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ORIGINAL ARTICLE

DETECTION OF THE PRESENCE OF BOTH SPECIES *SINANODONTA WOODIANA* (LEA, 1834) AND *SINANODONTA LAUTA* (MARTENS, 1877) (BIVALVIA, UNIONIDA, UNIONIDAE) IN THE LATE HOLOCENE SEDIMENTS OF SOUTHERN IRAQ

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ABSTRACT

The new pelecypod *Sinanodonta lauta* (Martens, 1877) (Bivalvia, Unionida, Unionidae), represented by specimens collected from seven sites on both banks of the Euphrates River (NW of Basrah Province), was recorded for the first time in southern Iraq. The following was the analysis to recognize the sediments at these sites and also of the different species shells in the area. It was found that the mud sediment was the most common compared to silt and sandy mud sediments. Two pelecypod species were recognized in the study region, *Sinanodonta woodiana* (Lea, 1834) and *S. lauta* (Martens, 1877), and one species of barnacles *Amphibalanus subalbidus* (Henry, 1973) (Maxillopoda, Sessilia, Balanidae). The presence of such species indicates that the area has already experienced an environmental change which occurred in the Late Holocene, when all such species were introduced from the outside the native ecosystem.

Keywords: Barnacle, Freshwater, Pelecypoda, *Sinanodonta*, Southern Iraq.

INTRODUCTION

The south of Iraq is the southern part of Mesopotamia, the interfluvial region between the Tigris and Euphrates rivers (Soden *et al*., 2024). Southern Mesopotamia is defined by its alluvial plains (Plaziat and Younis, 2005), mainly formed by the rivers Tigris and Euphrates, which have been formed through silt deposition from these rivers, lagoons, and marshes that are situated far to the south bordering the Arabian Gulf (Emberling, 2015; Soden *et al*., 2024). During the Quaternary, especially in the late Pleistocene and Holocene, these fluvial systems have been widely subjected to modifications that can be attributed to climatic variations and tectonic movements. These modifications have given rise to diverse depositional environments and were important for the interpretation of the molluscs habitat (Plaziat and Younis, 2005). These deposits show sedimentation involved with an active sedimentation history with low salinity conditions (Sissakian *et al*., 2018; Sissakian and Al-Ansari, 2019) favorable for freshwater mollusc species (Petrov *et al*., 2023). In Iraq, the study of molluscs has flourished, Ahmed (1975) reported on molluscs of southern Iraq; and AL-Hassan and Al-Hasani (1985) wrote about the different bivalves in Iraq. Subsequently, Ali *et al*. (2017) supplemented the list of Iraqi molluscs with the description of five more marine species. More recently, Bogan *et al*. (2021) and Naser *et al*. (2024) have shown the fresh water mussel *Sinanodonta woodiana* (Lea, 1834) in Iraq. Furthermore, Yasser *et al*. (2023) increased the number of Iraqi marine molluscs. Last but not least, Jihad (2023) there was a comprehensive review of the fresh and marine bivalves which has existed in Iraq during history.

This investigation aims to detect mollusc species from sediments exposed from the watercourses and to find the cause of the molluscs presence in Iraq for the first time, along with discussing the implications.

