NAT. CROAT. | VOL. 31 | No 2 | 393-398 | ZAGREB | December 30, 2022

short communication / kratko priopćenje
DOI 10.20302/NC.2022.31.28

THE FIRST RECORD OF THE INVASIVE CHINESE POND MUSSEL *SINANODONTA WOODIANA* (LEA, 1834) (BIVALVIA: UNIONIDAE) IN THE AFRICAN CONTINENT

Youness Mabrouki[1] & Abdelkhaleq Fouzi Taybi[2]

[1]Sidi Mohamed Ben Abdellah University, Faculty of Sciences Dhar El Mehraz, Biotechnology, Conservation and Valorisation of Natural Resources laboratoy, Fez, Morocco (Email: younes_mab@hotmail.fr / youness.mabrouki@usmba.ac.ma)

[2]Université Mohammed Premier, Faculté Pluridisciplinaire de Nador, Équipe de Recherche en Biologie et Biotechnologie Appliquées, Morocco (Email: taybiaf@gmail.com)

Mabrouki, Y. & Taybi, A. F.: The first record of the invasive Chinese pond mussel *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) in the African continent. Nat. Croat., Vol. 31, No. 2, 2022, 393-398, Zagreb.

The Chinese pond mussel *Sinanodonta woodiana* s.l., is a successful global invader. We report its first finding in Morocco, which represents the first record of the species in the African continent. Measures are needed to increase monitoring and management of its invasion process.

Keywords: new arrival, Morocco, aquatic invasion, alien mussel, Sebou River basin

Mabrouki, Y. & Taybi, A. F.: Prvi nalaz invazivne azijske bezupke *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) na afričkom kontinentu. Nat. Croat., Vol. 31, No. 2, 2022, 393-398, Zagreb.

Azijska bezupka *Sinanodonta woodiana* s.l. je svjetski uspješna invazivna vrsta. Izvještavamo o njenom prvom nalazu u Maroku, što predstavlja prvi nalaz te vrste na afričkom kontinentu. Potrebno je poduzeti mjere za pojačani monitoring i upravljanje njenom invazijom.

Ključne riječi: novi nalaz, Maroko, invazija u vodenim ekosustavima, strani školjkaš, sliv rijeke Sebou

INTRODUCTION

Biological invasions are one of the top threats to biodiversity and ecosystem functioning worldwide, and freshwater systems are among the most invaded ecosystems (Fenoglio *et al*., 2016). Besides involving huge economic costs, invasive species can also cause a reduction in the genetic diversity of native species and lead to biotic homogenization through a variety of mechanisms (Rahel, 2000). Continental aquatic environments are particularly sensitive to this problem (Gherardi *et al*., 2007). In fact, freshwater ecosystems have been subjected globally to deliberate or accidental introductions of alien species (Vitousek *et al*., 1997).

Within molluscs, many species have been considered as invasive in freshwater ecosystems. They are represented by Gastropoda, such as the New Zealand mudsnail *Potamopyrgus antipodarum* (J. E. Gray, 1843) and the apple snail *Pomacea canaliculata* (Lamarck, 1828) (Estebenet & Martín, 2002; Karatayev *et al*., 2009). Invasive freshwater bivalve species such as the zebra mussel *Dreissena polymorpha* (Pallas, 1771), and

the Asian clam *Corbicula fluminea* (O. F. Müller, 1774) (Reeders & de Vaate, 1990; Domagała *et al*., 2004) are also widespread species causing major ecological and economic problems (Sousa *et al*., 2014). Another good example is the Chinese pond mussel *Sinanodonta woodiana* (Lea, 1834), which is one of the most successful invasive freshwater mollusc species worldwide.

Sinanodonta woodiana is native to Eastern Asia (Zhadin, 1952; Watters, 1997). It was introduced in the early 1960s in Romania with fish carrying glochidia, imported to control algal development in lentic eutrophic areas (Bacalbasa-Dobrovici, 1984). Since then, *S. woodiana* has invaded lakes and rivers of North America and the Caribbean region, Europe and other parts of Asia (Yurishinets & Korniushin, 2001; Vikhrev *et al*., 2017; Bolotov *et al*., 2020; Fornillos *et al*., 2020; Bogan *et al*., 2021).

