

# First reliable record of *Mytilopsis sallei* (Récluz, 1849) (Bivalvia: Dreissenidae) in Vietnam

Konstantin A. Lutaenko<sup>1</sup>, Larisa A. Prozorova<sup>2</sup>, Ngo Xuan Quang<sup>3</sup> and Viktor V. Bogatov<sup>2</sup>

<sup>1</sup>*A.V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences (NSCMB FEB RAS), Vladivostok 690041, Russia*

<sup>2</sup>*Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok 690022, Russia (FSCEATB FEB RAS), Vladivostok 690022, Russia*

<sup>3</sup>*Department of Environmental Management and Technology, Institute of Tropical Biology, Vietnam Academy of Science and Technology, Ho Chi Minh City, Vietnam*

---

## ABSTRACT

The invasive Caribbean false mussel, *Mytilopsis sallei* (Récluz, 1849) (Dreissenidae), established in Asia during the 20<sup>th</sup> and 21<sup>st</sup> centuries, is recorded for the first time in southern Vietnam in brackish-water Ba Tai Lake (Kien Giang Province). Colonies of this species were found in 2017, mollusks were attached to stones on the muddy bottom, at a depth of 0.3-0.7 m and salinity of 15-20‰, and water temperature of up to 35-40°C. *M. sallei* was not registered in Bac Lieu Province (Mekong Delta), in mangroves of the Red River Delta and Con Dao Archipelago during recent surveys (2017-2019) as well not known in regional literature; closest localities are southern Thailand and Hainan Island.

**Key words:** *Mytilopsis sallei*, invasive species, brackish-water lake, Vietnam, new record.

## INTRODUCTION

The invasive Caribbean false mussel, *Mytilopsis sallei* (Récluz, 1849), the mussel-like bivalve species is well established in South, Southeast and East Asia during the 20<sup>th</sup> and 21<sup>st</sup> centuries (see a recent review: Tan and Tay (2018)). This species is originally known from the Caribbean islands and the Gulf of Mexico but then it was introduced to the Eastern Pacific via the Panama Canal to Fiji, Japan, Taiwan, Hong Kong, China (including Fujian, Guangdong, Guangxi and Hainan), the Philippines, Myanmar, Thailand, Singapore, Malaysia, India, northern Australia, Egypt

and Israel (Marelli and Gray 1983; Xu and Zhang, 2008; Huber, 2010; Tan and Tay, 2018). However, reliable records of *M. sallei* for Vietnam are non-existent (Cai and Li, 2002; Hylleberg and Kilburn, 2003; Thach, 2005; 2007; 2012; Huber, 2010; Tan and Tay, 2018) although Morton (1980) suggested that this species could arrive to Hong Kong as a biofouling component with small, wooden-hulled vessels of Vietnamese refugees and, equally possible, on ships of illegal Chinese immigrants. Here, we provide some data on occurrence of this species in southern Vietnam and its habitats.

## MATERIAL, METHODS AND REGIONAL SETTING

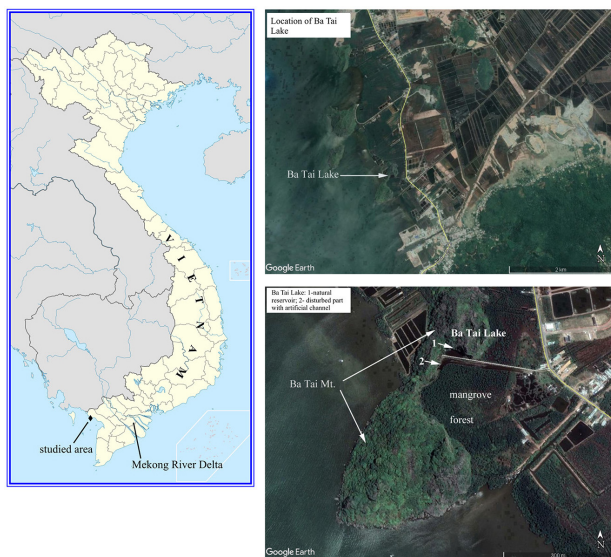
Alive mollusks were obtained during mangrove malacofaunal surveys in 2017-2018 by the joint research team of the Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS (Russia) and the Institute of Tropical Biology VAST (Vietnam) (Prozorova *et al.*, 2017; 2018) in Kien Giang Province

---

Received: December 16, 2019; Revised: December 23, 2019;  
Accepted: December 24, 2019

Corresponding author: Konstantin A. Lutaenko  
e-mail: lutaenko@mail.ru  
1225-3480/24751

This is an Open Access Article distributed under the terms of the Creative Commons Attribution Non-Commercial License with permits unrestricted non-commercial use, distribution, and reproducibility in any medium, provided the original work is properly cited.