MATERIALS AND METHODS

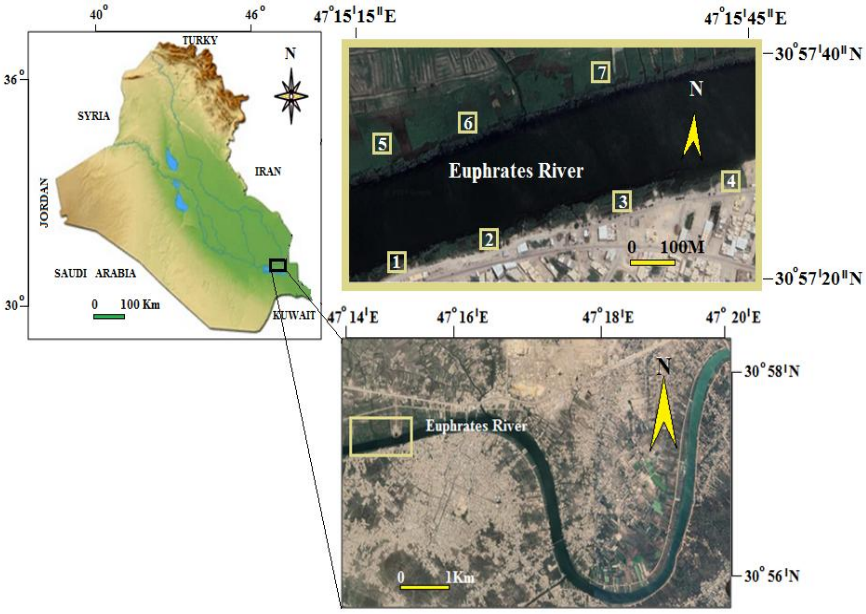
Study area: The study area is situated between latitudes (3057'40"N-3057'20"N) and longitudes (4715'15"E-4715'45"E), and is the northern part of the Al Madina District, which is located in the northwest area of the Basrah Province in the south of Iraq. It is adjacent to the Euphrates River (Map 1).

Sampling: Sixteen specimens were collected from seven sites distributed on the shore banks of the Euphrates River in the study area during July 2023, as illustrated in Map (1). The selection of depths for collecting specimens from the seven sites was based on the occurrence of pelecypod shells there. The sediments samples and shells specimens were extracted from a depth of between 0.35m and 0.75m using a shovel. The sediment samples were collected from the same depths as the specimens in the sites in order to identify the sediments type in which the shells were found.

Laboratory procedures: To determine the sediments types, present in the study area, 100 grams of sediments were collected from each sample in site, and a grain size analysis was conducted using wet sieving with a 0.0625 mm sieve. This method allowed for the separation of sand from silt and clay, facilitating the subsequent pipette analysis as outlined by Folk (1980).

As for the pelecypod shells, they were visible and large in size, ranging from 12 to 17 cm, which makes them identifiable with the naked eye. They were collected from the sediments, cleaned of any sediment residue attached to them, and dried in order to prepare them for classification. The valves of shells were photographed from both the outside and the inside. The identification of the pelecypods species and their identification is based on Akiyama and Natuhara (2015), Zieritz *et al*. (2018) and Lopes-Lima *et al*. (2021).

The study area prominently featured the presence of barnacles, which were easily observable on the surfaces of both shells and solid sediments at the various sites examined. The barnacle species is identified according to Shahdadi *et al.* (2014).



Map (1): The study area and the sites selected for sampling.

RESULTS

Sediments

The grain size analysis results (Folk, 1980) for the samples collected from the investigated sites indicate the existence of three sediment types: silt, sandy mud, and mud, as detailed in Table (1). Among these, mud emerged as the predominant sediment, accounting for 81% of the total samples analyzed, while silt comprised 13%, and sandy mud represented the smallest fraction at 6%. Mud was found in all depths. Overall, the sediments types suggest that their deposition occurred in a low-energy sedimentation environment (Bhattacharya *et al*., 2016).

Pelecypoda species

This study provides the first documentation of the *Sinanodonta lauta* (Martens, 1877) within Iraq. Whereas, the species *S. woodiana* (Lea, 1834) had been previously identified in central Iraq by Bogan *et al*. (2021), and in its southern region by Naser *et al*. (2024), as shown in Plate (1). The shells were observed to be devoid of any organic remnants and were found across all locations, manifesting both as intact shells and as individual valves, as illustrated in Table (2).

Barnacle species

Barnacle shells were observed throughout all sites within the study area (Pl. 2), commonly affixed to the shells of pelecypods as shown in Plate (1) and on various hard substrates as they appear in Plate (3), forming aggregates. The predominant species identified was *Amphibalanus subalbidus* (Henry,1973). Plates (2, 3) show the shells assemblages of the species. This species has also been documented in various locations along the banks of Shatt Al-Arab by Yasser *et al*. (2022).

Table (1): The texture of sediment samples collected from the study area.

