Diversity of marine bivalves of Madura Island, Indonesia based on the collections of Museum Zoologicum Bogoriense

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Abstract. Bivalves (group of clams, mussels, cockles, etc.) are members of the Mollusca phylum, widespread in Indonesian waters. Madura Island is one of the large islands in the eastern part of Java Island, Indonesia. The Zoologicum Bogoriense Museum has the authority to store scientific collections, thus the specimens stored in this museum can serve as identification references as well as provide data on the richness of bivalves in a particular area. The purpose of this study was to describe the richness of marine bivalves on Madura Island, Indonesia based on the collections of the Muzeum Zoologicum Bogoriense (MZB). This research method was in-situ observational by examining a collection of bivalves in MZB until August 2017. The research data obtained were then analyzed descriptive-quantitatively. The results revealed that based on the collection of specimens of MZB, there were thirty-six species of marine bivalves belonging to fourteen bivalve families in Madura, namely Arcidae, Carditidae, Donacidae, Glycymeridae, Isognomonidae, Mactridae, Malleidae, Mytilidae, Pectinidae, Pinnidae, Psammobiidae, Pteriidae, Spondylidae and Veneridae. Field works need to be carried out to inventory the bivalves found on Madura Island.

1 Introduction

Madura Island is part of the East Java Province, which consists of the Bangkalan, Sampang, Pamekasan, and Sumenep Regencies [1]. Madura Island has a long coastline and many beaches with varied substrates. The beaches on the north coast are generally rocky and sandy [2,3], while the beaches on the south coast are generally sandy [4,5,6], muddy sand, and have denser mangrove vegetation [6]. Thus, these beaches are potential habitats for marine animals, such as bivalves and gastropods.

Several previous studies have reported the diversity of bivalves on the coasts of Madura Island. Wahyuni et al. [7] reported the distribution of *Solen* spp. on several beaches, namely Modung, Sreseh, Kaduara, and Pragaan. A previous study listed 38 bivalves of Modung Beach [8]. Another reported the occurrence of two donacid bivalves on Nepa Beach, Sampang [2]. Another study showed that there was a population of *Donax faba* from Pantai

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Tengket, Bangkalan [3]. In two beaches of Pamekasan, a population of *Solen* sp. has been reported, while in Barung Toraja Beach, Sumenep, eight species of bivalves were found [9]. Meanwhile, recently 21 species of bivalves from two beaches of Sampang, Madura were recorded [4,5].

Bivalves of Madura Island face threats and challenges. Threats to the diversity of bivalves and gastropods are caused, among others, by pollution, sedimentation, and the introduction of foreign species. Madura Island is located close to international shipping lines; hence it is possible for invasive species to enter this area because the larvae are accidentally carried through the ballast water of the ship [10]. Thus, direct inventory through sampling and collection activities on the beaches and coastal waters of Madura Island is needed. In addition, complete data on the richness of bivalves on Madura Island, can also be done by identifying and inventorying specimens in the Museum Zoologicum Bogoriense (MZB) collection, as previously done which inventoried the species richness of gastropods of Kepulauan Seribu based on the MZB collection [11]. Until now there has been no publication on the species richness of marine bivalves on Madura Island based on the MZB collection. Therefore, this study aims to inventory the species richness of marine bivalves of Madura Island based on the MZB collection.

2 Method

The data for this study were obtained by observing the bivalve specimens of the Museum Zoologicum Bogoriense (MZB). Observations were made on specimens from the MZB collection – National Research and Innovation Agency (BRIN) until August 2017. Specimens were identified up to the species level based on their morphological characteristics and then grouped by family, collection location, and collection date. Updating the classification and species name refers to the World of Register Marine Species (https://www.marinespecies.org/), which hereinafter selected only marine species. Data were analyzed by descriptive qualitative.

3 Results

Based on the collection of the Museum Zoologicum Bogoriense, it is known that there were thirty-six species of bivalves on Madura Island. These bivalves belong to fourteen bivalve families, including Arcidae, Carditidae, Donacidae, Glycymerididae, Isognomonidae, Mactridae, Malleidae, Mytilidae, Pectinidae, Pinnidae, Psammobiidae, Pteriidae, Spondylidae, and Veneridae. Veneridae, Pteridae, and Arcidae had the most number of species, each consisting of five species (Fig. 1, Table 1).