In this paper, we report the first record of the giant Chinese pond mussel *S. woodiana* in the African continent. We discuss possible mechanisms of introduction. Moreover, we aim to increase awareness of the impacts of invasive species on native fauna in Morocco.

MATERIAL & METHODS

Field surveys were conducted in central Morocco, mainly on the Moulouya and Sebou River basins. These surveys include reservoirs such as the Al Kansra dam (Fig. 1). Our goal was to document macroinvertebrate biodiversity in the different microhabitats prospected at each sampling site. Located on the Beht River, the last major tributary of Oued Sebou before its mouth, about 20 km south of Sidi Slimane, the El Kansera dam built between 1927 and 1935 is the oldest accumulation dam in Morocco.

RESULTS

About thirty empty shells were collected from the Al Kansera dam on 01/31/2021 after the regression of water levels (Fig. 1). The size of the collected shells varied between 4 and 17 cm, with numerous shells of *C. fluminea* (O. F. Müller, 1774).

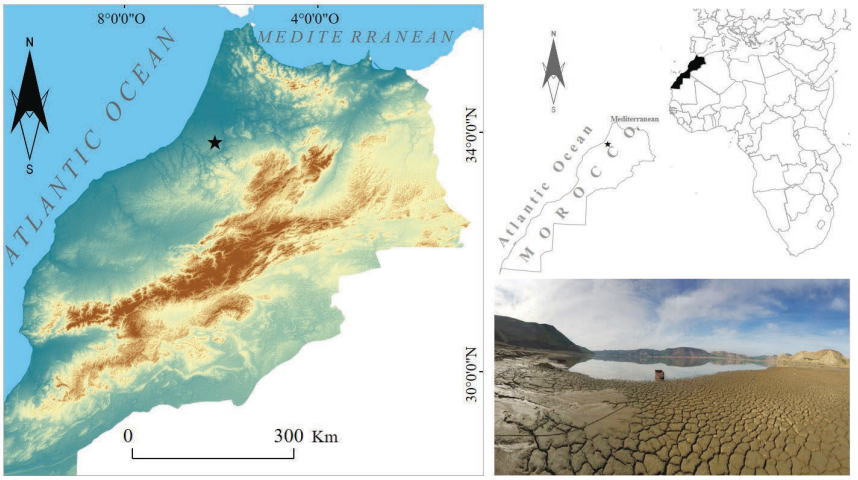

Fig. 1. Location and view of Al Kansera dam in Morocco.

Sinanodonta woodiana is distinguished from other species of Moroccan Unionidae of the genus *Anodonta* Lamarck, 1799 by its more rounded and swollen general shape (Fig. 2), fragile shells of irregular rhombic shape with clear growth lines and variable colour, from green to brown or blackish, sometimes with a greenish hue (Munjiu *et al.*, 2020).

Fig. 2. Shells of *S. woodiana* external view (L: 15cm): A, internal view: B, details of umbo sculpture with concentric wavelike folds: C, several empty shells *in situ*: D.

DISCUSSION

Since its first detection in Romania in 1979 and in Hungary in 1980 (Sárkány-Kiss 1986), *S. woodiana* expansion has continued in many water bodies and river basins around the world, often with the introductions of fish (Bastin *et al.* 2014; GBIF 2021). Many fish species are known to be suitable hosts of *S. woodiana*, mainly the common carp *Cyprinus carpio* (Linnaeus, 1758), the bighead carp *Hypophthalmichthys nobilis* (Richardson, 1845) and the silver carp *H. molitrix* (Valenciennes, 1844) which share the same native range as the giant Chinese pond mussel (Paunovic *et al.*, 2006). These Asiatic cyprinid fish have served as a vector of its introduction in many countries (Adam, 2010) and eventually in Morocco. The Al Kansera reservoir has been subjected to many introductions of freshwater fish and *S. woodiana* appeared to be released accidentally, most probably with the herbivorous "Chinese carp", which hosts its glochidia, as happened elsewhere (Yurishinets & Korniushin, 2001; Munjiu *et al.*, 2020).

Sinanodonta woodiana can reach high densities and biomass in invaded areas, being more competitive than the native species (Kraszewski & Zdanowski, 2007; Munjiu *et al.*, 2014). The high tolerance of *S. woodiana* to bottom substrates as well as to a wide range of environmental factors, such as temperature, water pollution and eutrophication, in addition to its flexible host specificity, explains its huge success as global invader (Beran, 2008; Alba *et al.*, 2011; Huber & Geist, 2019; Urbańska *et al.*, 2021). The proliferation of *S. woodiana* poses a potential threat to native and often already threatened species of Unionidae, competing for both food and fish hosts to the glochidia (Douda *et al.*, 2012; Bastin *et al.*, 2014).