Number of specimens	Site	Sample depth (m)	Sediment texture
1	1	0.35	Sandy mud
2		0.5	Mud
3		0.75	Mud
4	2	0.40	Mud
5		0.65	Mud
6	3	0.45	Mud
7		0.70	Mud
8	4	0.35	Silt
9		0.74	Mud
10	5	0.36	Mud
11		0.75	Mud
12	6	0.50	Mud
13		0.75	Mud
14	7	0.40	Silt
15		0.60	Mud
16		0.75	Mud

Table (2): Pelecypod species and number of shells and valves in the study area sites.

Site	Sample depth (m)	*Sinanodonta lauta*		*Sinanodonta woodiana*	
		Shell	Valve	Shell	Valve
1	0.35	1	0	3	2
	0.5	2	1	2	1
	0.75	0	0	4	0
2	0.40	1	1	2	1
	0.65	0	1	3	3
3	0.45	2	1	3	0
	0.70	0	1	2	1
4	0.35	3	1	1	0
	0.74	2	2	2	1
5	0.36	1	2	1	0
	0.75	3	2	2	1
6	0.50	1	1	1	0
	0.75	3	1	0	1
7	0.40	2	1	0	1
	0.60	2	2	0	0
	0.75	3	1	0	1

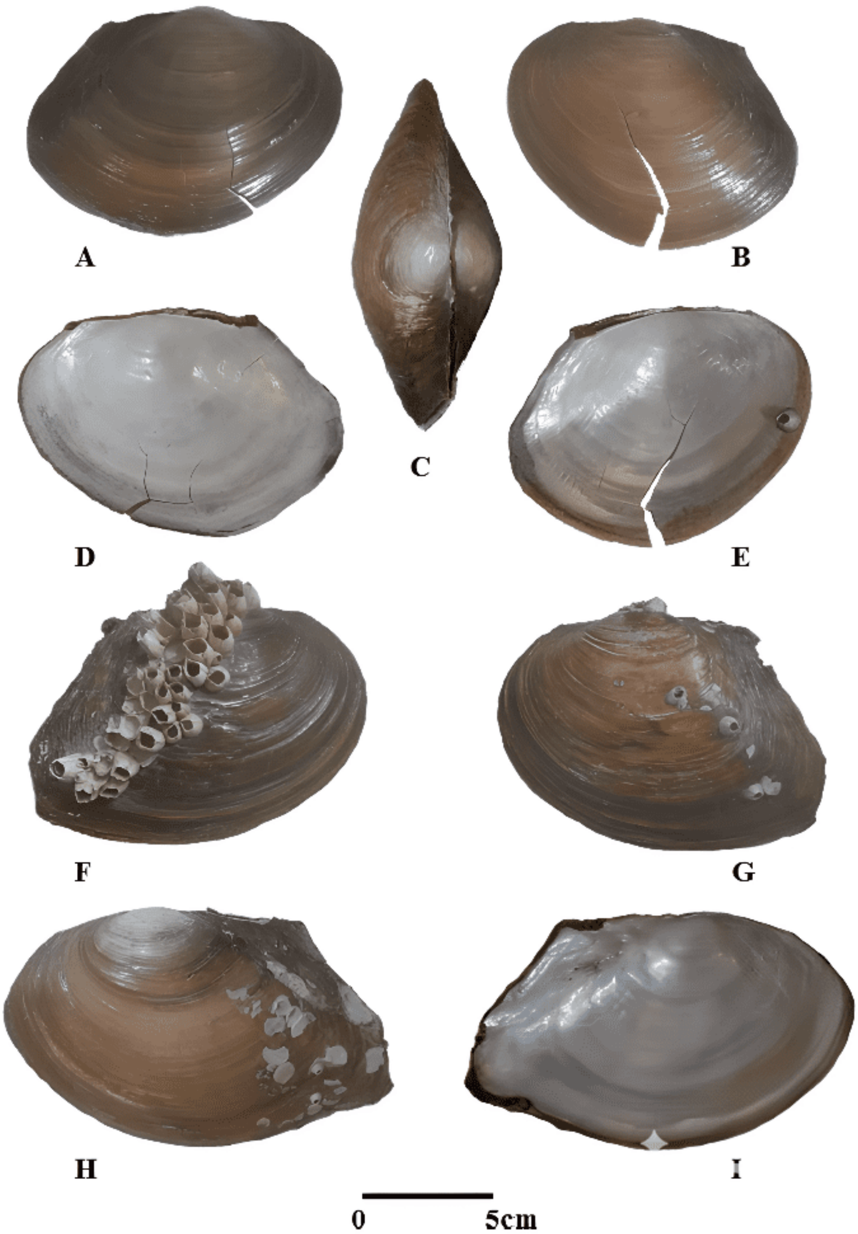


Plate (1): A-G: *Sinanodonta woodiana* (Lea, 1834); (A) Right valve(exterior view), (B) Left valve (exterior view), (C) Dorsal view (umbonal view), (D) Right valve (interior view), (E) Left valve (interior view); (F) Right valve (exterior view), (G) Left valve (exterior view), (H-I) *Sinanodonta lauta* (Martens, 1877), (H) Left valve (exterior view), (I) Left valve (interior view).

Detection of the presence of both species