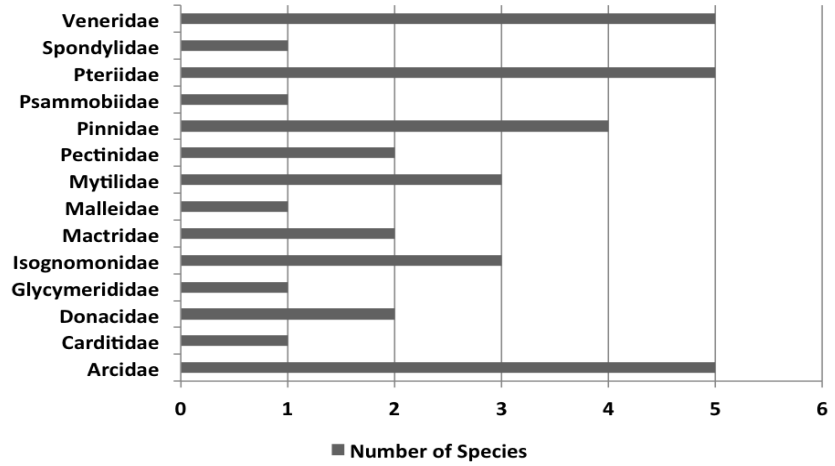

Fig. 1. Marine bivalves' families of Madura Island Based on the Collection of MZB

Table 1. Marine bivalves of Madura Island Based on the Collection of MZB

No.	Family	Species	
		Registered as	**Current Accepted Name***
1	Arcidae	*Anadara granosa*	*Tegillarca granosa* (Linnaeus, 1758)
		Anadara inflata	*Anadara broughtonii* (Schrenck, 1867)
		Arca bistrigata	*Mesocibota bistrigata* (Dunker, 1866)
		Barbatia decussata	*Barbatia decussata* (G. B. Sowerby I, 1833)
		Barbatia nivea	*Barbatia foliata* (Forsskål, 1775)
2	Carditidae	*Cardita cardioides*	*Cardites canaliculatus* (Reeve, 1843)
3	Donacidae	*Donax cuneatus*	*Latona cuneata* (Linnaeus, 1758)
		Donax faba	*Donax faba Gmelin, 1791*
4	Glycymerididae	*Glycymeris amboinensis*	*Tucetona pectunculus* (Linnaeus, 1758)
5	Isognomonidae	*Pedalion ephippium*	*Isognomon ephippium* (Linnaeus, 1758)
		Pedalion isognomum	*Isognomon isognomum* (Linnaeus, 1758)
		Pedalion perna	*Isognomon perna* (Linnaeus, 1767)
6	Mactridae	*Mactra antiquata*	*Mactra antiquata* Spengler, 1802
		Mactra violacea	*Mactra violacea* Gmelin, 1791
7	Malleidae	*Vulsella linguafelis*	*Vulsella rugosa* Lamarck, 1819
8	Mytilidae	*Lithophaga canalifera*	*Leiosolenus canaliferus* (Hanley, 1843)
		Modiolus elongatus	*Jolya elongata* (Swainson, 1821)
		Perna viridis	*Perna viridis* (Linnaeus, 1758)
9	Pectinidae	*Pecten singaporinus*	*Volachlamys singaporina* (G. B. Sowerby II, 1842)
		Pedum pedum	*Pedum spondyloideum* (Gmelin, 1791)
10	Pinnidae	*Atrina vexillum*	*Atrina vexillum* (Born, 1778)
		Pinna bicolor	*Pinna bicolor* Gmelin, 1791
		Streptopinna saccata	*Streptopinna saccata* (Linnaeus, 1758)
		Pinna inflata	*Atrina inflata* (Dillwyn, 1817)
11	Psammobiidae	*Asaphis deflorata*	*Asaphis deflorata* (Linnaeus, 1758)
12	Pteriidae	*Pinctada albina*	*Pinctada albina* (Lamarck, 1819)
		Pinctada chemnitzi	*Pinctada chemnitzii* (R. A. Philippi, 1849)

