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First record of *Anadara demiri* (Piani, 1981) (Bivalvia: Arcidae) in Italian waters

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KEY WORDS: *Anadara demiri, Anadara inaequivalvis,* Arcidae, Adriatic Sea, allochthonous

ABSTRACT Large samples of the lessepsian migrant, *Anadara demiri* (Piani, 1981), native of the Indo-Pacific, were collected during a sampling programme for the baby clam, *Chamelea gallina*, with hydraulic dredges in the central Italian Adriatic Sea. This is the first time the species has been reported for Italian waters, having been previously observed in the bay of Smirne in Turkey (DEMIR, 1977) and in the gulf of Thermaikos and the bay of Thessaloniki in Greece (ZENETOS, 1994). The great similarity of *A. demiri* to the other allochthonous clam, *Anadara inaequivalvis* (Bruguiére, 1789), established in the central Adriatic since the early seventies (RINALDI, 1972; GHISOTTI, 1973), lead to a morphometric comparison of the shells, in order to clarify the morphological differences between the two species. Differences in main shell characteristics are discussed.

RIASSUNTO Nel corso di una serie di campionamenti con draga idraulica per la valutazione dei banchi di vongole (*Chamelea gallina*) nel medio Adriatico (FROGLIA, 1989), sono stati rinvenuti numerosi esemplari di *Anadara demiri* (Piani, 1981). Questa specie, originaria dell'Indo-Pacifico, non è mai stata segnalata nelle acque marine del territorio italiano. In Mediterraneo fu individuata, per la prima volta, nella baia di Smirne, in Turchia (DEMIR, 1977) e, successivamente, nel golfo di Thermaikos e nella baia di Salonicco in Egeo (ZENETOS, 1994). Data la sua notevole somiglianza con la congenere *Anadara inaequivalvis* (Bruguiére, 1789), presente nel mare Adriatico da quasi trent'anni (RINALDI, 1972; GHISOTTI, 1973), è stato effettuato un confronto, tra le due specie, di alcuni parametri morfometrici della conchiglia. Le differenze morfologiche tra le due specie sono discusse.

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INTRODUCTION

The past twenty years have seen the successful colonisation of the Adriatic Sea by molluscs of extra-M/m origin such as *Rapana venosa*, *Xenostrobus* sp. and *Tapes philippinarum*. Individuals of newly established species generally have average dimensions which are greater than those reported for their native areas, probably due to the high nutrient concentrations typical of the Adriatic basin (RINALDI & TAMBINI, 1999) and most of the time such colonisations result in huge population explosions, generally coincident with eutrophication peaks (RINALDI, 1991; RINALDI & TAMBINI, 1999). A recent example is that of *Anadara inaequivalvis* (Bruguière, 1789) which was, probably, accidentally introduced into the Mediterranean basin through the Suez Canal at the post-larval stage and first observed in the Adriatic Sea 30 years ago (RINALDI, 1972; GHISOTTI, 1973). In addition to *A. inaequivalvis*, other members of the sub-family Anadarinae present in the Mediterranean basin are *Anadara corbuloides* (Monterosato, 1878), *Anadara demiri* (Piani, 1981), *Anadara diluvii* (Lamarck, 1805) and *Anadara natalensis* (Krauss, 1848). Amongst these only *A demiri* and *A. natalensis*, both lessepsian migrants, have never been reported for Italian waters.

Within the Mediterranean Sea, *A. demiri* was first recorded in the Bay of Izmir, in Turkey (DEMIR, 1977), as *Scapharca amygdalum*, and later in the gulfs of Thermaikos and Thessaloniki in the Aegean Sea (ZENETOS, 1994).

A large number of *A. demiri* specimens was collected in 2000 during a survey carried out with hydraulic dredges (FROGLIA, 1989) to evaluate the stock of baby-clams - *Chamelea gallina* (L.) - in the Italian central Adriatic Sea (table 1). *A. demiri* is native of the Indo-Pacific (Piani, 1981) and this is the first sighting of it in Italian waters, its northerly distribution in the Mediterranean previously being limited to the Aegean Sea. Due to the great variation in shell morphology of *A. demiri* and to its conspicuous similarity to *A. inaequivalvis*, a morphometric comparison of the shells was made to discriminate the two species.