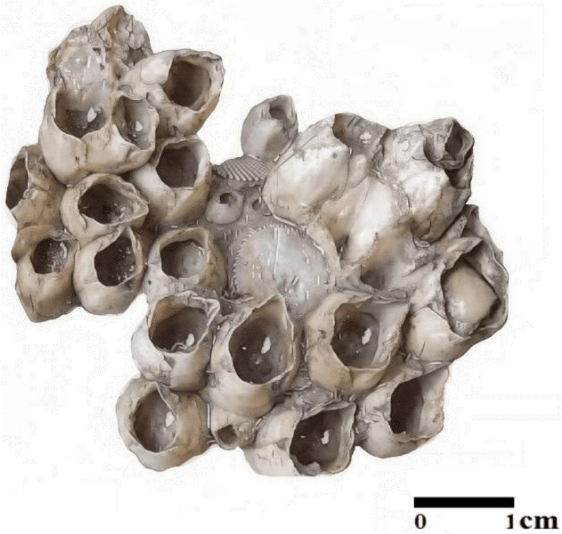


Plate (2): *Amphibalanus subalbidus* (Henry,1973).

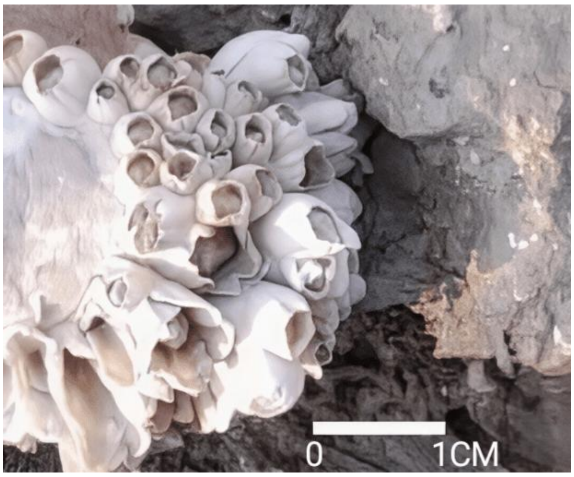


Plate (3): *Amphibalanus subalbidu*s fixed on hard.

DISCUSSION

Sinanodonta woodiana and *S. lauta* (Bivalvia, Unionida, Unionidae) are both freshwater pelecypods species that inhabit a variety of aquatic environments. *S. woodiana*, also known as the Chinese pond mussel, is native to East Asia but has been introduced to various regions around the world, including Europe and North America (Urbanska and Andrzejewski, 2019; Urbańska *et al*., 2021). The species has been observed in various sediment types, primarily preferring muddy substrates but also found in sandy environments (Urbańska *et al*., 2021). Also, it thrives in various freshwater habitats, including; lentic habitats, such as lakes, ponds, and oxbows and lotic habitats, including slow-flowing rivers, streams, and canals. *S. woodiana* has been found within various settings such as fishponds, abandoned mining pools, and rice paddy channels in Southeast Asia (Kondakov *et al*., 2020 a; Urbańska *et al*., 2021; Douda *et al*., 2025).

