since the 1960s and it is considered to be one of the most polluted environments of the Mediterranean Sea, until the establishment of a wastewater treatment station within the frame of 'The Grand Canal Project' in February 2000. Intense shipping activities in Alsancak Harbour are another factor contributing to the pollution of the inner part of Izmir Bay. However, introduction of some alien species into the area could be accepted as another effect of marine traffic of the bay. In the studies carried out before (Demir, 1977; Doğan *et al.*, 2005; Kazak and Cavas, 2007; Öztürk and Poutiers 2005), four alien mollusc species, i.e., *Bursatella leachii* de Blainville, 1817; *Anadara transversa* (Say, 1822), *Pinctada radiata* (Leach, 1814) and *Fulvia fragilis* (Forsskål in Niebuhr, 1775) were reported from Izmir Bay.

The present study deals with other three mollusc species sampled recently from the area: *Crepidula fornicata* (Linnaeus, 1758), *Anadara polii* (Mayer, 1868) and *Arcuatula senhousia* (Benson in Cantor, 1842).

The genus *Crepidula* (Calyptraeidae) is represented with three species (*Crepidula fornicata*, *Crepidula moulinsii* and *Crepidula unguiformis*) in the Mediterranean (Gofas, 2013). The slipper limpet *Crepidula fornicata* (Linnaeus, 1758) is native to the Atlantic coast of America, from Canada to Texas (Zenetos *et al.*, 2003) was accidentally introduced in Europe at the end of nineteenth century, currently

distributed along the Atlantic coasts of Europe from Irish Sea and Norway in the north to the Spain in the south, and with small populations in the Mediterranean Sea (Richard *et al.*, 2006; Mc Neill *et al.*, 2010).

Anadara polii, belonging to the family Arcidae, has a strong, rectangular and gibbous shell with a straight taxodont hinge line, and mostly with well-developed byssus. The family is represented by six genera and 14 species in the Mediterranean Sea (Gofas, 2013). *Anadara granosa*, *A. inflata*, *A. kagoshimensis*, *A. natalensis* and *A. transversa* are alien species of the genus in the Mediterranean Sea (Zenetos *et al*., 2010). *Anadara polii* is known to occur in the Mediterranean, in the Sea of Marmara as well as on the Atlantic coasts of Spain, Morocco, Portugal and Maderia (Cachia *et al*., 2004).

The Asian date mussel *Arcuatula senhousia* is a small thin shelled and filter feeding species of Mytilidae, living in the intertidal and subtidal soft substrates of the bays and estuaries where the species builds a nest or cocoon by holding sediment with its byssal threads, which may stabilise and protect the organism within the sediment (Morton, 1973, Crooks, 1996). *Arcuatula senhousia*, which is considered as an opportunistic species with a high reproductive capacity and a fast growth rate, may constitutes large populations with over than 10,000 ind/m^2, and this situation can alter the nature of the sediment where it occurs (Morton, 1973; Mistri, 2003; Munari, 2008). According to Zenetos *et al*. (2012), *A. senhousia* is one of the most successful invader which was introduced into the Mediterranean through aquaculture.

The present study includes some descriptive and distributional information on three mollusc species mentioned above, which were sampled during the surveys conducted in Izmir Bay between November 2008 and May 2012.

Materials and Methods

The benthic samples were taken from the infralittoral and circalittoral zones of various localities in Izmir Bay with a Van Veen Grab and beam trawl by the *R/V K. Piri Reis* and *Egesüf* from November 2008 to May 2012 (Figure 1).

The coordinates and characteristics of the stations are given in Table 1. The sampling material was sieved through 0.5 mm mesh, then fixed in 4% formalin, and after the sorting process in the laboratory, the specimens were preserved in 70% ethanol. The investigated specimens were deposited in the museum collections of the Faculty of Fisheries, Ege University (EFSM) (Izmir, Turkey).

Results

The examination of the benthic material taken from different localities in Izmir Bay revealed the presence of three mollusc species: *Crepidula fornicata* (Gastropoda), *Anadara polii* (Bivalvia) and *Arcuatula senhousia* (Bivalvia). Of these, *A. senhousia* is new record for the Aegean Sea fauna, and the calyptraeid gastropod *C. fornicata* is new report for the Turkish mollusc fauna.