METHODS

Specimens of *A. demiri* (fig. 1) collected by the Authors were identified, with the aid of Mr Emidio Rinaldi, by comparison with those collected in Turkey (bay of Smirne) and Greece (gulf of Thermaikos and bay of Thessaloniki) by Demir (1977) and Zenetos (1994), respectively. In order to further clarify the morphological differences between *A. demiri* and *A. inaequivalvis* (fig.2), a random sample of 50 individuals of each species was selected from the collected material (table1) and the following measurements and counts were made:

L = maximum length of shell (mm);
H = height of shell at the umbo (mm);
W = maximun width of the left valve (mm)
R = number of ribs

Regression equations of the linear type, $Y = a + bX$, were calculated for length-height (L-H) and length-thickness (L-S) relationships for both species. Due to the non-normal distribution of the data, a Mann-Whitney test (ZAR, 1999) was used to compare

height/length (H/L) and thickness/length (S/L) ratios. The number of ribs (R) of the two species was compared using a two-tailed t-test (Zar, 1999).

RESULTS

The size range of the *A. demiri* specimens examined was 10.0-31.2 mm with a mean length of 21.3 ± 5.5 mm. *A. inaequivalvis* specimens ranged between 17.7 and 30.0 mm with a mean length of 25.4 ± 2.9 mm. The regression equations for both species for length/height and length/thickness relationships are summarised in table 2 and illustrated in figures 3 and 4. A highly significant difference resulted from the Mann Whitney tests carried out to compare height/length and thickness/length ratios (table 3) for the two species. Figures 3 and 4 illustrate this clearly, showing that *A. inaequivalvis* has significantly greater thickness/length and height/length ratios than *A. demiri*. The main features of the shell of *A. demiri*, as described by DEMIR (1977), are herein presented:

"Shell solid. Completely closing all along its margins. Some shells, especially in young phases, have a slight depression on each valve, or on the right valve radiating from the beak to the ventral margin where the byssus emerges. This depression is seen on the valves of old shells, too, but usually only at the umbonal part. Inequivalve: left valve overlaps right valve and is more conspicuous posteriorly. Inequilateral: incurved beaks approximately at the end of the anterior third of the length of the hinge margin. Ovate-oblong in shape, ovateness varies from shell to shell. Hinge margin straight. Upper corners angulated, in some shells slightly auriculated, too. Sculpture of radiating ribs, concentric ribs and concentric furrows of growth. Periostracum scaly between ribs. Hinge plate long, straight, somewhat wide at extremities, becoming narrow at the centre."

The number of ribs in *A. demiri* ranged from 29 to 35 with a mean value of 33.1 ± 1.5 and for *A. inaequivalvis* from 31 to 35 with a mean value of 32.6 ± 1.0. The two-tailed t-test (table 4) carried out to compare the two species resulted non-significant at $p = 0.05$.

CONCLUSIONS

The results summarised in tables 2 and 3 show that, compared to *A. inaequivalvis* (fig. 2), *A. demiri* (fig. 1) has a shell which is, within the same length range, narrower and less globose, confirming previous descriptions. Nevertheless, there is no significant difference in the number of ribs of the two species; character which, therefore, cannot be used for discrimination purposes.

A. demiri was first reported in Turkey in the late 1970's (DEMIR, 1977) and in Greece (ZENETOS, 1994) twenty years later. Its presence in the Italian Adriatic today could indicate some conformity with the Island Jumping Model (GOFAS, 1992; CHEMELLO & OLIVERIO, 1996) as evidenced by another lessepsian migrant, *Brachidontes pharaonis* (P. Fischer, 1870) (GIANGUZZA *et al.*, 1998) Alas, insufficient data are available on such dispersal for an accurate prediction to be made on its progressive expansion towards Italian waters, whether by a step by step colonisation or by a more likely anthropogenic input. This first recording of *A. demiri* in the Adriatic Sea expands the extent of its westerly and northerly distribution significantly. It would now be interesting to carry out a detailed study on the establishment of the species in Italian waters, giving an account on its recruitment patterns, in light of the fact that a significant settlement of spat was found off Porto Recanati, south of the Ancona area.