**Fig. 1.** A mangrove area and Ba Tai Lake studied in Kien Giang Province (Kien Luong District) in southern Vietnam.

(southern Vietnam, Gulf of Thailand) (Fig. 1). In Vietnam, mangrove forests mainly grow along the sea coast of the Mekong Delta within Ca Mau and Bac Lieu provinces in the south, and around Red River Delta in the north (Veettil *et al.*, 2019). Besides this, a mangrove belt still covers part of the coastline in Kien Giang Province. Kien Luong District in this province is dissected by a network of canals, and, therefore, has some brackish-water characteristics. At the territory of An Binh Commune in Kien Luong District, brackish-water karst Ba Tai Lake (near Ba Tai limestone hills) was investigated as well. This area is well-known as a home for invertebrate and plant endemic species and a habitat of the Indochina silvery langur (*Trachypithecus germaini*), classified as endangered (EN) in the World Red List. In spite of this, mineral companies still plan to commercially explore limestone of Kien Luong including Ba Tai area. In connection with these plans, a dam was built in Ba Tai Lake split the lake into two parts—an original, deep-water part near the hills, and another, shallow part connected with a network of artificial channels and small shrimp ponds (Fig. 2). There are indications that the limestone Ba Tai hills, the brackish-water karst lake inside that formation as well as mangroves around hills are rich in endemic species



**Fig. 2.** Views of the channel in disturbed part of Ba Tai Lake where settlements of *Mytilopsis sallei* were found.

(Deharveng *et al.*, 2001; Prozorova *et al.*, 2017; 2018). In particular, the limestone karst supports a high diversity of cave invertebrates (Deharveng *et al.*, 2001), both terrestrial and aquatic, including local and regional endemics of Arthropoda and Mollusca. In a disturbed, shallow part of the Ba Tai Lake no endemic species have been found, but only a widely distributed gastropods and bivalves including invasive species, *M. sallei*, were recorded. Mollusks were hand-picked on the muddy bottom, at the depth of 0.3-0.7 m (Fig. 3). Then mollusks were fixed in 70% alcohol, partly dried as empty shells and deposited in the malacological collection of the Zoological Museum, Science and Educational Museum of the Far Eastern Federal University (ZMFU; Vladivostok).

## Results and discussion

Subclass **Heterodonta** Neumayr, 1884

Order **Venerida** Gray, 1854  
 Superfamily **Dreissenoidea** Gray, 1840  
 Family **Dreissenidae** Gray, 1840  
 Genus **Mytilopsis** Conrad, 1857  
*Mytilopsis sallei* (Récluz, 1849)

**Synonyms:** *Mytilus perviridis* Holten, 1802 (probable); *Dreissena domingensis* Récluz, 1852; *Tichogonia pfeifferi* Dunker, 1853; *Tichogonia rossmaessleri* Dunker, 1853; *Tichogonia riisei* Dunker, 1853; *Dreissenia gundlachii* Dunker, 1855; *Dreissenia mörchiana* Dunker, 1855; *Mytilopsis adamsi* Morrison, 1946; *Mytilopsis zeteki* Hertlein et Hanna, 1949; *Mytilopsis allyneana* Hertlein et Hanna, 1949.

**Taxonomy:** There was a long discussion in literature about status of the Indo-Pacific introduced *Mytilopsis*: some workers believed that *Mytilopsis adamsi* Morrison, 1946 is a separate species while others synonymized it with *M. sallei* (Tan and Tay, 2018) and the problem is still not resolved. Here we provide an enlarged synonymy assuming that *M. sallei* is correct name for this introduced species. Marelli and Gray (1985) suggested that *M. adamsi* is a widely distributed, introduced to the Indo-Pacific species whereas *M. sallei* is mainly Caribbean species. Huber (2010) shared this opinion and described some differences between the species: *Mytilopsis* found in the Gulf of Thailand and Japan grow larger and are identical to Panamic specimens of *M. adamsi* but they are larger, less trigonal, ventrally straighter and less hooked than the Caribbean *M. sallei*; *M. adamsi* has a comparatively small septum, whereas in *M. sallei* this is quite large; *M. sallei* is often whitish inside, whereas *M. adamsi* is generally bluish. A worldwide molecular study is needed to resolve this problem.