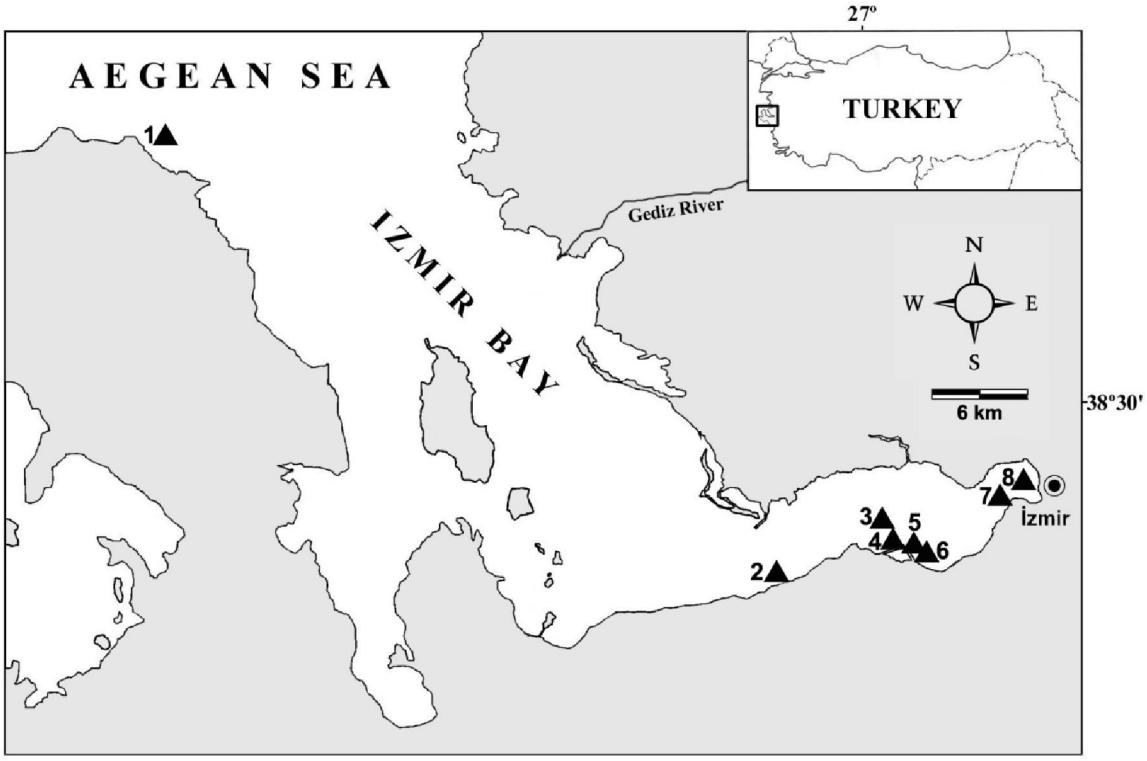

Figure 1. Map of the studied area with the location of the sampling sites.

***Crepidula fornicata* (Linnaeus, 1758) (Figure 2)**

Material examined: Sta. 2, mud with detritus, 15 m, 1 sp.; sta. 3, mud, 8 m, 8 sp.; sta. 5, mud, 11 m, 38 sp.; sta. 7, mud, 10 m, 1 sp.

Description: Shell oval and taller compared to the other European *Crepidula* species. No sculpture on the shell surface, except for irregular growth lines. Shell colour exteriorly cream or yellowish with brownish spots; interiorly dirty white with spots of yellowish to brown in colour. The aperture has a white septum extending to the middle part of the shell. Minimum length: 13 mm. Maximum length: 42 mm.

***Anadara polii* (Mayer, 1868) (Figure 3)**

Material examined: Sta. 1, sand, 76 m, 2 sp.

Description: Shell solid, inequivalve, almost equilateral, strongly inflated, obliquely ovate with a slightly extended posterior-ventral part, beaks just in front of midline. Umbones inflated, sculpture of 27 wide radial ribs with interspaces evidently narrower than ribs. Periostracum light brown getting dark towards margin, bearing hair-like extensions. Hinge line taxodont with numerous teeth. Length=12.8 and 9.1 mm.

***Arcuatula senhousia* (Benson in Cantor, 1842) (Figure 4)**

Material examined: Sta. 4, mud, 4 sp.; sta. 5, mud, 63 sp.; sta. 6, mud, 2 sp.; sta. 8, mud, 5 sp.