Invasive and alien species keep being recorded from the aquatic ecosystems of Morocco, leading to the formation of new communities of species with diverse interactions and unpredictable changes, especially in freshwater ecosystems including the Sebou River basin (Mabrouki *et al*., 2019a, b; 2020; Taybi & Mabrouki, 2020; Taybi *et al*. 2020a, b; 2021a). This unique ecosystem is home to a diverse array of animal and plant species, many of which are endemic, rare and vulnerable, including freshwater molluscs such as *Ifrania zerroukansis* Glöer, Mabrouki & Taybi, 2020, *Pikasia smenensis* Taybi, Glöer, & Mabrouki 2021 and *Gyraulus marocana* Mabrouki, Glöer & Taybi, 2022 (Glöer *et al*., 2020; Taybi *et al*., 2021b; Mabrouki *et al*., 2022). Including the Moroccan endemic Unionidae such as *Unio foucauldianus* Pallary, 1936 and the critically endangered *Pseudunio marocanus* (Pallary, 1918), these freshwater bivalves have particularly suffered from the degradation of streams and water bodies and are threatened to varying degrees (Gomes-dos-Santos *et al*., 2019; Sousa *et al*., 2019). Because of its recognized impacts and rates of spread, there is an urgent needto increase knowledge of the current invasive threat posed by *S. woodiana* at country or continental scale and effective management must be ensured.

ACKNOWLEDGEMENTS

Thanks are due to Ronaldo Sousa, for his valuable help and for improving this manuscript.

Received April 2, 2022

REFERENCES

Huber, V. & Geist J., 2019: Reproduction success of the invasive *Sinanodonta woodiana* (Lea 1834) in relation to native mussel species. Biological Invasions **21**(11), 3451–3465.

Adam, B., 2010: L'Anodonte chinoise *Sinanodonta woodiana* (Lea, 1834) (Mollusca, Bivalvia, Unionidae): une espèce introduite qui colonise le bassin Rhône-Méditerranée. MalaCo **6**, 278–287.

Alba, D. M., Tarruella, A., Prats, L., Guillén, G. & Corbella, J., 2011: Nova llista actualitzada dels molluscos continentals de Catalunya. Spira **4**(1–2), 39–69.

Bacalbasa-Dobrovici, N., 1984: Introduction de nouvelles espèces de poissons dans les pêcheries d'eau douce de la Roumanie. In: Commission européenne consultative pour les pêches dans les eaux intérieures. Documents présentés au Symposium sur l'amélioration des stocks dans le cadre de l'aménagement des pêcheries d'eau douce. Introductions et transplantations. Tenu à Budapest, Hongrie du 31 mai au 2 juin 1982 à l'occasion de la douzième session de la CECPI. EIFAC Tech.Pap./Doc.Tech. CECPI, (42) Suppl. Vol. **2**, 283–554. 827351.

Bastin, K., Mandorlo, G. & Charles, L., 2014: Découverte de l'Anodonte chinoise *Sinanodonta woodiana* (Lea, 1834) (Mollusca, Bivalvia, Unionidae) dans la Sèvre Nantaise (Poitou-Charentes, France). MalaCo **10**, 2–4.

Beran, L., 2008: Expansion of *Sinandonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) in the Czech Republic. Aquatic Invasions **3**(1), 91–94.

Bogan, A. E., Al-Fanharawi, A. A. & Lopes-Lima, M., 2021: First record of *Sinanodonta woodiana* and report for freshwater bivalves from Iraq (Mollusca: Bivalvia: Unionidae). Ecologica Montenegrina **46**, 52–60.

Bolotov, I. N., Bespalaya, Y. V., Gofarov, M. Y., Kondakov, A. V., Konopleva, E. S. & Vikhrev, I. V., 2016: Spreading of the Chinese pond mussel, *Sinanodonta woodiana*, across Wallacea: One or more lineages invade tropical islands and Europe. Biochemical Systematics & Ecology **67**, 58–64. DOI: 10.1016/j.bse.2016.05.018

Domagała, J., Łabęcka, A. M., Pilecka-Rapacz, M. & Migdalska, B., 2004: *Corbicula fluminea* (O. F. Müller, 1774) (Bivalvia: Corbiculidae) a species new to the Polish malacofauna. Folia Malacologica **12**(3), 145–148.