If *Mytilus perviridis* Holten, 1802 (type locality-India, Tuticorin, based on a Chemnitz's non-binominal work) would appear a valid name, this should be taken as priority binomen otherwise current name in wide use (either *M. sallei* or *M. adamsi*) can be declared as a nomen protectum. Huber (2010) suggested that type material of *M. perviridis* may be stored in the Zoological Institute RAS (St. Petersburg, Russia).

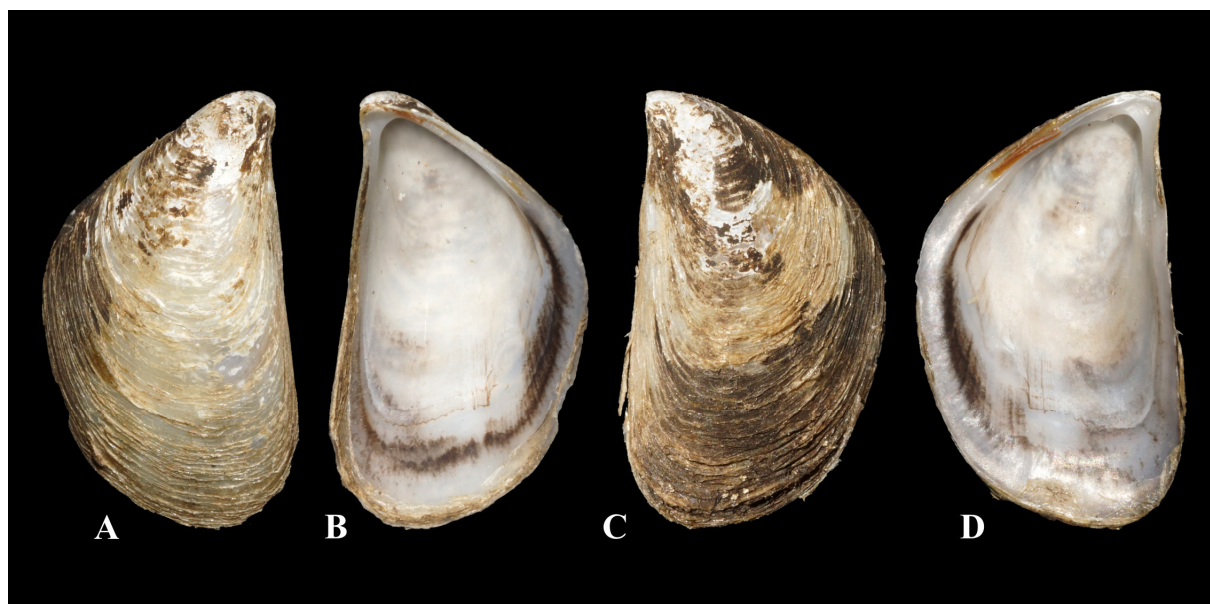
*Congerina hoeblichii* Schütt, 1989 tentatively regarded



**Fig. 3.** Colonies of *Mytilopsis sallei* (A) on the bottom of Ba Tai Lake; collected clusters of *M. sallei* (B).

by Huber (2010) as a synonym of *M. sallei* was recently re-assigned in a new genus *Rheodreissena* Geda, Lujan, Perkins, Abernethy, Sabaj et Gangloff, 2018, with three additional species from freshwaters of Brazil and Venezuela (Geda *et al.*, 2018; Mansur and Pereira, 2019).

**Morphology and anatomy** were described by Morton (1989) and Tan and Tay (2018). Generally, the shell is mytiliform, with the left valve slightly smaller than the right; the periostracum is thin, pale brown, some individuals may have pigmented, light to dark grey concentric markings (“black-striped mussel” is another name of this species), but Vietnamese specimens are black and dirty white; internally, the shell is white with brownish or black spots or stripes along the margin (Fig. 4). The internal ligament is located anteriorly, a septum and an apophysis are present. A byssal notch is present. The shell length is up to 35 mm.



**Fig. 4.** *Mytilopsis sallei* from Ba Tai Lake: right (A, B) and left (C, D) valves, external and internal views. Shell length 19.7 mm (reg. no. 52073/Bv-8139, ZMFU).