Description: Shell thin and fragile, elongate, roughly trigonal ovate in outline, umbones subterminal, very small crenulations in the hinge line,

Table. Coordinates and ecological characteristics of the stations where the studied species were sampled

Stations	Coordinates Bts	Coordinates Btf	Date	Depth (m)	Biotope	Sampling gear
1	38°40′51″N 26°30′17″E		23.11.2008	76	Sand	Grab
2	38°23'40"N 26°57'17"E	38°23'44"N 26°57'32"E	03.05.2012	15	Detritic mud	Beam trawl
3	38°25'46"N 27°02'11"E	38°25'43"N 27°02'25"E	03.05.2012	8	Mud	Beam trawl
4	38°25'11"N 27°02'51"E		10.04.2012	10	Mud	Grab
5	38°24'47"N 27°03'57"E	38°24'49"N 27°04'11"E	03.05.2012	11	Mud	Beam trawl
6	38°24'33"N 27°04'30″E		23.04.2009	12	Mud	Grab
7	38°26'44"N 27°08'18"E		03.05.2012	10	Mud	Grab
8	38°27'16"N 27°08'55"E		10.04.2012	8	Mud	Grab

(Bts: Beam trawl start, Btf: Beam trawl finish).

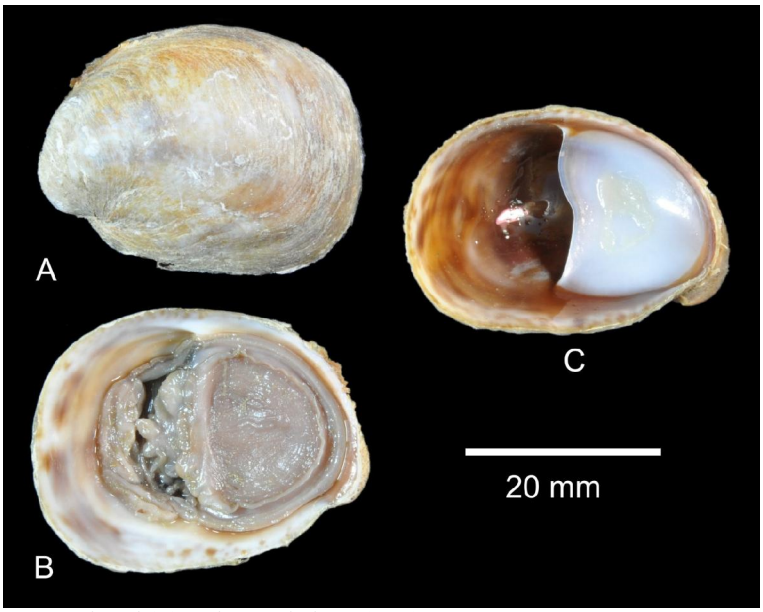

Figure 2. *Crepidula fornicata*: dorsal (A) and ventral views (B, C).

outer surface of the valves smooth with weak sculpture of numerous concentric lines, several small radial grooves in front of the umbones making the anterior part slightly crenulated; periostracum shiny and smooth, yellowish green to olive brown in colour; stripes in different tones of brown colour more evident in larger specimens, and irregular transverse bands more common in smaller specimens. Minimum length: 5.2 mm. Maximum length: 19.4 mm.

Discussion

As a result of evaluating the benthic material taken from Izmir Bay, three mollusc species were identified. Of these species, *Crepidula fornicata* is new record for the Turkish mollusc fauna and *Arcuatula senhousia* is new report for the Aegean Sea mollusc fauna.

Anadara polii is a rare species (Poppe and Goto, 1993) and was first recorded in Turkey by Sturany (1895) from the Sea of Marmara. Demir (2003) first reported this species in a species list from the Aegean coasts of Turkey without any specific data. Therefore, we provided here some ecological and distibutional features of this species from Izmir Bay.

The common slipper snail *C. fornicata* can rapidly spread out of the region where it introduces, and can create huge populations effecting native communities (Mc Neill *et al.*, 2010). The amazing success of the species can be attributed to its ecological properties. *Crepidula fornicata* is an eurytopic, eurythermal and euryhaline species and can be found in different biotopes having various