No.	Family	Species	
		Registered as	**Current Accepted Name***
		Pinctada fucata	*Pinctada fucata* (A. Gould, 1850)
		Pinctada maculata	*Pinctada maculata* (A. Gould, 1850)
		Pteria brevialata	*Pteria heteroptera* (Lamarck, 1819)
13	Spondylidae	*Spondylus ducalis*	*Spondylus sinensis* Schreibers, 1793
14	Veneridae	*Chione isabellina*	
		Gafrarium divaricatum	*Gafrarium divaricatum* (Gmelin, 1791)
		Gafrarium gibbia	
		Lioconcha castrensis	*Lioconcha castrensis* (Linnaeus, 1758)
		Meretrix meretrix	*Meretrix meretrix* (Linnaeus, 1758)

*Based on World of Registered Marine Species

Most of the specimens of Madura Island do not know the specific collection location. Meanwhile, it is known that the collections of Madura Island deposited in MZB come from Prenduan Beach, Nepa, and Jumiang. There are fourteen species collected from Jumiang Beach (Figure 2).

Based on the date of collection, it can be known that the first specimen from Madura Island was collected in 1914. Furthermore, there was no further collection record for more than three decades. The newest collection was discovered in 2009. However, some collections on Madura Island do not include the year of collection (Figure 3).

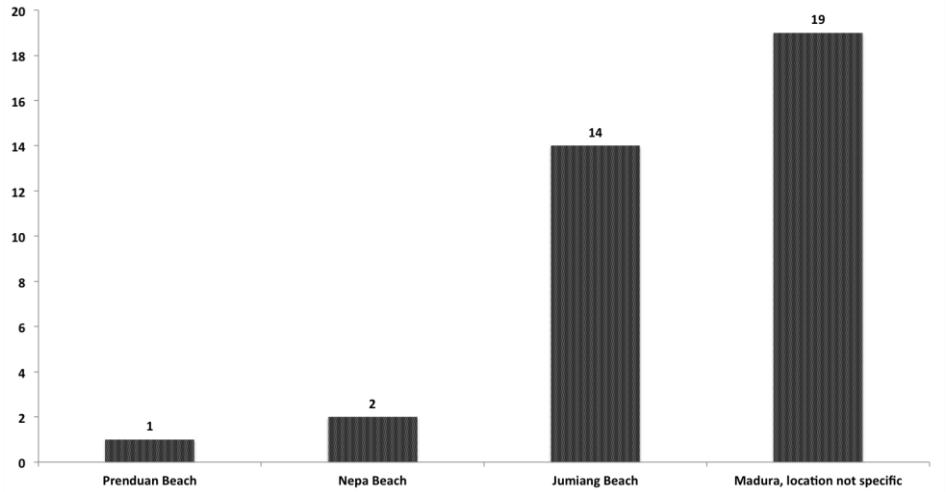

Fig. 2. Distribution of Marine Bivalves of Madura Island Based on Collection Location