**Habitats:** It is intertidal to upper subtidal (2.5 m deep) species inhabiting freshwater and brackish-water lagoons, estuarine and also mangrove areas; it byssally attaches to stones, underside of rocks or shells in the mud, mangrove roots, also nestling in holes of wood, locally gregarious (Huber, 2010; both *M. sallei* and *M. adamsi*). Adults are able to survive over a wide range of salinities between freshwater and hypersaline conditions up to 50‰ and mollusks are tolerant to pollution (Tan and Tay, 2018). In Asia, its populations appear to be stable and persistent, and while localized they may be the dominant organism on intertidal and subtidal hard surfaces of sheltered, estuarine harbours and brackish water aquaculture farms (Tan and Tay, 2018). In Manila Bay, *M. sallei* does not exist in high abundance as opposed to similar conditions in Singapore and Thailand, due to its inability to compete with other bivalves, most notably green mussel *Perna viridis* and the oyster *Crassostrea bilineata* (Vallejo et al., 2019). In southern Vietnam, *M. sallei* was the most abundant in the shallow Bai Tai Lake covering stones on the muddy bottom, at the depth of 0.3-0.7 m, at salinity of 15-20‰, and very high water temperature in dry season, up to 35-40°C (Fig. 3).

**Some comments on introduction and impacts:**

According to Thai biologists (Wangkulangkul and Lheknim, 2008), the most likely routes of introduction *M. sallei* to southern Thailand (lower part of the Gulf of Thailand) are believed to be from larvae released in discharged ballast water or adults attached to a boat or ship's hull, rather than to a natural dispersal of the species; the occurrence of the mussel *M. adamsi* in south Thailand was probably the result of the accidental introduction by international ships traveling to Hong Kong and Singapore between the 1980s and 1990s. However, natural ways of regional dispersal of this species due to high abundance, ecological adaptability and relative proximity of already established populations should not be neglected.

*M. sallei* is a particularly aggressive invasive species due to its rapid reproductive and fast-growing capabilities; in India, Hong Kong, and Taiwan, this species causes severe fouling (Tan and Tay, 2018). This species has also occupied several lagoons in southern Thailand, attaching to fishing and aquaculture equipment in high densities (Wangkulangkul and Lheknim 2008). In southern Vietnam, abundance of *M. sallei* in Ba Tai Lake, although not estimated quantitatively, is also high pointing out its potential impact on aquaculture and

fisheries. Moreover, taking into account northern records of this species (Hong Kong, Taiwan and Japan), *M. sallei* can potentially be found in other Vietnamese regions. During our field survey in Bac Lieu Province (Mekong Delta), in mangroves of the Red River Delta and Con Dao Archipelago (Prozorova *et al.*, 2019), this species was not recorded. Mangrove bivalves of Vietnam are poorly known, yet in Khánh Hòa Province mangroves (south-central Vietnam), this species was not registered as well (Zvonareva *et al.*, 2019).

### ACKNOWLEDGEMENTS

Field surveys were supported by the Far Eastern Branch, Russian Academy of Sciences (grants Nos. 17-007 and 18-4-039, V.V. Bogatov, Principal Investigator) and Vietnam Academy of Science and Technology (grant VAST.HTQT.NGA.01/17-18, Ngo Xuan Quang, Principal Investigator). Photographs of *M. sallei* and maps were prepared by Mrs. Irina E. Volvenko (Science and Educational Museum, Far Eastern Federal University). Dr. Zhang Junlong (Institute of Oceanology CAS) kindly translated some Chinese texts. We are very grateful to these persons for their help.