S. woodiana was first collected from freshwater waterbodies of Iraq in the Hilla River, an eastern tributary of the Euphrates River, was collected in the middle area of Hilla City (Bogan *et al*., 2021), but its recorded range was only in the upper part of Shatt Al-Arab which is in the southern part of Iraq (Naser *et al*., 2024). *S lauta* is another genus and, like wild species *S. woodiana*, belongs to the family Unionidae and is found in comparable environments (Bogan *et al*., 2021; Zieritz *et al*., 2022). *S. lauta* (Martens, 1877) has also been reported in multiple freshwater bodies beyond its natural range such as big rivers and lakes in European Russia and Siberia. It cohabits with other species of mussels, which demonstrates its ability to adapt to various environmental conditions (Kondakov *et al*., 2020 b; Douda *et al*., 2025).

The Holocene was a time of warming following the last remaining ice age. This warming resulted in alterations in the precipitation, temperature and global ecosystem dynamics, influencing freshwater habitats where both *Sinanodonta woodiana* and *S. lauta* were present; which, in consequence, determined the use of the two species in the environmental change detection. *S. woodiana* has been used in Holocene palaeoenvironmental investigations. Its calcareous shells provide an environmental record that can be used for reconstructions of past conditions, and that have been used previously to assess climatic and hydrological fluctuations over time (Zieritz *et al*., 2022). The species are recorded from diverse sedimentary strata and help to interpret past biodiversity and environmental turn-overs of fresh-water ecosystems. In the context of the Holocene, *S. lauta* further provides information about freshwater ecosystems, especially habitat preferences and ecological functions. It has been reported to inhabit the same niches as *S. woodiana*, which has additional conservation and management implications for freshwater biodiversity (Bolotov *et al*., 2020; Urbańska *et al*., 2021). *S. woodiana* has proved its adaptability to different environmental conditions, thus it has become a successful colonizer of a variety of freshwater systems including ponds, lakes, and rivers. Increased temperatures led, from the Holocene onward, to range expansion of *S. woodiana* in previously glaciated areas, particularly in Europe and the North American continent as an invader. The fact that it has the potential to live on very different bottom sediments (from sandy to muddy) provided its colonization of different freshwater ecosystems (Kondakov *et al*., 2020 b).

The most likely impact is the warming climate, which increased the habitat suitability for *S. woodiana*, the species which can survive in warm waters, thus its adaptability in turn promoted its demographic success in local regions (Kondakov *et al*., 2020 b). *S. lauta*, however, is inferred to occupy a narrower range of environments and could not have similarly experienced greater success in colonizing the changing Holocene landscape. Although it has some ecological overlap with *S. woodiana*, its range is narrower and is mostly restricted to its native East Asian range. The effects of Holocene climate change specifically on *S. lauta* are not so clear, but the same warming trends that favored *S. woodiana* could have been detrimental to *S. lauta*, particularly if it had narrower habitat preferences (Alwanzadegan *et al*., 2023; Mehler *et al*., 2024).

The finding of both species in recent sediment of the study locality, therefore, suggests the complex nature of freshwater ecosystems of the area in the present study. The study area is under the influence of the waters of two rivers; Karkheh River is discharged into Hawizeh Marsh southeast of the city of Amara, draining into the Tigris River north of Qurna and the Shatt al-Arab south of Qurna, and Karun River is discharged into Shatt al-Arab south of the city of Basrah. Therefore, the water in the Shatt al-Arab is a combination of water derived from the four rivers (that is, the Karkheh, Karun, Tigris, and Euphrates), and is exposed to the tidal oscillations, and mixes with sea water in its turn, which influences the water levels in Shatt al-Arab to rise or fall with it and hence the changes the characteristics of water in Shatt al-Arab (Al-Manssory,1996).