Douda, K., Vritlek, M., Slavik, O. & Reichard, M., 2012: The role of host specificity in explaining the invasion success of the freshwater mussel *Anodonta woodiana* in Europe. Biological Invasions **14**, 127–137.

Estebenet, A. L. & Martín, P. R., 2002: *Pomacea canaliculata* (Gastropoda: Ampullariidae): life-history Traits and their Plasticity. Biocell **26**(1), 83–89.

Fenoglio, E., Bonada, N., Guareschi, S., Lopez-Rodriguez, M. & Millan, A., 2016: Freshwater ecosystems and aquatic insects: A paradox in biological invasions. Biology Letters **12**, 20151075.

Fornillos, R. J. C., Que, G. C. L., Mendoza, R. V. D., Fontanilla, I. K. C. & Ong, P. S., 2020: Molecular identification of the Chinese Pond Mussel *Sinanodonta woodiana* (Lea, 1834) from Mindoro and Leyte Islands, Philippines. *Science* Dillman **32**, 77–96.

GBIF, 2021: *Sinanodonta woodiana* (I. Lea, 1834) in GBIF Secretariat (2021). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2022-04-01.

Gherardi, F., Genovesi, P., Scalera, R., Pöckl, M. & Kovác, V., 2007: *Biological invaders in inland waters: Profiles, distribution, and threats*. Invading nature: springer series in invasion ecology 2. Springer Netherlands: 733 pp.

Glöer, P., Mabrouki, Y. & Taybi, A. F., 2020: Two new valvatoid genera (Gastropoda, Hydrobiidae) from Morocco. Ecologica Montenegrina **30**, 124–128. DOI: 10.37828/em.2020.30.12

Gomes-dos-Santos, A., Froufe, E., Gonçalves, D., Sousa, R., Prié, V., Ghamizi, M., Benaissa, H., Varandas, S., Teixeira, A., Lopes-Lima, M., 2019: Freshwater conservation assessments in (semi-)arid regions: Testing river intermittence and buffer strategies using freshwater mussels (Bivalvia, Unionida) in Morocco. Biological Conservation **236**(2), 420–434

Karatayev, A. Y., Burlakova, L. E., Padilla, D. K., Mastitsky, S. E. & Olenin, S., 2009: Invaders are not a random selection of species. Biological Invasions **11**, 2009-2019.

Kraszewski, A. & Zdanowski, B., 2001: The distribution and abundance of the Chinese mussel *Anodonta woodiana* (Lea, 1834) in the heated Konin lakes. Archives of Polish Fisheries **9**(2), 253–265.

Mabrouki, Y., Taybi, A. F., Skalli, A. & Sánchez-Vialas, A., 2019a: Amphibians of the Oriental Region and the Moulouya River Basin of Morocco: distribution and conservation notes. Basic and Applied Herpetology **33**, 19–32. DOI: 10.11160/bah.134

Mabrouki, Y., Ben Ahmed R., Taybi, A. F. & Rueda, J., 2019b: Annotated checklist of the leech (Annelida: Hirudinida) species of the Moulouya river basin, Morocco with several new distribution records and an historical overview. African Zoology **54**(4), 199–214. DOI: 10.1080/15627020.2019.1671218

Mabrouki, Y., Taybi, A. F., Bahhou, J. & Doadrio, I., 2020: The first record of the green swordtail *Xiphophorus helleri* (Miller, 1966) (Poeciliidae) established in the wild from Morocco. Journal of Applied Ichthyology **36**(6), 1–6. DOI: 10.1111/jai.14105

Mabrouki, Y., Glöer, P. & Taybi, A. F., 2022: *Gyraulus marocana* sp. nov., a new freshwater snail species (Mollusca, Gastropoda, Planorbidae) from Morocco. Nature Conservation Research **7**(1), 1–5. DOI: 10.24189/ncr.2022.007

Munjiu, O., Șubernetkii, I., Andreev, N., Railean, N. & Toderaș, I., 2020: Distribution and Characteristics of the Invasive Alien Species *Sinanodonta woodiana* (Lea, 1834) (Bivalvia: Unionidae) in the Republic of Moldova. Acta Zoologica Bulgarica **72**(4), 531–538.