### REFERENCES

- Cai, Y. and Li, H. (2002) Studies on the Bivalvia (Mollusca) of the Vietnam coast. *Journal of Zhanjiang Ocean University*, **22**: 1-13. [in Chinese with English abstract].
- Deharveng, L., Le, C.K. and Bedos, A. (2001) Vietnam. *In*; Encyclopaedia Biospeologica. Tome 3 (ed. by Juberthie, C., Decu, V.). Société Internationale de Biopéologie; International Society for Subterranean Biology (SIBIOS-ISSB), Moulis; Bucarest. P. 2027-2037. [in French].
- Geda, S.R., Lujan, N.K., Perkins, M., Abernethy, E., Sabaj, M.H. and Gangloff, M. (2018) Multilocus phylogeny of the zebra mussel family Dreissenidae (Mollusca: Bivalvia) reveals a fourth Neotropical genus sister to all other genera. *Molecular Phylogenetics and Evolution*, **127**: 1020-1033.
- Huber, M. (2010) Compendium of Bivalves. A Full-Color Guide to 3,300 of the World's Marine Bivalves. A Status on Bivalvia after 250 Years of Research. 901 pp. ConchBooks, Hackenheim.
- Hylleberg, J. and Kilburn, R.N. (2003) Marine molluscs of Vietnam: annotations, voucher material, and species in need of verification. *Phuket Marine Biological Center Special Publication*, **28**: 1-300.
- Mansur, M.C.D. and Pereira, D. (2019) Morphological assessment of *Rheodreissena* (Bivalvia: Veneroida: Dreissenidae) with an updated diagnosis of the genus, descriptions of two new species, redescription of *R. lopesi*, and the first account of larval brooding in New World dreissenids. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **166**: 1-45.
- Marelli, D.C. and Gray, S. (1983) Conchological redescrptions of *Mytilopsis sallei* and *Mytilopsis leucophaeata* of the brackish Western Atlantic. *Veliger*, **25**: 185-193.
- Marelli, D.C. and Gray, S. (1985) Comments on the status of recent members of the genus *Mytilopsis* (Bivalvia: Dreissenidae). *Malacological Review*, **18**: 117-122.
- Morton, B. (1980) *Mytilopsis sallei* (Récluz) (Bivalvia: Dreissenacea) recorded from Hong Kong: an introduction by Vietnamese refugees? *Malacological Review*, **13**: 90-92.
- Morton, B. (1981) The biology and functional morphology of *Mytilopsis sallei* (Recluz) (Bivalvia: Dreissenacea) fouling Visakhapatnam Harbour, Andhra Pradesh, India. *Journal of Molluscan Studies*, **47**: 25-42.
- Prozorova, L.A., Ngo, X.Q. and Ternovenko, V.A. (2019) Aquatic and terrestrial mollusk of the Con Dao Archipelago (southern Vietnam): first result of malacological survey in March 2019. *In*; International Seminar on Biodiversity and Evolution of Mollusks, September 26-27, 2019, Vladivostok, Russia: Abstracts. NSCMB FEB RAS; RFEMS, Vladivostok. P. 58-59.
- Prozorova, L.A., Bogatov, V.V., Ngo, X.Q., Tran, T.T. and Hoang, N.S. (2017) The first report on mollusk fauna in the Kien Luong mangrove forest (Kien Giang Province, Vietnam). *In*; Bien Dong 2017, Science for Blue Growth in the South China Sea, Nha Trang, Khanh Hoa, Vietnam, 12-14 September 2017: Abstract Book. Institute of Oceanology VAST, Nha Trang. P. 32.
- Prozorova, L.A., Lutaenko, K.A., Bogatov, V.V., Ngo, X.Q. and Tran, T.T. (2018) Mangrove mollusk fauna of the Kien Giang Province in the Mekong River delta (South Vietnam). *In*; The 1<sup>st</sup> International Conference on Northeast Asia Biodiversity, September 17-21, 2018, Vladivostok, Russia: Abstracts. FSCEATB FEB RAS (Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS), Vladivostok. P. 67.
- Tan, K.S. and Tay, T. (2018) The invasive Caribbean *Mytilopsis sallei* (Bivalvia: Dreissenidae): a short review. *ASEAN Journal of Science and Technology for Development*, **35**: 133-139.
- Thach, N.N. (2005) Shells of Vietnam. 338 pp. ConchBooks, Hackenheim.

First reliable record of *Mytilopsis sallei* in Vietnam

- Thach, N.N. (2007) Recently Collected Shells of Vietnam. 384 pp. L'Informatore Piceno, Ancona.
- Thach, N.N. (2012) New Records of Molluscs from Vietnam. 276 pp. 48HrBooks Co., Akron (Ohio).
- Vallejo, B.M., Jr., Aloy, A.B., Ocampo, M., Conejar-Espedido, J. and Manubag, L.M. (2019) Manila Bay ecology and associated invasive species. *In*: Impacts of Invasive Species on Coastal Environments, Coastal Research Library 29 (ed. by Makowski, C., Finkl, C.W.). Springer. P. 145-169.
- Veettil, B.K., Ward, R.D., Ngo, X.Q., Ngo, T.T.T., Tran, H.G. (2019) Mangroves of Vietnam: historical development, current state of research and future threats. *Estuarine, Coastal and Shelf Science*, **218**: 212-236.
- Wangkulangkul, K. and Lheknim, V. (2008) The occurrence of an invasive alien mussel *Mytilopsis adamsi* Morrison, 1946 (Bivalvia: Dreissenidae) in estuaries and lagoons of the lower south of the Gulf of Thailand with comments on their establishment. *Aquatic Invasions*, **3**: 325-330.
- Xu, F. and Zhang, S. (2008) An Illustrated Bivalvia Mollusca Fauna of China Seas. 336 pp. Science Press, Beijing. [in Chinese].
- Zvonareva, S.S., Mekhova, E.S., Hà, V.T. and Kantor, Yu.I. (2019) Checklist of bivalve molluscs in mangroves of Khánh Hòa Province, Vietnam. *Molluscan Research*, **39**: 296-312.