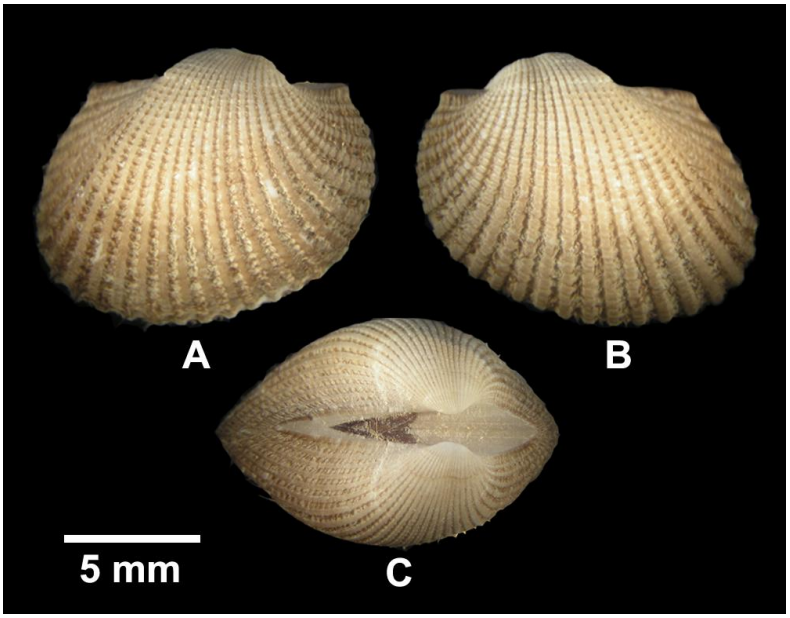

Figure 3. *Anadara polii*: right (A) and left (B) valves, and dorsal view (C).

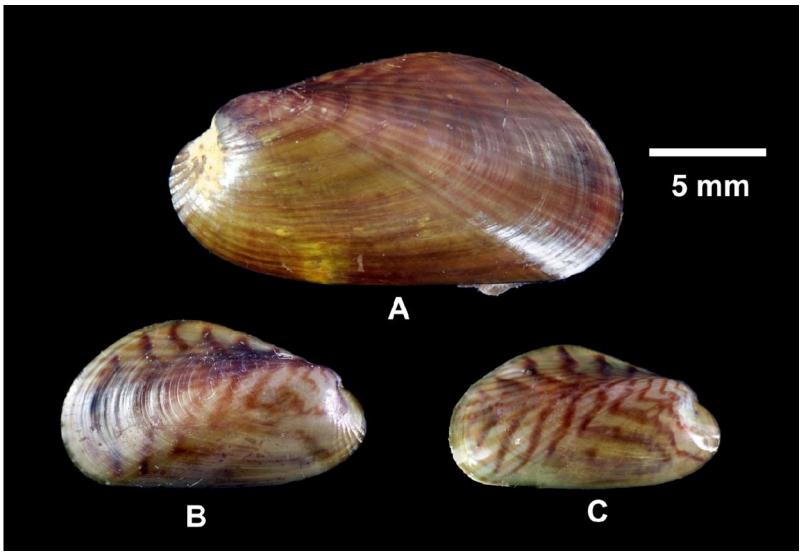

Figure 4. *Arcuatula senhousia*: left (A) and right (B, C) valves.

ecological characteristics (Hamon and Blanchard, 1994). Unlike the grazing gastropods, *C. fornicata* is a filter-feeding species, which allows specimens to form clusters by settling on top of each other and thereby enables it to form large populations in a given area (Blanchard, 1997). Thirty eight living specimens of *C. fornicata* were found in total in the present study as they were attached to the top of each other and the clusters were free, not attached to any substrates. The other characteristic of this species is that it is a protandrous hermaphrodite and the youngest specimens being male are able to inseminate several females lying below, resulting in a high survival rate (Blanchard, 1997; Dupont *et al.,* 2006). Although this species currently formed a scarce population (10 ind./m^2) in Izmir Bay, it has a great potential to become one of the dominant components of the benthic environments in the future due to its unique biology.

Crepidula fornicata was introduced to the Mediterranean mainly by bivalve farming and hull fouling (Blanchard, 1997). The occurrence of this species in Izmir Bay could be attributed to shipping because of the absence of bivalve farming in the area.

Arcuatula senhousia was reported for the first time from the Levantine coasts of Turkey by Uysal et al. (2008) but there was no specific information about the species. Eleftheriou *et al.* (2011) also reported many juvenile specimens of *A. senhousia* from Iskenderun Bay. In the present study, *A. senhousia* was encountered in the polluted inner part of Izmir Bay in April 2009 (20 ind./m^2), then in April 2012 (40 and 50 ind./m^2).The beam-trawl samples taken in May 2012 in the area had also 63 specimens of this species. Therefore, *A. senhousia* seems to have been established in the bay and enlarged its population density during a 3 year-period. It is known that alien species can expand its populations rapidly in the polluted areas and become dominant components of benthic communities (Çınar *et al.*, 2012).

The way of introduction of *A. senhousia* into Izmir Bay might be the same with *C. fornicata*. Thereby, the shipping transport seems to be one of the main factors for the introduction of alien species in Izmir Bay.

As a result of the present study, the number of the alien species found in Izmir Bay increased to six. Further investigations should be implemented in order to evaluate the potential impacts of the alien species on the native communities of the bay.

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