Munjiu, O., Toderas, I., Zubcov, E., Biletchi, L. & Shubernetski, I., 2014: Composition and distribution of benthic macroinvertebrates in the Prut River (2012–2013). Analele Științifice ale Universității „Alexandru Ioan Cuza" din Iași, s. Biologie animală **60**, 27–34.

Rahel, F. J., 2000: Homogenization of fish faunas across the United States. Science **288**, 854–856.

Reeders, H. H. & de Vaate, A. B., 1990: Zebra mussels (*Dreissena polymorpha*): a new perspective for water quality management. Hydrobiologia **200-201**(1), 437–450.

Sárkány-Kiss, A., 1986: *Anodonta woodiana* (Lea, 1834) a new species in Romania (Bivalvia, Unionacea). Travaux du Museum National d'Histoire Naturalle "Grigore Antipa" **28**, 15–17.

Sousa, R., Teixeira, A., Benaissa, H., Varandas, S., Ghamizi, M. & Lopes-Lima, M., 2019: Refuge in the sāqya: Irrigation canals as habitat for one of the world's 100 most threatened species. Biological Conservation **238**, 108209.

Taybi, A. F. & Mabrouki, Y., 2020: The American blue crab *Callinectes sapidus* Rathbun, 1896 (Crustacea: Decapoda: Portunidae) is rapidly expanding through the Mediterranean coast of Morocco. Thalassas **36**(2), 1–5. DOI: 10.1007/s41208-020-00204-0

Taybi, A. F., Mabrouki, Y., Chavanon, G. & Millán, A., 2020a: The alien boatman *Trichocorixa verticalis verticalis* (Hemiptera: Corixidae) is expanding in Morocco. Limnetica **39**(1), 49–59. DOI: 10.23818/limn.39.04

Taybi, A. F., Mabrouki, Y. & Doadrio, I., 2020b: The occurrence, distribution and biology of invasive fish species in fresh and brackish water bodies of NE Morocco. Arxius de Miscellania Zoologica **18**, 59–73. DOI: 10.32800/amz.2020.18.0059

Taybi, A. F., Mabrouki, Y. & Glöer, P., 2021a: First record of the New Zealand Mudsnail *Potamopyrgus antipodarum* (J.E. Gray, 1843) (Tateidae, Mollusca) in Africa. Graellsia. 77(2):e140. DOI: 10.3989/GRAELLSIA.2021.V77.303

Taybi, A. F., Glöer, P. & Mabrouki, Y., 2021b: Description of a new valvatoid *Pikasia smenensis* n. gen. n. sp. (Gastropoda, Hydrobiidae) from Morocco. Animal Biodiversity and Conservation **44**(2), 317–320. DOI: 10.32800/abc.2021.44.0317

Urbańska, M., Kamocki, A., Kirschenstein, M. & Ożgo, M., 2021: The Chinese pond mussel *Sinanodonta woodiana* demographically outperforms European native mussels. Scientific Reports **11**, 17058.

Vikhrev, I. V., Konopleva, E. S., Gofarov, M. Yu., Kondakov, A. V., Chapurina, E. Yu. & Bolotov, I. N., 2017: A tropical biodiversity hotspot under the new threat: Discovery and DNA barcoding of the invasive Chinese pond mussel *Sinanodonta woodiana* in Myanmar. Tropical Conservation Science **10**, 1–11.

Vitousek, P. M., D'antonio, C. M., Loope, L., Rejmánek, M. & Westbrooks. R., 1997: Introduced species: a significant component of human-caused global environmental change. New Zealand Journal of Ecology **21,** 1–16.

Watters, G. T., 1997: A synthesis and review of the expanding range of the Asian freshwater mussel *Anodonta woodiana* (Bivalvia: Unionidae). Veliger **40,** 152–156.

Yurishinets, V. I. & Korniushin, A. V., 2001: The new species in the fauna of Ukraine *Sinanodonta woodiana* (Bivalvia: Unionidae), its diagnostics and possible ways of introduction. Vestnik Zoologii **35**(1), 79–84. (In Russian).

Zhadin, V. I., 1952: Mollusca of fresh and brackish waters of the USSR. Vol. 43. Moscow – Leningrad: AN SSSR, 346 p. (In Russian).