A. inaequivalvis mainly inhabits sandy bottoms (CESARI & PELLIZZATO, 1985), although its great physiological adaptability enables it to survive under critical conditions and adapt to different habitats, often displacing the less resistant native species (BROOKS *et al.*, 1991; CATTANI, 1992). Similarly, ZENETOS (1994) reported the presence of *A. demiri* in the gulf of Thessaloniki to be invariably linked to unfavourable environmental conditions, where the highest densities (up to 180 individuals per square metre) were found in polluted waters, leading to the proposition of it being used as an indicator species. Owing to this, competition could arise between *A. demiri* and the allochthonous *A. inaequivalvis*.

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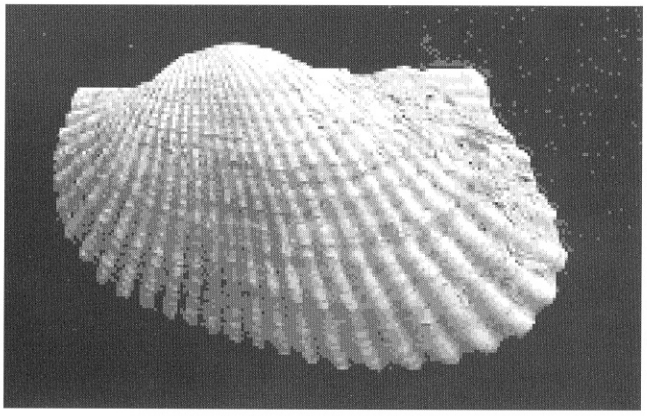

Figure 1 - *Anadara demiri* (18.6mm)

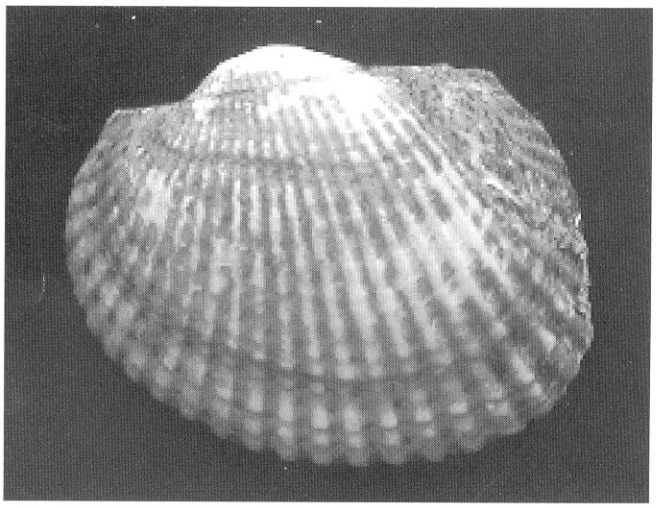

Figure 2 - *Anadara inaequivalvis* (17.3mm)

Locality and date	coordinates	species	depth	substrate
Palombina di Ancona 04/09/2000	43° 38.42N 13° 26.26E	*A. demiri* *A. inaequivalvis*	10 metres	Sandy
Porto Recanati 14/09/2000	43° 25.71N 13° 42.66E	*A. demiri* *A. inaequivalvis*	11 metres	Sandy

Table 1 - Sampling locality of examined specimens.

Relationship	Species	Regression equation	R^2	N
L-H	*A. demiri*	H=0.6231L - 0.2781	0.9459	50
	A. inaequivalvis	H=0.7572L + 1.1564	0.8768	50
L-S	*A. demiri*	S=0.2434L + 0.0331	0.8809	50
	A. inaequivalvis	S=0.3555L + 0.1632	0.7808	50

Table 2 - Regression equations.