This sharing of water sources not only affects water quality, but also shapes the composition of the kinds of organisms that are found in such environments. This can be seen in the study area as well as the species *S. woodiana* which was reported in Iraq in Hillah city (Bogan *et al*., 2021) and recorded in Turkey (Ecrn *et al*., 2013). Regarding the species *S. lauta*, it has been reported from Iran (Alwanzadegan *et al*., 2023). The existence of this species in the vicinity of Iraq in regions from which they have water, is proof of their having migrated from there. What really validates the influence of the water body in the arrival of the species to the study site is the presence of barnacle shell, which is well known to the saline habitat and it is identified as the *Amphibalanus subalbidus* (Henry, 1973) and also identified as an exotic species in the area. This species is recorded for the first time from a locality other than its natural distribution in the Western Atlantic and it is considered to be well-established in the lower parts of the Euphrates, Tigris and Karun Rivers (Shahdadi *et al*., 2014). The occurrence of these species in association with the barnacle shells gives the impression that the species has settled in southern of Iraq for a period of time. The large size of the species shells and their presence in most of the study areas also is a similar proof, particularly as the shells in this study area are found completely void of organic tissues. Regarding the number of shells and valves of the species, there was a predominance of the species was predominantly *S. woodiana*, and perhaps the species can adapt to the environmental change at the end of Holocene (Urbańska *et al*., 2021).

CONCLUSIONS

The present investigation is the first record of the species *Sinanodonta lauta* in southern Iraq; in addition to the occurrence of the invasive species, *S. woodiana* that was previously recorded in Iraq. The presence of pelecypod species in the study area (which is a muddy environment) and their migration and tendency to establish elsewhere prompted the assumption of their environmental sensitivity to Holocene climatic changes such as warming. The accompanied presence of barnacle shells with pelecypod species demonstrates that the two species have lived in southern Iraq for a long time, probably since the Late Holocene; and given the presence of both *S. woodiana* (Lea, 1834) and *S. lauta* in the recent sediment of the investigated region, this emphasizes the complex and interesting nature of the freshwater ecosystem as found in the recent studied sites.

CONFLICT OF INTEREST STATEMENT

"The author has no conflicts of interest to declare".

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الكشف عن وجود النوعين

***Sinanodonta lauta* (Martens, 1877) و *Sinanodonta woodiana* (Lea, 1834)**

(Bivalvia, Unionida, Unionidae)

في رواسب الهولوسين المتأخر من جنوب العراق

بشرى مجيد عيسى

قسم علم الارض، كلية للعلوم- جامعة البصرة، البصرة، العراق

الاستلام: 2025/6/20، المراجعة: 2025/8/21، القبول: 2025/8/24، النشر: 2025/12/20

الخلاصة

كشفت الدراسة عن نوع جديد من المحاريات *Sinanodonta lauta* (Martens, 1877) يتم توثيقه لأول مرة في جنوب العراق وذلك من خلال جمع نماذج من سبعة مواقع تقع على ضفتي نهر الفرات، شمال غرب محافظة البصرة. وأجري تحليل لتحديد أنواع الرواسب في هذه المواقع، إلى جانب أنواع الاصداف المختلفة الموجودة في المنطقة.

بينت النتائج أن الرواسب الوحلية تغلبت على أنواع الرواسب الأخرى، والتي شملت الغرين والوحل الرملي. وفي منطقة الدراسة، تم تحديد نوعين من المحاريات هما: *S. lauta* (Martens, 1877) و *Sinanodonta woodiana* (Lea, 1834) (Bivalvia, Unionida, Unionidae)، إلى جانب نـــوع من البرنقيـــل البحري متمثلا بـ *Amphibalanus subalbidus* (Henry, 1973) (Maxillopoda, Sessilia, Balanidae). يشير وجود هذه الأنواع إلى أن المنطقة تأثرت بالتغيرات البيئية التي حدثت نحو فترة الهولوسين المتأخرة، حيث أن جميع الأنواع التي تم تحديدها قدمت من خارج النظام البيئي الأصلي للمنطقة.