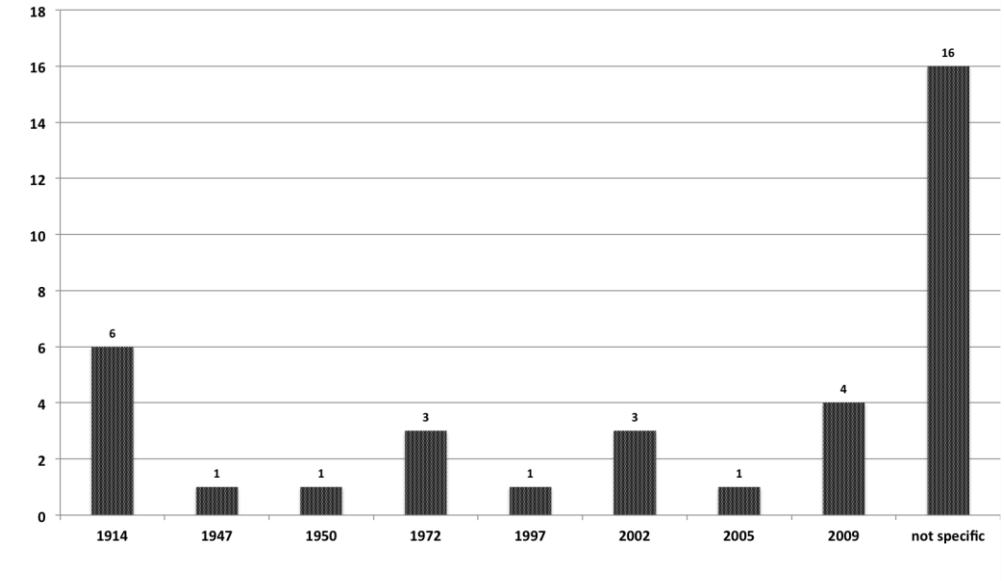

Fig. 3. Profile of Collection Date of Bivalves of Madura Island deposited in MZB

4 Discussion

Museum Zoologicum Bogoriense has a vital role in recording the biodiversity of fauna in Indonesia, including mollusks [11]. MZB has been used collection to inventory the gastropod species in the Kepulauan Seribu and recommended one of the islands in the archipelago as a gastropod conservation area [11]. Based on the MZB collection, it is known that there were 36 species of bivalves originating from Madura Island. The species richness of bivalves in Madura Island based on the MZB collection is less than that reported in scientific publications in this area, for example, a previous report showed that there were 38 species of bivalves from Modung Beach [8]. This is presumably because the specimen collection came from individual grants instead of the result of a survey visit, as was done at Kepulauan Seribu [11]. However, the number of families based on the MZB collection (Table 1) is almost the same as that reported in the publication. The same report also found that the 38 bivalves in Modung Beach bivalves that belong to 15 families, namely Arcidae, Cardiidae, Corbiculidae, Mactridae, Mytilidae, Ostreidae, Pectenidae, Pharidae, Propeamussiidae, Psammobidae, Pinnidae, Solenidae, Tellinidae, Veneridae, and Laternulidae [8]. Another study also reported several families similar to those collected at MZB, for example, Arcidae, Veneridae, Pinnidae, Ostreidae, Isognomonidae, and Mytilidae [5].

This diverse family corresponds to the varied coastal substrates of Madura Island. Veneridae and Donacidae are usually found on sandy beaches [2,12], while Arcidae, Tellinidae, and Mactridae are usually found on muddy bottoms [13]. On rocky beaches, Pinnidae, Ostreidae, and Isognomonidae are usually found [13]. *Tegillarca granosa* was collected at MZB in 1972, then the occurrence of this clam has often been reported on Madura Island, including in Bangkalan [14,15], Kwanyar [15[, Modung [8], Sreseh Sampang, Batu Putih [5,16], and Pamekasan [15]. These bivalves are commonly consumed and traded both on Madura Island and in the adjacent area of Madura Strait [17]. The edible *Meretrix meretrix* [18] was collected in 1997. Several studies have also reported the presence of *M. meretrix*, for example, in Modung [8], Sreseh, and Batu Putih [5,16]. Meanwhile, the date of collection of another member of Veneridae, namely *Grafarium divaricatum*, has not been specified.

The presence of *G. divaricatum* on Madura Island was rediscovered at Sreseh Beach and Batu Putih Beach [4,5].

Isognomon isognomum was collected at MZB in 1950. Among the three other members of Isognomidae, namely *I. ephippium, I. isognomum*, and *I. perna*, only *I. isognomum* was reported in a publication on Maduranese bivalves, at Sreseh Beach and Batu Putih [4,5]. These shells are collected by locals for consumption. Among the other four members of the Pinnidae that were collected from Madura Island, namely *Atrina vexillum, Pinna bicolor, Streptopinna saccata*, and *Pinna inflata*, only *A. vexillum* (collected in 2009) was reported in further publications and found at Sreseh Beach and Batu Putih [4,5]. These shells are also collected and consumed by local people. Based on the MZB collection, there were three species of Mytilidae found on Madura Island, namely *Leiosolenus canaliferus, Jolya elongata*, and *Perna viridis*. However, only *Perna viridis* was reported in further publications, namely at Modung Beach [8] and Sreseh Beach and Batu Putih, Sampang [4,5]. Several subsequent studies reported the presence of other Mytilidae members, namely from the genus *Modiolus* [8] on Modung Beach and the genus *Byssogerdius* on Badur Beach [19].

5 Conclusion

Based on the MZB collection, there were thirty-six species of bivalves on Madura Island. Bivalve survey activities in the field need to be carried out to inventory the bivalves found on Madura Island. In addition, researchers are encouraged to deposit bivalve samples obtained at MZB as the scientific national repository for fauna.

Acknowledgment

Thanks to DAPT-EQUITY Program, Lembaga Pengelola Dana Pendidikan (LPDP), Ministry of Finance, Indonesia for supporting this publication.

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