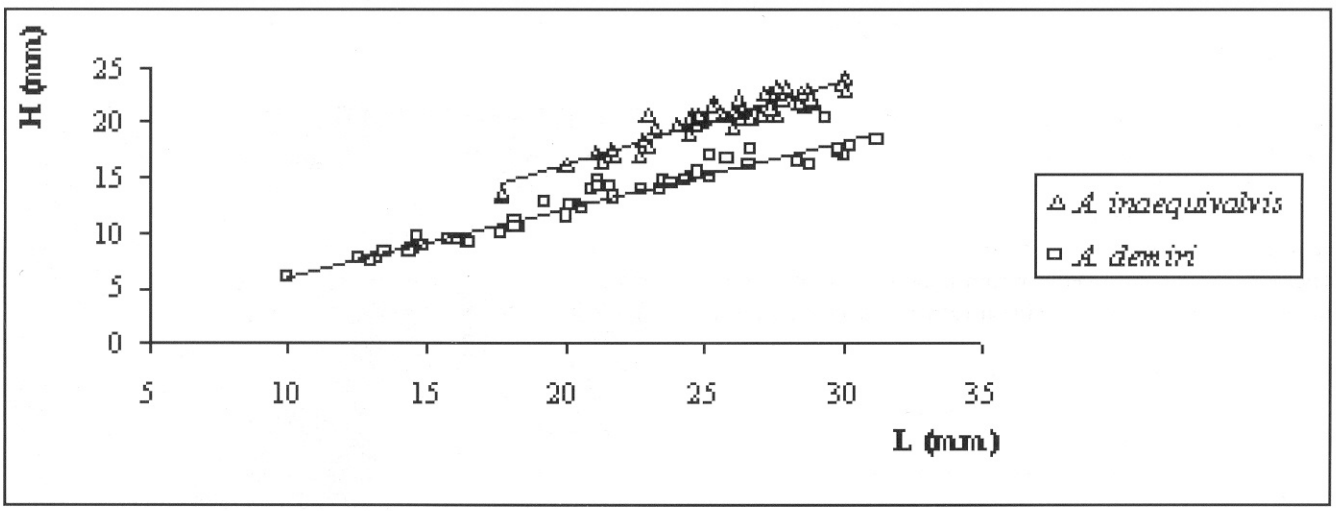

Figure 3 - Height/length relationship for *A. inaequivalvis* and *A. demiri*.

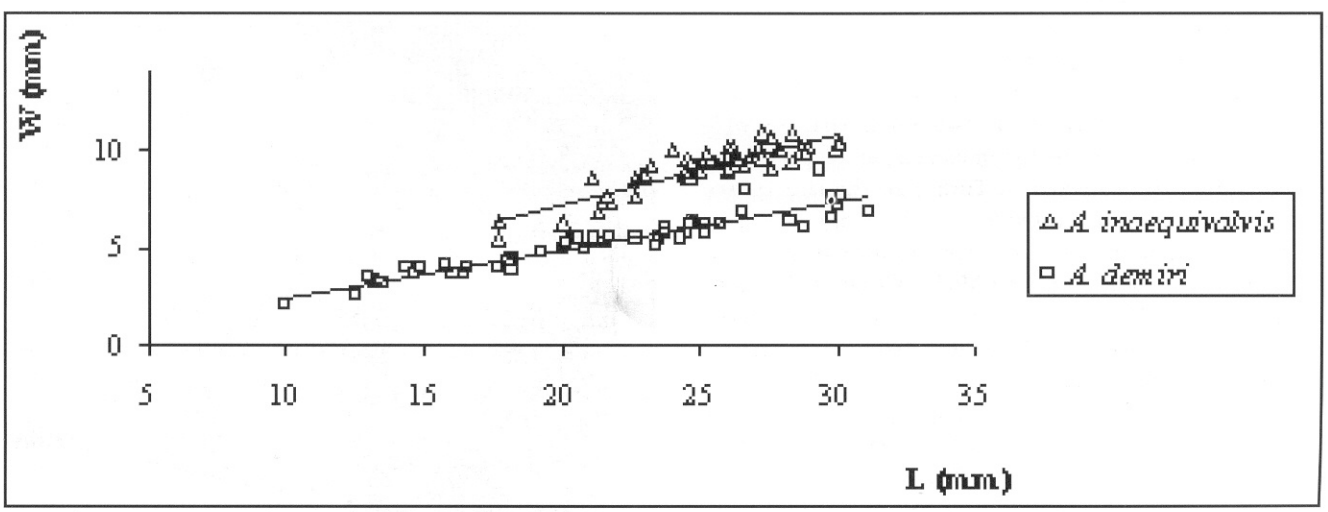

Figure 4 - Width/length relationship for *A. inaequivalvis* and *A. demiri*.

Ratio	Zo	Zc
H/L	- 8.6167	1.96
S/L	- 8.6167	1.96

Table 3 - Z values for the Mann-Whitney test on morphometric data (Zo = observed Z; Zc = critical Z at p = 0.05).

Variable	to	tc	df
R	1.75	1.98	98

Table 4 - t values for the two-tailed t-test number of ribs (to = observed t; tc = critical t at p = 0.05).

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